SB 911_Testimony_AditiBhargava.pdf
Uploaded by: Aditi Bhargava
Position: FAV

In favor of SB911
The views expressed here are my own based on my professional experience and not as a faculty member of UCSF.

Dear members of the Health and Government Operations committee:

Remember when the corn stalk was just a whisp and looked nothing like the present-day corn? Don't remember it? Neither do I. That was eons ago, like over eight thousand years ago. Crossbreeding and domestication gave rise to our present-day corn. Exchange of genetic information or crossbreeding is key for survival. In nature, this exchange of genetic information ***is unique to sexual reproduction***; even single cell bacteria undergo "sexual" reproduction periodically to maintain a diverse and healthy genome. They do so with different mating types and do not need to make eggs or sperms. Viruses are unique- they are neither living nor dead. They come to "life" in their hosts, and in the process of making copies of themselves, which they do by usurping host's resources, they also exchange information. Sometimes they steal from the host, sometimes they leave behind their or stolen genetic material in the host, thereby crosspollinating. This crosspollination can be beneficial or harmful or neither (dormant). Genetic modification techniques rely on using viruses and bacteria as vectors and hosts. Hence, regardless of the technique used, CRISPR, mRNA, viral vectors, bacterial plasmids- we cannot prevent or guarantee that exchange of genetic information will not happen. The unintended consequences of such exchanges remain largely unknown. But given that bacteria and viruses use a number of these techniques for their immunity and to evade our immune systems (for examples, CRISPR and RNA modifications, respectively), exchange or integration of these vectors and genes used for modification can have tremendous impact on the functioning of our immune systems and alter expression and function of other genes when consumed.

Recall the bit of green on tomatoes, strawberries, and many other fruits? That green "calyx" has a function- protection from pests and ripening. But without understanding the proper function of calyx, someone got the idea of removing that imperfection and forcibly modified the calyx of crops such as tomatoes, red delicious apples, strawberries, and many others to be perfectly red and "flawless". As a result, the fruits ripened too quickly or didn't ripen at all. And that also comprised their taste. Then to correct ripening error, another gene was introduced to delay ripening. How does that make sense? And despite several modifications, the fruits are now insipid and require ripening under artificial conditions. The latest focus is to remove bitter taste from green leafy vegetables. The bitter taste serves as a satiety signal and people who like bitter foods are relatively thinner. The absurdity of such modifications is beyond words. We are trying to correct issues that were never a problem to start with just because we have cool techniques, instead of focusing on the real problems.

I would like to end by giving an analogy. Many of us like fast and powerful cars. Some dream of owning a Ferrari or a McLaren, or driving a F1 car, an unachievable dream for most. Now imagine, if we could just swap the engine of an F1 racing car and put that into a Fiat or any regular car. Will the modified Fiat run faster than the unmodified one? Will it attain 0-120 mph faster than an unmodified Fiat? Will it give the driver the thrill of F1 car? Would we have achieved the goal of making an F1 car accessible for all? For sure we would have achieved many

of the listed goals. Will this modified Fiat qualify or is fit to race in a real-world F1 formula race? Perhaps it might be able to race with other similarly modified cars of different brands in controlled settings, but will it survive in the real race? Do these modified cars pose a real threat to the original Formula 1 cars? Should we now start tinkering with F1 cars so that these modified Fiats have a better chance of survival in the F1 world? For whose benefit, for what purpose, and at what cost? Keep in mind that the engine is only one part of the game. We need the whole nine yards- the chassis, fuel, the brakes, the tires, the bodyline, lighter material etc. We also need to keep in mind that the F1 cars don't race on regular tracks, are gas guzzlers and the race takes a huge toll on the cars. And the drivers? They are a special breed too and require special training and skills.

So where am I going with this? To modify just one genetic trait or part of a body to make it function better without equipping other parts of the body, whether in plants or animals, is short-sighted and causes more harm than good. To function accordingly with the higher functioning modification that we are trying to make comes at a price. At what stage does that price become apparent? If too much energy and too many resources have been used, will the stakeholders ever accept the mistakes? Or will they continue with the collateral damage no matter what at what cost. So, I urge you to consider that when we tinker with one gene or 1 aspect of a physiological function to try and improve that aspect, we do not fully understand the consequences that it might have on other unmodified traits and functions that go along with that particular trait. In the short term we may not be able to see the harms or understand the full spectrum of the adverse effects that we may experience, but in the long term we might impact not just the modified plant or Organism but the whole ecosystem.

Thank you,
Aditi Bhargava, PhD
Professor Emeritus
UCSF

Sequivity label USDA.pdf
Uploaded by: Alexandra Latypova
Position: FAV

Summary of Studies Supporting USDA Product Licensure

Establishment Name	Intervet Inc.
USDA Vet Biologics Establishment Number	165A
Product Code	19A5.R8
True Name	Swine Influenza Vaccine, N1 & N2, RNA Particle
Tradename(s) / Distributor or Subsidiary (if different from manufacturer)	Sequivity - Merck Animal Health
Date of Compilation Summary	June 24, 2022

Disclaimer: Do not use the following studies to compare one product to another. Slight differences in study design and execution can render the comparisons meaningless.

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<tr><td>Product Administration</td><td>Two doses, administered intramuscularly, three weeks apart.
NA1 (A/swine/IA/A01410307/2014 (H1N1)) – NA6 (A/swine/MN/A01483170/2014 (H1N1))
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*Lesion scores were calculated as the percentage of total lung area

Raw data are shown below.</td></tr>
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Table 1: Lung Lesion Scoring (LLS) by 1st Scorer

Pig ID	Treatment	DLA	DLC	DLD	DRA	DRC	DRD	VLA	VLC	VLD	VRA	VRC	VRD	INT	Total Lung Score	LLS
2904	Vaccinate	0.0	1.0	0.0	0.0	0.0	0.0	0.0	1.5	0.0	0.0	0.0	0.0	0.0	2.5	0.21
2908	Vaccinate	0.0	14.0	5.0	0.5	14.5	1.5	0.0	10.0	2.0	0.0	15.0	1.0	2.5	66.0	5.59
2913	Vaccinate	0.0	2.0	0.0	0.0	2.0	0.0	0.0	2.0	0.0	0.0	1.5	0.0	0.0	7.5	0.64
2914	Vaccinate	0.0	2.0	1.0	0.0	2.0	0.0	0.0	1.5	0.0	0.0	1.5	1.5	0.0	9.5	0.80
2915	Vaccinate	0.0	8.5	1.5	0.0	9.5	0.0	0.0	2.5	0.0	0.0	4.0	1.5	0.0	27.5	2.33
2920	Vaccinate	0.0	4.5	2.0	0.0	4.5	2.5	1.0	3.0	1.5	0.5	6.0	0.5	1.5	27.5	2.33
2924	Vaccinate	0.0	0.5	0.0	0.0	2.0	0.0	0.0	1.0	0.0	0.0	2.5	0.0	0.0	6.0	0.51
2927	Vaccinate	0.0	2.0	0.0	0.0	1.0	1.0	0.0	2.0	0.0	0.0	1.0	0.5	0.5	8.0	0.68
2932	Vaccinate	0.0	0.5	0.0	1.0	0.5	0.0	0.0	0.0	0.0	0.0	1.5	1.5	1.5	6.5	0.55
2935	Vaccinate	0.0	3.0	2.0	0.0	1.5	0.0	0.0	3.5	2.0	0.0	1.0	1.0	0.0	14.0	1.19
2945	Vaccinate	0.0	2.5	1.5	1.5	2.0	1.0	0.5	2.0	1.0	1.5	2.0	1.0	1.0	17.5	1.48
2947	Vaccinate	0.0	2.0	1.0	0.5	1.5	1.0	0.0	0.5	0.0	0.5	2.0	0.5	1.5	11.0	0.93
2957	Vaccinate	0.0	1.5	0.0	0.0	2.0	0.0	0.0	1.5	0.0	0.0	1.5	0.0	0.0	6.5	0.55
2959	Vaccinate	0.0	3.0	2.5	0.0	4.0	1.5	0.0	1.0	1.5	0.0	2.0	1.0	0.0	16.5	1.40
2972	Vaccinate	2.5	5.0	5.5	2.5	5.0	7.0	2.0	4.0	0.0	4.0	7.0	2.5	2.5	49.5	4.19
2975	Vaccinate	0.0	6.0	4.0	0.0	6.5	0.5	0.0	4.5	3.0	0.0	7.5	3.5	1.0	36.5	3.09
2983	Vaccinate	0.0	2.5	0.0	0.0	1.5	0.0	0.0	2.0	0.0	0.0	2.5	0.0	0.0	8.5	0.72
2986	Vaccinate	0.0	8.0	2.5	9.0	8.5	5.0	0.0	9.0	3.0	8.5	14.0	3.0	2.0	72.5	6.14
2987	Vaccinate	1.5	1.5	0.0	1.0	4.5	0.0	1.0	2.0	1.5	0.0	5.0	1.0	0.0	19.0	1.61
2990	Vaccinate	0.0	6.5	0.0	4.0	9.0	1.0	0.0	4.5	1.0	3.0	8.0	1.5	2.0	40.5	3.43
2901	Placebo	2.5	18.5	4.0	3.0	24.0	1.5	5.5	21.5	2.0	4.5	27.5	1.0	3.5	119.0	10.08
2910	Placebo	0.5	23.0	3.0	1.0	11.5	1.0	1.5	12.0	8.0	1.5	19.0	2.0	2.0	86.0	7.28
2916	Placebo	1.0	12.0	0.0	2.5	4.5	0.0	2.0	4.5	0.0	1.0	5.5	0.5	1.5	35.0	2.96
2918	Placebo	0.0	3.0	2.0	1.5	6.0	7.0	2.5	2.5	2.0	3.0	9.0	2.5	5.5	46.5	3.94
2919	Placebo	0.0	21.5	4.0	2.5	13.5	3.0	1.5	11.5	2.0	0.0	10.5	2.5	3.5	76.0	6.44
2922	Placebo	2.5	16.0	8.5	7.0	28.0	17.0	8.0	16.0	4.5	9.5	40.0	7.5	5.0	169.5	14.35
2923	Placebo	3.5	31.5	26.0	5.5	27.0	5.5	11.5	25.0	18.5	5.0	40.0	3.0	10.5	212.5	17.99
2933	Placebo	5.0	8.0	14.5	7.0	16.0	8.5	9.0	11.0	12.0	14.0	22.0	6.5	8.0	141.5	11.98
2934	Placebo	1.0	22.0	3.0	1.0	11.0	1.0	1.5	11.5	2.5	1.0	13.5	0.0	1.0	70.0	5.93
2941	Placebo	0.5	12.5	3.0	5.0	5.5	2.5	1.5	8.0	1.5	7.5	15.0	2.0	6.0	70.5	5.97
2946	Placebo	1.5	6.0	3.5	15.5	15.5	13.0	2.0	9.0	2.0	19.5	23.5	8.0	5.5	124.5	10.54
2952	Placebo	1.5	23.5	14.5	8.5	22.0	5.5	8.0	14.5	8.5	11.0	38.0	2.5	4.5	162.5	13.76
2956	Placebo	2.5	23.0	4.0	6.0	28.0	5.0	1.0	22.0	2.0	5.5	35.0	4.0	4.5	142.5	12.07
2977	Placebo	10.0	26.0	20.0	12.5	25.0	27.0	18.5	30.5	26.0	21.0	60.0	20.0	10.5	307.0	25.99
2982	Placebo	0.0	11.5	4.0	3.5	10.0	5.0	4.0	4.5	3.5	7.5	14.0	2.0	1.0	70.5	5.97
2984	Placebo	1.5	31.0	15.0	8.5	17.0	3.0	3.5	16.5	26.0	5.0	33.0	3.0	3.0	166.0	14.06
2993	Placebo	0.0	5.5	3.0	6.5	6.5	0.0	3.5	10.5	1.5	6.0	7.0	1.5	2.0	53.5	4.53
2994	Placebo	2.0	23.5	3.0	7.0	7.5	0.0	7.0	16.0	3.0	7.5	11.5	5.0	4.0	97.0	8.21

Code

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INT =	Intermediate Lobe		

Table 2: Lung Lesion Scoring (LLS) by 2nd Scorer

Pig ID	Treatment	DLA	DLC	DLD	DRA	DRC	DRD	VLA	VLC	VLD	VRA	VRC	VRD	INT	Total Lung Score	LLS
2904	Vaccinate	0.0	2.0	0.0	0.0	0.0	0.0	0.0	1.5	0.0	0.0	0.0	0.0	0.0	3.5	0.30
2908	Vaccinate	0.0	16.5	2.0	0.5	19.0	1.0	0.5	10.5	1.0	1.0	13.5	1.5	0.5	67.5	5.72
2913	Vaccinate	0.0	1.5	0.0	0.0	1.5	1.0	0.0	2.5	0.0	0.0	2.0	0.0	0.0	8.5	0.72
2914	Vaccinate	0.0	3.5	0.5	0.0	4.5	0.5	0.0	2.0	1.0	0.5	3.0	1.0	0.5	17.0	1.44
2915	Vaccinate	0.0	12.0	1.0	0.0	6.0	1.0	0.5	3.0	1.5	0.0	5.0	0.0	0.5	30.5	2.58
2920	Vaccinate	0.0	8.0	2.0	0.5	5.5	2.0	1.0	6.0	0.5	1.0	5.5	2.0	1.5	35.5	3.01
2924	Vaccinate	0.0	0.5	1.0	0.0	1.5	0.0	0.0	1.0	0.0	0.5	2.0	0.0	0.0	6.5	0.55
2927	Vaccinate	0.0	3.0	1.0	0.0	1.5	1.0	0.0	2.0	0.0	0.0	1.5	0.5	0.5	11.0	0.93
2932	Vaccinate	0.0	1.0	1.5	0.5	0.5	0.5	0.0	1.0	0.0	0.5	0.5	1.5	1.0	8.5	0.72
2935	Vaccinate	0.5	1.5	2.0	0.0	1.5	0.0	0.0	3.5	2.0	0.0	3.0	0.5	0.5	15.0	1.27
2945	Vaccinate	0.0	3.0	1.0	1.5	2.0	1.0	1.0	2.5	0.5	1.5	1.0	0.0	1.0	16.0	1.35
2947	Vaccinate	0.0	1.0	0.5	0.0	1.5	0.5	0.0	0.5	0.0	0.0	1.0	0.5	0.5	6.0	0.51
2957	Vaccinate	0.0	1.0	0.0	0.0	1.5	0.0	0.0	2.5	0.0	0.0	1.5	0.0	0.0	6.5	0.55
2959	Vaccinate	0.0	2.0	2.5	0.0	4.0	0.0	0.0	1.0	1.0	0.5	2.0	1.0	0.0	14.0	1.19
2972	Vaccinate	1.0	4.0	4.0	1.0	4.0	7.0	1.5	4.0	3.0	1.5	3.5	6.0	2.0	42.5	3.60
2975	Vaccinate	0.0	8.5	0.0	0.0	6.5	1.5	0.0	7.5	3.0	0.0	8.5	1.5	0.5	37.5	3.18
2983	Vaccinate	0.0	2.0	0.0	0.0	2.0	0.0	0.0	4.0	0.0	0.0	1.5	0.0	0.5	10.0	0.85
2986	Vaccinate	1.0	13.5	4.0	10.0	8.5	5.5	0.0	9.5	3.0	9.0	17.0	6.0	3.5	90.5	7.66
2987	Vaccinate	1.0	2.0	1.5	1.0	2.5	0.0	1.0	3.0	1.5	1.0	5.5	1.0	0.0	21.0	1.78
2990	Vaccinate	0.5	7.0	3.5	4.0	9.5	2.5	0.0	10.5	1.0	1.5	8.5	2.5	0.5	51.5	4.36
2901	Placebo	3.5	24.0	2.5	3.0	17.5	1.5	6.0	23.0	4.0	8.0	28.5	2.0	1.0	124.5	10.54
2910	Placebo	2.0	23.5	6.0	3.0	11.5	2.0	7.0	20.5	4.5	2.5	14.5	3.5	1.5	102.0	8.64
2916	Placebo	2.5	16.0	1.0	3.0	5.0	0.0	3.5	12.0	0.0	2.5	6.5	1.0	1.0	54.0	4.57
2918	Placebo	0.0	6.0	4.0	1.5	6.0	4.5	3.5	4.0	3.5	3.0	11.0	3.0	2.0	52.0	4.40
2919	Placebo	0.0	19.5	3.0	1.5	10.5	3.0	1.5	14.5	2.5	1.0	12.5	2.5	2.5	74.5	6.31
2922	Placebo	3.0	16.5	9.0	5.0	29.5	12.0	4.5	16.0	4.0	9.5	38.0	7.0	5.0	159.0	13.46
2923	Placebo	3.0	26.5	19.5	4.5	29.0	2.0	6.0	21.5	9.5	3.0	40.0	3.0	3.0	170.5	14.44
2933	Placebo	5.0	10.0	10.0	4.5	11.0	5.0	10.5	9.0	6.5	12.0	18.0	6.0	2.0	109.5	9.27
2934	Placebo	0.0	24.0	5.0	1.0	12.0	0.5	2.0	17.5	2.5	1.0	9.5	0.0	0.5	75.5	6.39
2941	Placebo	1.0	5.5	2.5	3.0	6.0	0.5	0.5	6.0	1.0	4.5	12.0	3.0	4.5	50.0	4.23
2946	Placebo	0.5	9.0	5.0	13.5	10.0	8.0	4.0	9.5	1.5	17.5	14.0	7.0	7.0	106.5	9.02
2952	Placebo	3.5	23.5	6.5	7.5	28.5	4.0	7.5	22.0	5.0	8.5	30.5	3.5	6.0	156.5	13.25
2956	Placebo	3.5	28.0	3.0	3.5	30.5	3.5	3.0	21.0	1.5	5.0	32.0	6.0	1.0	141.5	11.98
2977	Placebo	9.5	22.5	17.0	13.0	36.5	21.5	11.5	33.5	25.0	12.0	45.5	22.5	7.5	277.5	23.50
2982	Placebo	0.0	11.0	5.5	4.5	15.0	2.5	2.0	5.0	3.0	5.5	13.0	2.5	1.0	70.5	5.97
2984	Placebo	4.0	31.0	18.0	6.0	19.0	3.0	3.5	18.0	15.0	3.0	35.5	3.0	4.5	163.5	13.84
2993	Placebo	0.0	8.0	4.0	4.5	8.0	0.0	4.0	8.0	2.0	5.0	7.5	2.0	1.5	54.5	4.61
2994	Placebo	2.0	21.0	3.0	7.5	11.0	0.0	7.5	18.0	2.0	6.0	12.0	3.5	1.5	95.0	8.04

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<tr><td>Results</td><td>Five number summary for lung lesion scores*:
<table><tr><th>Group</th><th>Number</th><th>Minimum</th><th>Q1</th><th>Median</th><th>Q3</th><th>Maximum</th></tr><tr><td>Vaccinate</td><td>20</td><td>0.5</td><td>0.9</td><td>1.4</td><td>2.6</td><td>5.5</td></tr><tr><td>Placebo</td><td>20</td><td>0.9</td><td>6.2</td><td>10.1</td><td>13.5</td><td>20.4</td></tr></table>*Lesion scores were calculated as the percentage of total lung area

Raw data are shown below.</td></tr>
<tr><td>USDA Approval Date</td><td>June 5, 2020</td></tr>
</table>

Table 1: Lung Lesion Scoring (LLS) by 1st Scorer

Pig ID	Treatment	DLA	DLC	DLD	DRA	DRC	DRD	VLA	VLC	VLD	VRA	VRC	VRD	INT	Total Lung Score	LLS
5700	Placebo	2.00	31.50	15.50	5.00	28.00	6.00	8.50	38.00	12.50	4.50	52.50	4.50	3.50	212.00	17.95
5701	Placebo	2.00	30.00	20.50	7.50	22.00	30.50	6.00	28.00	12.00	8.00	33.50	27.00	11.50	238.50	20.19
5707	Placebo	1.50	29.50	3.00	0.00	27.50	14.00	3.00	28.00	2.00	0.00	46.50	17.00	17.00	189.00	16.00
5709	Placebo	2.00	13.50	4.00	1.00	17.00	4.00	2.50	10.00	5.00	1.00	14.00	7.00	3.50	84.50	7.15
5725	Placebo	0.00	17.50	6.00	0.00	16.00	2.50	0.00	10.00	3.00	0.00	11.50	3.00	1.00	70.50	5.97
5730	Placebo	3.00	13.00	6.00	1.00	9.00	6.50	5.00	7.00	4.00	0.00	7.50	5.00	0.00	67.00	5.67
5734	Placebo	0.00	7.00	0.00	1.00	3.00	2.50	3.00	5.00	0.50	1.00	4.00	1.50	1.50	30.00	2.54
5739	Placebo	3.00	17.50	2.00	1.00	22.50	12.00	6.50	17.00	2.50	1.00	32.50	16.00	6.50	140.00	11.85
5744	Placebo	0.00	23.00	5.50	0.00	25.50	13.00	1.50	15.00	5.00	1.50	31.50	9.00	8.00	138.50	11.73
5751	Placebo	1.00	24.00	12.50	5.50	25.00	8.50	3.00	18.50	19.00	4.00	33.50	7.50	3.50	165.50	14.01
5757	Placebo	1.50	22.00	13.00	2.00	21.50	7.50	2.50	15.00	8.00	1.00	17.00	7.00	1.50	119.50	10.12
5759	Placebo	4.50	31.50	35.00	9.00	27.50	19.50	6.00	20.50	13.50	8.00	26.50	23.00	5.50	230.00	19.48
5762	Placebo	8.00	15.00	2.50	2.00	28.00	43.50	7.00	15.50	3.50	2.50	24.00	35.00	11.50	198.00	16.77
5763	Placebo	1.00	21.00	18.50	2.50	16.00	17.50	3.50	13.00	9.50	3.50	10.00	15.50	2.50	134.00	11.35
5766	Placebo	1.00	7.50	2.00	1.50	9.00	7.50	2.50	10.00	0.50	1.00	8.50	7.00	2.00	60.00	5.08
5772	Placebo	4.50	16.00	2.00	0.00	25.50	5.00	3.50	16.50	2.50	1.00	34.00	5.50	7.50	123.50	10.46
5778	Placebo	0.00	15.00	5.50	1.00	16.50	4.00	0.50	11.00	4.50	0.50	12.00	4.00	5.00	79.50	6.73
5781	Placebo	3.00	23.00	10.00	4.00	12.50	7.00	4.00	29.00	5.50	2.50	13.00	11.00	3.50	128.00	10.84
5787	Placebo	0.00	13.50	3.00	0.00	27.50	7.00	1.50	6.00	1.50	1.00	26.50	5.50	6.50	99.50	8.43
5796	Placebo	0.00	2.50	1.50	0.00	2.50	0.00	0.00	2.00	0.00	0.00	2.00	0.00	0.00	10.50	0.89
5703	Vaccinate	2.00	3.00	2.00	2.00	4.50	2.00	2.00	2.00	1.00	1.50	4.00	1.50	0.00	27.50	2.33
5704	Vaccinate	0.00	4.00	1.50	0.00	2.50	0.00	0.00	2.50	0.50	0.00	0.50	0.00	0.00	11.50	0.97
5705	Vaccinate	0.00	8.00	7.00	2.00	6.50	7.00	0.00	6.00	4.00	2.00	7.00	4.00	6.50	60.00	5.08
5710	Vaccinate	0.00	1.00	0.00	0.00	8.00	4.00	0.00	1.50	0.00	0.00	5.50	0.00	1.00	21.00	1.78
5722	Vaccinate	0.00	2.50	1.50	1.00	1.50	0.50	0.00	2.00	1.00	0.00	1.00	2.00	0.00	13.00	1.10
5731	Vaccinate	0.00	4.00	4.50	0.00	3.50	3.00	0.00	3.50	1.50	0.00	3.50	1.50	0.00	25.00	2.12
5738	Vaccinate	0.00	1.50	0.50	0.00	2.00	0.50	0.00	3.50	0.00	0.00	2.50	0.50	0.00	11.00	0.93
5740	Vaccinate	0.00	2.00	1.00	0.00	2.50	1.00	0.00	2.00	1.00	0.00	1.50	1.00	0.00	12.00	1.02
5745	Vaccinate	0.00	3.00	1.00	0.00	3.50	2.00	0.00	3.00	0.00	0.00	3.00	0.00	0.00	15.50	1.31
5752	Vaccinate	0.00	2.00	0.00	0.00	2.00	0.00	0.00	1.50	0.00	0.00	2.50	0.00	0.00	8.00	0.68
5754	Vaccinate	1.00	2.00	1.50	1.50	3.00	0.50	0.00	3.00	2.00	1.50	3.50	1.50	1.50	22.50	1.91
5755	Vaccinate	0.00	3.00	0.00	0.50	2.50	0.00	0.00	2.50	0.00	0.00	2.50	0.00	0.00	11.00	0.93
5758	Vaccinate	0.00	5.00	4.50	0.50	6.00	2.00	0.00	5.00	3.50	0.50	5.00	3.00	0.00	35.00	2.96
5761	Vaccinate	0.00	12.00	7.50	0.00	8.00	5.00	0.00	4.50	3.00	0.00	7.50	7.00	3.50	58.00	4.91
5765	Vaccinate	0.00	8.00	6.50	0.50	7.00	3.50	0.00	5.50	4.00	1.00	5.00	2.50	1.50	45.00	3.81
5773	Vaccinate	0.00	1.50	1.00	0.00	1.00	0.00	0.00	1.50	0.50	0.00	0.00	0.00	0.00	5.50	0.47
5784	Vaccinate	1.00	7.00	1.50	1.50	9.00	2.00	1.00	6.00	2.00	1.50	8.00	2.50	2.50	45.50	3.85
5786	Vaccinate	0.00	4.00	0.00	0.00	2.50	1.50	0.00	3.50	0.00	0.00	3.00	1.50	0.50	16.50	1.40
5793	Vaccinate	0.00	1.50	0.00	0.00	1.00	0.00	0.00	2.00	0.00	0.00	1.00	0.00	0.00	5.50	0.47
5798	Vaccinate	0.00	2.00	0.00	0.00	1.50	0.00	0.00	2.50	0.00	0.00	1.50	0.00	0.00	7.50	0.64

Code

DLA =	Dorsal Left Apical Lobe	VLA =	Ventral Left Apical Lobe
DLC =	Dorsal Left Cardiac Lobe	VLC =	Ventral Left Cardiac Lobe
DLD =	Dorsal Left Diaphragmatic Lobe	VLD =	Ventral Left Diaphragmatic Lobe
DRA =	Dorsal Right Apical Lobe	VRA =	Ventral Right Apical Lobe
DRC =	Dorsal Right Cardiac Lobe	VRC =	Ventral Right Cardiac Lobe
DRD =	Dorsal Right Diaphragmatic Lobe	VRD =	Ventral Right Diaphragmatic Lobe
INT =	Intermediate Lobe		

Table 2: Lung Lesion Scoring (LLS) by 2nd Scorer

Pig ID	Treatment	DLA	DLC	DLD	DRA	DRC	DRD	VLA	VLC	VLD	VRA	VRC	VRD	INT	Total Lung Score	LLS
5700	Placebo	4.50	34.00	8.00	2.00	27.50	5.50	3.00	36.00	6.50	18.50	51.00	17.00	2.00	215.50	18.25
5701	Placebo	1.50	43.00	12.00	4.00	37.50	25.00	6.00	37.50	24.00	6.00	32.00	10.50	4.50	243.50	20.62
5707	Placebo	1.50	35.00	3.00	0.00	37.50	13.00	5.00	25.00	2.00	1.00	45.00	17.50	17.50	203.00	17.19
5709	Placebo	2.00	15.00	4.50	1.50	22.00	3.50	3.00	11.00	6.00	1.50	15.50	7.50	2.50	95.50	8.09
5725	Placebo	0.50	13.50	4.50	0.00	12.50	2.50	0.00	9.00	2.00	0.00	12.00	2.50	1.50	60.50	5.12
5730	Placebo	1.50	7.00	6.50	0.50	9.50	2.50	3.50	6.50	3.00	1.00	6.00	4.50	0.50	52.50	4.45
5734	Placebo	1.00	6.50	1.00	0.00	3.00	1.50	3.00	4.50	0.50	1.50	5.00	2.00	0.50	30.00	2.54
5739	Placebo	3.50	14.50	1.50	1.00	20.50	8.00	6.00	12.50	3.50	1.00	30.00	16.00	3.50	121.50	10.29
5744	Placebo	0.50	19.50	5.50	1.50	26.50	10.00	1.50	15.00	3.50	1.00	34.00	10.50	2.00	131.00	11.09
5751	Placebo	1.00	16.00	10.00	4.00	28.00	2.00	3.50	11.00	9.50	3.00	30.50	8.00	1.00	127.50	10.80
5757	Placebo	2.00	24.50	13.50	1.50	16.50	4.00	2.00	16.50	7.50	1.00	26.00	7.50	1.00	123.50	10.46
5759	Placebo	4.00	28.00	14.50	8.50	35.50	16.00	7.50	24.00	10.00	16.00	33.00	18.50	4.00	219.50	18.59
5762	Placebo	6.50	20.00	4.00	2.50	31.50	33.50	7.00	20.00	2.00	6.50	19.50	41.50	10.00	204.50	17.32
5763	Placebo	2.50	19.00	14.00	1.50	14.50	13.50	3.00	14.50	7.00	3.50	14.00	10.50	2.00	119.50	10.12
5766	Placebo	1.00	14.50	1.00	0.50	10.00	2.50	1.00	9.00	0.50	1.00	11.50	6.00	2.00	60.50	5.12
5772	Placebo	2.00	13.50	2.50	0.50	23.00	4.50	3.50	12.00	2.50	0.50	34.00	5.00	3.50	107.00	9.06
5778	Placebo	1.50	16.00	3.50	2.00	11.50	2.00	2.00	9.50	3.00	1.00	14.00	4.50	1.50	72.00	6.10
5781	Placebo	1.50	26.00	4.50	2.50	11.00	3.50	3.50	17.00	4.00	2.00	15.00	8.00	2.00	100.50	8.51
5787	Placebo	0.00	11.00	2.50	0.00	21.50	4.00	1.50	7.50	1.50	1.00	26.00	4.50	3.00	84.00	7.11
5796	Placebo	0.00	2.00	1.50	0.00	2.00	0.50	0.00	2.00	0.00	0.00	1.50	0.00	1.00	10.50	0.89
5703	Vaccinate	0.50	3.00	2.00	2.00	7.50	1.00	1.50	2.50	1.00	1.50	6.00	1.00	0.50	30.00	2.54
5704	Vaccinate	0.00	5.00	1.50	0.00	2.00	0.50	0.00	5.00	0.50	0.50	2.00	0.50	0.00	17.50	1.48
5705	Vaccinate	0.00	13.50	6.50	1.50	9.00	5.00	1.00	10.00	3.50	2.00	10.00	6.00	3.00	71.00	6.01
5710	Vaccinate	0.00	1.50	0.50	0.00	5.00	2.00	1.00	1.50	0.50	0.50	5.50	2.00	0.50	20.50	1.74
5722	Vaccinate	0.00	2.00	1.00	1.00	2.00	1.00	0.00	2.00	1.50	0.50	2.00	1.50	0.50	15.00	1.27
5731	Vaccinate	0.00	3.50	2.50	0.00	2.00	1.50	0.00	4.50	1.50	0.00	2.50	2.00	0.00	20.00	1.69
5738	Vaccinate	0.00	2.00	0.50	0.00	2.00	0.50	0.00	3.50	0.50	0.00	2.50	0.00	0.50	12.00	1.02
5740	Vaccinate	0.00	1.50	1.50	0.00	1.50	1.00	0.00	0.50	1.00	0.00	1.50	1.00	0.00	9.50	0.80
5745	Vaccinate	0.00	2.50	1.50	0.00	2.00	2.00	0.00	3.00	1.50	0.50	3.50	1.50	0.00	18.00	1.52
5752	Vaccinate	0.00	0.50	0.00	0.00	1.50	0.00	0.00	0.50	0.00	0.00	1.50	0.00	0.00	4.00	0.34
5754	Vaccinate	0.50	1.50	0.50	1.00	4.50	0.50	0.50	3.50	1.00	1.50	5.00	1.00	1.00	22.00	1.86
5755	Vaccinate	0.00	2.50	0.00	1.00	1.50	0.50	0.50	2.00	0.50	0.00	1.50	0.00	0.00	10.00	0.85
5758	Vaccinate	0.00	7.50	1.50	0.00	7.00	2.00	0.00	6.50	2.50	1.00	9.00	2.50	0.50	40.00	3.39
5761	Vaccinate	2.00	14.50	6.50	0.50	12.00	5.50	1.00	7.50	3.50	0.50	7.00	7.50	0.50	68.50	5.80
5765	Vaccinate	0.00	7.00	5.00	1.00	6.50	3.50	1.00	5.50	4.00	0.50	4.50	3.50	0.50	42.50	3.34
5773	Vaccinate	0.00	1.50	0.50	0.00	1.00	0.00	0.00	1.00	1.00	0.00	0.50	0.00	0.50	6.00	0.51
5784	Vaccinate	1.00	6.00	1.00	2.00	6.50	1.00	0.00	4.50	1.50	1.50	6.00	2.00	2.00	35.00	2.96
5786	Vaccinate	0.00	2.00	1.00	0.00	2.50	1.00	0.00	4.00	1.50	0.00	2.00	1.00	0.50	15.50	1.31
5793	Vaccinate	0.00	2.00	0.50	0.00	1.00	0.50	0.00	2.50	0.50	0.50	1.50	0.00	0.50	9.50	0.80
5798	Vaccinate	0.00	1.50	0.00	0.00	1.50	0.00	0.00	2.00	0.00	0.00	2.50	0.00	0.00	7.50	0.64

Code

DLA =	Dorsal Left Apical Lobe	VLA =	Ventral Left Apical Lobe
DLC =	Dorsal Left Cardiac Lobe	VLC =	Ventral Left Cardiac Lobe
DLD =	Dorsal Left Diaphragmatic Lobe	VLD =	Ventral Left Diaphragmatic Lobe
DRA =	Dorsal Right Apical Lobe	VRA =	Ventral Right Apical Lobe
DRC =	Dorsal Right Cardiac Lobe	VRC =	Ventral Right Cardiac Lobe
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INT =	Intermediate Lobe		

<table>
<tr><td>Study Type</td><td>Efficacy</td></tr>
<tr><td>Pertaining to</td><td>Swine Influenza Virus, H1N2</td></tr>
<tr><td>Study Purpose</td><td>Demonstrate efficacy against swine influenza virus, H1N2</td></tr>
<tr><td>Product Administration</td><td>Two doses, administered intramuscularly, three weeks apart.
NA1 (A/swine/IA/A01410307/2014 (H1N1)) – NA6 (A/swine/MN/A01483170/2014 (H1N1))
NA4 (A/swine/MI/A02077465/2015 (H1N2)) – NA2 (A/swine/IL/A01475495/2014 (H1N2))</td></tr>
<tr><td>Study Animals</td><td>Commercial pigs, three days of age at 1st vaccination; 32 vaccinates and 32 controls (placebo vaccinated).</td></tr>
<tr><td>Challenge Description</td><td>All pigs were challenged 38 days post second vaccination with swine influenza strain A/swine/Illinois/A01475495/2014 (H1N2)</td></tr>
<tr><td>Interval observed after challenge</td><td>Lung lesion scores were assessed 5 days post challenge on a subgroup of 20 vaccinates and 20 controls.</td></tr>
<tr><td>Results</td><td>Five number summary for lung lesion scores*:
<table>
<tr><th>Group</th><th>Number</th><th>Minimum</th><th>Q1</th><th>Median</th><th>Q3</th><th>Maximum</th></tr>
<tr><td>Vaccinate</td><td>20</td><td>0.5</td><td>0.7</td><td>1.2</td><td>3.1</td><td>6.9</td></tr>
<tr><td>Placebo</td><td>20</td><td>5</td><td>9.1</td><td>11.8</td><td>22.1</td><td>37.3</td></tr>
</table>
*Lesion scores were calculated as the percentage of total lung area

Raw data are shown below.</td></tr>
<tr><td>USDA Approval Date</td><td>August 12, 2020</td></tr>
</table>

Table 1: Lung Lesion Scoring (LLS) by 1st Scorer

Pig ID	Treatment	DLA	DLC	DLD	DRA	DRC	DRD	VLA	VLC	VLD	VRA	VRC	VRD	INT	Total Lung Score	LLS
3006	Vaccinate	0.00	1.50	1.00	0.00	1.00	1.50	0.00	1.00	0.00	0.00	1.50	0.00	0.00	7.50	0.64
3009	Vaccinate	0.00	2.00	1.00	0.00	3.50	1.00	0.00	2.50	1.00	0.00	2.50	1.50	0.00	15.00	1.27
3014	Vaccinate	0.00	2.50	1.50	1.00	5.00	0.00	0.00	3.50	2.00	1.00	3.50	0.00	0.00	20.00	1.69
3015	Vaccinate	0.00	5.00	4.50	0.50	4.00	1.50	0.50	4.50	3.00	0.00	5.50	1.50	0.00	30.50	2.58
3024	Vaccinate	0.00	5.00	2.00	0.00	0.00	0.00	0.00	4.50	0.00	0.00	0.00	0.00	0.50	12.00	1.02
3027	Vaccinate	0.00	3.50	1.50	0.00	5.00	0.00	0.00	2.00	1.50	1.00	3.50	0.00	0.00	18.00	1.52
3036	Vaccinate	0.00	10.00	5.00	8.00	12.00	5.50	1.00	8.50	2.00	7.50	9.00	5.00	2.50	76.00	6.44
3037	Vaccinate	0.00	1.50	0.00	0.00	1.50	0.00	0.00	1.50	1.50	0.00	1.00	1.00	0.00	8.00	0.68
3041	Vaccinate	0.00	3.50	1.00	0.00	1.50	0.00	0.00	3.00	0.00	0.00	2.00	0.00	0.00	11.00	0.93
3042	Vaccinate	0.00	1.50	3.50	0.00	1.00	0.00	0.00	2.00	0.00	0.00	1.00	0.00	0.00	9.00	0.76
3046	Vaccinate	0.00	1.50	2.00	0.00	1.50	0.00	0.00	0.50	0.00	0.00	1.50	0.00	0.00	7.00	0.59
3047	Vaccinate	1.00	7.00	4.50	0.50	7.50	4.00	1.00	4.50	4.00	1.50	7.00	3.00	1.00	46.50	3.94
3052	Vaccinate	0.00	2.00	0.00	1.00	2.00	1.00	0.00	3.50	0.00	1.00	2.00	1.00	0.00	13.50	1.14
3056	Vaccinate	0.00	2.00	0.00	0.00	1.50	1.00	0.00	2.00	0.00	0.00	2.00	0.00	0.00	8.50	0.72
3066	Vaccinate	0.00	19.00	6.50	1.00	9.00	1.50	0.00	15.00	4.50	2.00	14.00	1.50	3.50	77.50	6.56
3067	Vaccinate	1.00	4.00	1.50	0.00	5.50	1.00	0.00	5.00	2.00	0.00	5.00	1.50	0.00	26.50	2.24
3068	Vaccinate	0.00	6.50	8.00	1.00	5.00	5.00	0.00	4.50	2.00	0.50	3.50	1.50	2.00	39.50	3.34
3070	Vaccinate	0.00	5.00	9.50	2.50	3.50	6.50	1.00	6.50	5.00	2.00	10.50	6.50	2.00	60.50	5.12
3076	Vaccinate	0.00	3.50	2.00	0.00	1.00	2.50	0.00	4.50	0.50	0.00	2.50	1.50	0.00	18.00	1.52
3078	Vaccinate	0.00	6.50	5.00	1.50	2.50	5.00	0.00	6.00	3.50	1.00	3.00	4.00	0.00	38.00	3.22
3003	Placebo	4.00	21.00	7.50	2.50	20.00	5.00	7.00	17.50	6.00	3.00	30.50	4.50	14.00	142.50	12.07
3005	Placebo	0.00	8.50	7.00	0.00	14.00	0.00	0.00	8.00	5.50	1.00	10.50	3.00	3.00	60.50	5.12
3017	Placebo	2.00	10.00	13.00	3.00	17.50	6.50	2.00	8.50	5.00	2.50	11.00	7.50	1.00	89.50	7.58
3020	Placebo	4.50	25.00	21.50	21.50	27.50	5.50	5.50	34.00	9.50	17.00	32.00	4.00	7.50	215.00	18.20
3021	Placebo	0.00	10.50	20.50	1.00	30.00	2.50	3.00	14.00	10.50	1.50	32.50	6.50	5.50	138.00	11.69
3022	Placebo	0.00	16.50	3.00	1.50	15.50	1.50	4.00	14.00	1.00	1.50	18.50	2.50	3.50	83.00	7.03
3034	Placebo	1.50	12.50	10.50	1.50	17.00	12.50	2.50	9.00	6.50	2.00	21.00	5.50	6.50	108.50	9.19
3039	Placebo	0.00	8.00	10.50	10.00	17.00	4.50	1.50	10.50	3.00	8.50	23.00	7.00	2.50	106.00	8.98
3043	Placebo	12.00	37.50	13.50	9.50	24.00	11.00	11.50	52.00	19.00	26.00	57.00	6.50	19.00	298.50	25.28
3044	Placebo	0.00	16.00	11.00	0.00	31.50	9.50	3.00	11.50	4.50	0.00	37.50	4.50	12.50	141.50	11.98
3045	Placebo	14.50	42.50	36.00	10.50	31.00	16.50	26.50	52.00	63.00	9.00	68.00	31.50	34.50	435.50	36.88
3049	Placebo	4.50	33.00	12.00	7.00	18.00	24.50	9.00	28.50	12.00	12.50	47.00	20.00	13.00	241.00	20.41
3058	Placebo	12.00	23.00	31.50	13.50	28.50	18.50	16.00	24.00	36.50	15.00	43.50	20.50	16.50	299.00	25.32
3061	Placebo	0.00	23.00	3.00	9.50	22.50	17.50	1.50	14.00	2.00	7.50	19.00	10.00	4.00	133.50	11.30
3064	Placebo	5.00	38.50	20.00	4.50	29.50	15.00	16.00	52.00	16.50	8.00	47.00	18.00	8.00	278.00	23.54
3065	Placebo	0.00	18.00	9.00	2.00	21.50	9.00	1.00	14.50	4.00	2.00	15.00	5.50	3.50	105.00	8.89
3069	Placebo	2.00	18.00	15.50	5.50	15.50	19.50	4.50	9.50	11.00	5.50	28.50	13.00	7.00	155.00	13.12
3072	Placebo	6.00	25.50	21.50	10.50	27.50	38.50	10.00	23.50	27.00	18.50	43.00	36.50	24.50	312.50	26.46
3081	Placebo	6.50	24.00	37.00	1.00	31.50	24.50	13.00	32.00	31.50	4.50	46.00	35.00	15.00	301.50	25.53
3082	Placebo	3.50	17.00	29.00	1.00	19.50	26.50	10.00	12.00	36.00	1.00	41.50	20.00	20.50	237.50	20.11

Code

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INT =	Intermediate Lobe		

Table 2: Lung Lesion Scoring (LLS) by 2nd Scorer

Pig ID	Treatment	DLA	DLC	DLD	DRA	DRC	DRD	VLA	VLC	VLD	VRA	VRC	VRD	INT	Total Lung Score	LLS
3006	Vaccinate	0.00	1.50	0.50	0.00	1.50	1.00	0.00	1.00	0.00	0.50	1.00	0.00	0.00	7.00	0.59
3009	Vaccinate	0.00	2.00	1.00	0.00	4.00	1.00	0.00	1.50	1.00	0.00	2.00	1.00	0.50	14.00	1.19
3014	Vaccinate	0.00	0.50	1.50	0.00	2.50	0.00	0.00	1.00	2.50	0.00	1.50	0.00	0.50	10.00	0.85
3015	Vaccinate	0.50	3.50	1.50	0.00	3.00	1.50	0.50	4.50	2.50	0.00	3.00	1.50	0.00	22.00	1.86
3024	Vaccinate	0.00	2.50	0.50	0.00	0.00	0.00	0.00	1.50	1.00	0.00	0.00	0.00	0.00	5.50	0.47
3027	Vaccinate	0.00	1.00	2.00	0.00	2.50	0.00	0.00	2.00	0.00	0.00	2.00	0.00	0.00	9.50	0.80
3036	Vaccinate	0.00	9.00	2.50	4.50	6.50	5.00	0.00	9.50	2.00	6.00	8.00	4.00	1.50	58.50	4.95
3037	Vaccinate	0.00	1.00	0.00	0.00	1.50	0.00	0.00	0.00	0.00	0.00	2.50	0.00	0.00	5.00	0.42
3041	Vaccinate	1.00	3.50	0.50	0.00	2.00	0.00	0.00	3.00	0.00	0.00	1.50	0.50	0.00	12.00	1.02
3042	Vaccinate	0.00	0.00	2.50	0.00	0.00	0.00	0.00	2.50	0.00	0.00	0.00	0.00	0.00	5.00	0.42
3046	Vaccinate	0.00	1.00	2.00	0.00	0.50	0.00	0.00	0.50	1.00	0.50	0.00	0.00	0.00	5.50	0.47
3047	Vaccinate	0.50	4.50	2.50	0.00	7.00	3.50	0.00	4.00	2.00	0.00	7.50	4.50	0.50	36.50	3.09
3052	Vaccinate	0.00	2.00	0.50	0.50	2.00	0.00	0.00	3.00	0.00	1.50	1.00	1.50	0.00	12.00	1.02
3056	Vaccinate	0.00	1.50	0.00	0.00	1.00	0.00	0.00	1.50	0.50	0.00	2.00	0.00	0.00	6.50	0.55
3066	Vaccinate	0.00	24.00	7.00	1.50	9.50	2.50	1.50	17.50	5.00	2.50	11.00	2.00	2.00	86.00	7.28
3067	Vaccinate	1.00	8.00	3.00	0.00	9.00	1.00	0.50	5.50	2.50	0.00	9.50	1.00	1.00	42.00	3.56
3068	Vaccinate	0.00	7.00	5.50	1.50	6.00	3.00	0.50	7.00	3.00	2.00	9.50	1.50	2.00	48.50	4.11
3070	Vaccinate	0.50	5.00	8.50	1.00	6.00	4.00	0.00	5.50	5.00	2.00	7.00	7.00	2.50	54.00	4.57
3076	Vaccinate	0.00	2.00	3.00	0.00	1.50	0.50	0.50	1.50	0.00	0.00	2.00	1.50	0.00	12.50	1.06
3078	Vaccinate	0.00	4.50	5.50	0.50	2.00	3.50	0.00	4.00	2.50	0.50	2.00	5.00	0.00	30.00	2.54
3003	Placebo	2.00	19.00	4.00	3.50	28.00	3.50	6.50	19.50	6.00	3.00	24.50	4.50	12.50	136.50	11.56
3005	Placebo	0.00	11.50	5.50	0.00	11.00	0.00	0.00	10.00	3.00	1.00	10.50	4.00	1.50	58.00	4.91
3017	Placebo	1.50	5.50	9.00	1.50	26.50	8.00	4.50	9.00	8.00	3.00	20.50	10.00	1.50	108.50	9.19
3020	Placebo	4.50	26.50	13.50	9.00	27.00	3.00	8.50	30.50	12.00	20.00	37.00	4.50	5.00	201.00	17.02
3021	Placebo	0.00	11.00	13.50	0.00	26.50	2.00	2.50	13.50	8.50	2.00	33.00	5.00	3.50	121.00	10.25
3022	Placebo	0.00	11.50	2.00	3.00	11.50	0.50	1.00	13.00	0.50	0.50	16.00	2.00	2.00	63.50	5.38
3034	Placebo	2.00	11.50	5.50	1.50	30.00	7.00	1.00	11.50	4.00	1.50	21.50	5.50	6.50	109.00	9.23
3039	Placebo	0.50	8.00	6.50	9.50	18.50	2.00	2.00	9.50	7.00	10.00	22.00	10.00	0.00	105.50	8.93
3043	Placebo	10.00	32.50	15.50	17.50	37.00	11.00	15.50	48.50	20.00	30.50	53.50	10.50	24.50	326.50	27.65
3044	Placebo	0.00	21.50	6.00	0.00	28.00	7.00	4.00	11.00	6.00	0.50	33.00	7.50	13.00	137.50	11.64
3045	Placebo	16.50	34.00	44.00	8.50	36.50	28.00	25.00	52.00	72.00	10.00	57.00	32.50	29.50	445.50	37.72
3049	Placebo	3.50	32.50	13.00	6.00	19.00	16.50	7.50	31.00	13.00	10.00	32.00	10.00	7.50	201.50	17.06
3058	Placebo	10.00	25.50	18.00	5.50	22.50	12.00	14.50	29.50	28.50	10.50	38.50	17.50	14.00	246.50	20.87
3061	Placebo	0.00	21.50	3.00	6.50	26.50	8.00	2.00	15.50	3.50	5.00	21.00	7.00	2.00	121.50	10.29
3064	Placebo	4.50	30.50	15.00	4.50	41.50	16.00	9.00	36.50	14.00	9.00	33.00	17.00	7.00	237.50	20.11
3065	Placebo	0.50	12.00	6.50	3.50	18.00	8.50	1.00	12.00	4.00	3.50	22.00	6.50	1.50	99.50	8.43
3069	Placebo	2.00	12.00	10.00	4.50	17.50	11.50	2.50	9.50	6.00	2.50	32.00	11.50	3.00	124.50	10.54
3072	Placebo	7.50	29.00	19.00	8.00	30.00	14.00	10.00	26.50	17.00	8.50	40.00	33.50	25.00	268.00	22.69
3081	Placebo	4.00	22.00	17.00	1.50	36.00	27.00	12.00	24.00	30.00	6.50	45.00	33.50	10.50	269.00	22.78
3082	Placebo	4.50	13.50	14.50	0.00	29.00	14.00	6.00	17.50	26.00	1.50	30.00	15.50	15.50	187.50	15.88

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<table>
<tr><td>Study Type</td><td>Efficacy</td></tr>
<tr><td>Pertaining to</td><td>Swine Influenza Virus, H1N2</td></tr>
<tr><td>Study Purpose</td><td>Demonstrate efficacy against swine influenza virus, H1N2</td></tr>
<tr><td>Product Administration</td><td>Two doses, administered intramuscularly, three weeks apart.
NA1 (A/swine/IA/A01410307/2014 (H1N1)) – NA6 (A/swine/MN/A01483170/2014 (H1N1))
NA4 (A/swine/MI/A02077465/2015 (H1N2)) – NA2 (A/swine/IL/A01475495/2014 (H1N2))</td></tr>
<tr><td>Study Animals</td><td>Commercial pigs, three days of age at 1st vaccination; 31 vaccinates and 32 controls (placebo vaccinated).</td></tr>
<tr><td>Challenge Description</td><td>All pigs were challenged 34 days post second vaccination with swine influenza strain A/swine/Oklahoma/A01409770/2014 (H1N2, $N2_{1998}$ clade)</td></tr>
<tr><td>Interval observed after challenge</td><td>Lung lesion scores were assessed 5 days post challenge on a subgroup of 20 vaccinates and 20 controls.</td></tr>
<tr><td>Results</td><td>Five number summary for lung lesion scores*:
<table><tr><th>Group</th><th>Number</th><th>Minimum</th><th>Q1</th><th>Median</th><th>Q3</th><th>Maximum</th></tr><tr><td>Vaccinate</td><td>20</td><td>0.1</td><td>0.3</td><td>0.6</td><td>1.2</td><td>6.9</td></tr><tr><td>Placebo</td><td>20</td><td>1.9</td><td>4.3</td><td>7.2</td><td>9.8</td><td>17.2</td></tr></table>
*Lesion scores were calculated as the percentage of total lung area

Raw data are shown below.</td></tr>
<tr><td>USDA Approval Date</td><td>February 16, 2021</td></tr>
</table>

Table 1: Lung Lesion Scoring (LLS) by 1st Scorer

Pig ID	Treatment	DLA	DLC	DLD	DRA	DRC	DRD	VLA	VLC	VLD	VRA	VRC	VRD	INT	Total Lung Score	LLS
3	Placebo	2.00	2.50	2.00	1.50	9.50	1.00	3.50	3.00	1.50	3.00	15.00	2.50	4.50	51.50	4.36
5	Placebo	1.00	18.50	29.50	4.50	24.50	51.50	5.50	19.00	15.50	6.00	20.50	19.00	8.00	223.00	18.88
12	Placebo	1.50	8.50	2.50	8.00	6.00	1.00	2.00	8.50	3.00	7.00	6.00	3.00	2.00	59.00	5.00
16	Placebo	2.00	23.00	2.50	6.00	16.50	2.00	5.50	11.50	2.00	6.00	18.00	0.00	6.50	101.50	8.59
23	Placebo	2.00	8.50	1.50	3.00	10.50	3.00	3.00	4.50	1.50	2.00	12.00	3.00	2.50	57.00	4.83
25	Placebo	0.50	1.50	1.00	1.00	3.50	1.00	1.50	1.50	1.50	2.00	3.50	0.00	0.00	18.50	1.57
29	Placebo	1.50	13.50	0.00	2.50	21.00	3.50	2.50	11.00	0.00	2.00	16.50	1.50	5.50	81.00	6.86
32	Placebo	6.50	27.00	6.50	7.00	23.50	12.00	10.50	19.00	8.50	7.50	33.50	9.50	6.00	177.00	14.99
38	Placebo	0.00	6.50	4.00	2.00	5.00	5.00	1.50	4.00	3.00	2.50	6.50	2.50	0.00	42.50	3.60
39	Placebo	1.50	19.00	7.50	6.00	19.50	2.00	4.50	10.00	9.50	6.50	12.50	6.50	4.50	109.50	9.27
49	Placebo	3.00	25.00	2.00	7.50	26.00	7.50	3.00	32.50	8.00	6.00	51.00	10.50	8.50	190.50	16.13
50	Placebo	1.50	32.00	6.50	7.00	18.00	3.50	1.00	31.50	5.00	8.50	24.00	1.50	6.00	146.00	12.36
66	Placebo	0.50	9.00	0.00	3.50	6.50	0.50	0.00	11.50	0.50	4.00	8.50	1.00	5.00	50.50	4.28
68	Placebo	1.50	17.50	4.50	7.00	12.00	9.00	4.00	11.50	9.00	10.00	13.00	2.00	9.50	110.50	9.36
75	Placebo	0.50	15.50	6.00	7.50	23.50	21.50	9.00	20.50	18.00	7.00	32.50	15.00	13.00	189.50	16.05
76	Placebo	0.00	5.50	1.50	3.00	7.00	4.50	0.00	6.00	1.50	3.00	6.50	3.50	1.50	43.50	3.68
87	Placebo	0.50	16.00	3.50	2.50	19.00	1.00	2.00	12.50	0.50	3.00	15.50	2.50	5.00	83.50	7.07
88	Placebo	0.00	6.00	2.50	1.50	20.50	3.00	1.00	11.50	2.50	4.00	19.50	2.00	1.50	75.50	6.39
97	Placebo	0.00	0.00	0.50	8.50	24.00	10.50	0.00	0.00	0.00	8.00	23.00	8.00	5.00	87.50	7.41
99	Placebo	0.00	0.00	0.00	0.00	20.00	0.00	0.00	0.00	0.00	0.00	20.00	0.00	2.00	42.00	3.56
1	Vaccinate	0.00	8.00	6.50	0.00	16.50	11.50	0.00	8.00	8.50	0.00	19.50	8.50	1.00	88.00	7.45
6	Vaccinate	0.00	0.00	0.00	0.50	0.00	0.00	0.00	0.00	0.50	0.00	0.00	0.00	0.00	1.00	0.08
10	Vaccinate	1.00	4.50	1.50	1.00	1.50	1.00	0.50	2.50	1.00	0.00	0.00	1.50	0.50	16.50	1.40
13	Vaccinate	0.00	0.50	0.50	0.00	0.50	0.00	0.00	0.50	0.00	0.00	0.50	0.00	0.00	2.50	0.21
20	Vaccinate	0.00	1.50	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	1.00	0.00	0.00	3.50	0.30
24	Vaccinate	0.50	3.00	2.50	0.50	2.50	2.00	0.50	2.50	1.00	0.50	1.00	0.00	0.00	16.50	1.40
27	Vaccinate	0.00	1.50	2.00	0.00	3.00	1.50	0.00	1.00	0.50	0.00	3.00	1.00	0.00	13.50	1.14
28	Vaccinate	0.00	1.00	0.50	0.00	0.00	0.00	0.00	1.00	1.00	0.00	0.00	0.00	0.00	3.50	0.30
35	Vaccinate	0.00	1.50	2.00	0.00	1.00	0.00	0.00	1.00	1.50	0.00	1.00	0.50	0.00	8.50	0.72
37	Vaccinate	0.00	5.00	2.50	1.50	4.50	5.00	0.00	8.50	1.50	1.50	5.00	2.00	0.50	37.50	3.18
51	Vaccinate	0.00	3.50	0.00	0.50	1.50	0.50	0.00	1.00	1.00	0.50	1.00	0.50	0.50	10.50	0.89
55	Vaccinate	0.00	1.00	0.00	0.00	0.50	0.00	0.00	1.00	0.00	0.00	0.50	0.00	0.50	3.50	0.30
64	Vaccinate	0.00	2.50	1.00	0.00	4.50	0.00	0.50	2.50	0.50	0.50	3.50	0.00	1.50	17.00	1.44
69	Vaccinate	0.00	0.00	0.00	0.00	1.50	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	2.50	0.21
72	Vaccinate	0.00	1.00	0.00	0.00	2.00	0.00	0.00	1.00	0.00	0.00	1.50	0.00	0.00	5.50	0.47
77	Vaccinate	0.00	1.00	0.00	0.50	1.00	0.00	0.00	0.50	0.00	0.00	0.50	0.00	0.00	3.50	0.30
89	Vaccinate	1.00	16.50	2.50	0.00	3.50	0.00	0.00	4.50	1.00	0.00	3.00	0.50	1.00	33.50	2.84
90	Vaccinate	0.00	0.00	0.00	1.50	0.50	0.00	0.00	0.00	0.00	2.00	0.00	0.00	0.00	4.00	0.34
98	Vaccinate	0.00	1.50	1.00	0.00	1.50	0.50	0.00	1.50	0.50	0.00	1.00	1.00	0.50	9.00	0.76
100	Vaccinate	0.00	1.00	0.00	0.50	1.50	0.00	0.00	0.50	0.00	0.00	3.50	0.00	0.00	7.00	0.59

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INT =	Intermediate Lobe		

Table 2: Lung Lesion Scoring (LLS) by 2nd Scorer

Pig ID	Treatment	DLA	DLC	DLD	DRA	DRC	DRD	VLA	VLC	VLD	VRA	VRC	VRD	INT	Total Lung Score	LLS
3	Placebo	2.50	1.00	1.00	2.00	14.00	1.00	3.50	3.00	1.00	4.00	15.00	1.00	3.00	52.00	4.40
5	Placebo	1.50	20.00	17.50	3.50	16.00	42.50	7.00	18.00	8.50	4.00	16.00	21.50	8.00	184.00	15.58
12	Placebo	1.50	10.00	2.50	6.00	4.50	0.50	2.00	10.00	2.00	6.00	4.50	3.50	1.00	54.00	4.57
16	Placebo	3.00	16.00	2.00	11.00	11.50	1.50	5.00	15.00	1.00	10.50	17.50	1.50	4.00	99.50	8.43
23	Placebo	2.00	7.00	1.50	2.50	7.50	3.00	3.00	6.00	0.50	2.50	3.50	3.00	1.00	43.00	3.64
25	Placebo	0.50	2.00	2.00	2.00	7.00	1.50	1.00	1.50	1.50	2.00	4.50	0.50	1.00	27.00	2.29
29	Placebo	1.00	9.50	0.50	2.00	19.00	2.50	0.00	14.00	1.00	2.50	26.50	4.00	5.00	87.50	7.41
32	Placebo	9.00	23.50	8.00	3.00	24.50	7.50	10.50	18.50	7.00	10.00	36.00	9.00	1.00	167.50	14.18
38	Placebo	0.50	4.00	2.50	2.00	3.00	1.50	1.50	4.00	1.50	2.00	5.00	2.00	0.50	30.00	2.54
39	Placebo	2.50	18.50	6.00	5.50	13.50	3.00	3.50	14.50	6.00	7.00	20.50	2.00	2.50	105.00	8.89
49	Placebo	2.00	30.50	3.50	5.00	20.50	6.00	4.00	31.00	8.50	13.00	48.00	10.50	5.00	187.50	15.88
50	Placebo	1.00	30.50	3.50	5.00	19.50	1.00	1.00	31.00	3.00	6.50	24.50	2.50	12.00	141.00	11.94
66	Placebo	1.00	14.00	1.50	6.50	14.50	0.00	0.50	8.50	0.50	6.50	10.00	1.00	5.50	70.00	5.93
68	Placebo	1.00	13.50	4.50	6.00	6.00	4.50	2.50	10.00	5.50	12.00	12.50	2.50	5.00	85.50	7.24
75	Placebo	1.50	13.00	6.00	6.50	28.50	8.00	6.00	19.50	19.00	10.50	36.00	20.00	17.00	191.50	16.22
76	Placebo	0.50	5.00	0.50	2.00	5.00	2.00	0.00	5.50	0.50	3.00	5.50	2.00	1.00	32.50	2.75
87	Placebo	1.50	20.00	5.00	2.00	11.00	2.00	4.00	14.00	0.50	3.00	15.50	3.50	4.00	86.00	7.28
88	Placebo	0.00	7.00	4.00	2.50	13.50	5.50	1.00	12.00	2.50	4.50	22.00	3.50	3.00	81.00	6.86
97	Placebo	0.50	0.00	1.00	6.50	25.50	7.00	0.00	0.50	0.50	6.00	32.00	5.50	2.00	87.00	7.37
99	Placebo	0.00	1.00	0.00	0.00	22.50	0.00	0.00	1.00	0.00	0.50	15.50	0.00	3.50	44.00	3.73
1	Vaccinate	0.00	5.00	8.50	0.50	15.00	10.50	0.50	4.00	4.50	1.50	15.50	8.00	1.00	74.50	6.31
6	Vaccinate	0.00	0.00	0.50	0.50	0.00	0.00	0.00	0.00	0.50	0.00	0.00	0.50	0.50	2.50	0.21
10	Vaccinate	0.50	3.50	1.50	1.00	3.50	1.00	1.00	4.00	1.00	0.50	0.50	1.00	0.50	19.50	1.65
13	Vaccinate	0.00	0.50	0.50	0.00	0.50	0.50	0.00	0.50	0.50	0.50	0.50	0.00	0.50	4.50	0.38
20	Vaccinate	0.00	1.50	0.00	0.00	0.50	0.00	0.00	1.50	0.00	0.00	1.00	0.00	0.00	4.50	0.38
24	Vaccinate	0.00	1.00	1.50	0.00	1.00	0.00	0.50	3.50	1.00	0.00	2.00	0.50	0.50	11.50	0.97
27	Vaccinate	0.50	1.50	0.50	0.00	2.00	0.50	1.00	1.00	1.50	0.00	2.00	0.50	0.50	11.50	0.97
28	Vaccinate	0.00	1.00	1.00	0.00	0.00	1.00	0.00	1.00	1.00	0.00	1.00	0.00	0.00	6.00	0.51
35	Vaccinate	0.00	1.50	0.50	0.50	0.50	0.00	0.00	1.00	1.50	0.00	0.50	1.00	0.00	7.00	0.59
37	Vaccinate	0.00	8.50	3.50	1.00	4.00	3.50	1.00	9.00	1.50	2.00	8.00	2.50	0.50	45.00	3.81
51	Vaccinate	0.00	2.50	1.00	1.00	1.50	1.00	0.00	2.50	1.00	1.00	2.00	1.00	1.00	15.50	1.31
55	Vaccinate	0.00	0.50	0.00	0.00	0.50	0.00	0.50	1.00	0.00	0.50	0.50	0.00	0.00	3.50	0.30
64	Vaccinate	0.00	2.00	0.50	0.50	2.00	0.00	0.50	1.50	0.50	0.50	2.50	0.00	1.50	12.00	1.02
69	Vaccinate	0.00	0.00	0.50	0.00	0.50	0.00	0.00	1.00	0.00	0.00	1.00	0.00	0.50	3.50	0.30
72	Vaccinate	0.00	1.50	0.00	0.00	2.50	0.00	0.00	1.50	0.00	0.00	1.50	0.00	0.50	7.50	0.64
77	Vaccinate	0.00	1.50	0.00	0.50	1.00	0.00	0.00	0.50	0.50	0.00	0.50	0.00	0.00	4.50	0.38
89	Vaccinate	2.00	8.00	3.00	0.50	4.00	0.00	0.50	5.50	1.50	0.50	4.50	0.50	0.50	31.00	2.62
90	Vaccinate	0.50	0.00	0.50	1.00	0.00	0.00	0.00	0.00	0.00	2.00	0.00	0.00	0.00	4.00	0.34
98	Vaccinate	0.00	1.00	1.50	0.50	1.50	0.50	0.00	1.50	0.50	0.50	1.00	2.00	0.50	11.00	0.93
100	Vaccinate	0.00	1.00	0.00	0.50	1.50	0.00	0.00	1.00	0.00	0.50	2.00	0.50	0.00	7.00	0.59

Code

DLA =	Dorsal Left Apical Lobe	VLA =	Ventral Left Apical Lobe
DLC =	Dorsal Left Cardiac Lobe	VLC =	Ventral Left Cardiac Lobe
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INT =	Intermediate Lobe		

<table>
<tr><td>Study Type</td><td>Efficacy</td></tr>
<tr><td>Pertaining to</td><td>Swine Influenza Virus, H3N2</td></tr>
<tr><td>Study Purpose</td><td>Demonstrate efficacy against swine influenza virus, H3N2</td></tr>
<tr><td>Product Administration</td><td>Two doses, administered intramuscularly, three weeks apart.
NA1 (A/swine/IA/A01410307/2014 (H1N1)) – NA6 (A/swine/MN/A01483170/2014 (H1N1))
NA4 (A/swine/MI/A02077465/2015 (H1N2)) – NA2 (A/swine/IL/A01475495/2014 (H1N2))</td></tr>
<tr><td>Study Animals</td><td>Commercial pigs, three days of age at 1st vaccination; 32 vaccinates and 32 controls (placebo vaccinated).</td></tr>
<tr><td>Challenge Description</td><td>All pigs were challenged 34 days post second vaccination with swine influenza strain A/swine/Missouri/A01840724/2015 (H3N2, $N2_{2002}$ clade)</td></tr>
<tr><td>Interval observed after challenge</td><td>Lung lesion scores were assessed 5 days post challenge on a subgroup of 20 vaccinates and 20 controls.</td></tr>
<tr><td>Results</td><td>Five number summary for lung lesion scores*:
<table>
<tr><th>Group</th><th>Number</th><th>Minimum</th><th>Q1</th><th>Median</th><th>Q3</th><th>Maximum</th></tr>
<tr><td>Vaccinate</td><td>20</td><td>0.7</td><td>1.4</td><td>2.3</td><td>3.5</td><td>9.2</td></tr>
<tr><td>Placebo</td><td>20</td><td>4</td><td>5.7</td><td>10.5</td><td>13.7</td><td>21.2</td></tr>
</table>
*Lesion scores were calculated as the percentage of total lung area

Raw data are shown below.</td></tr>
<tr><td>USDA Approval Date</td><td>September 24, 2020</td></tr>
</table>

Table 1: Lung Lesion Scoring (LLS) by 1st Scorer

Pig ID	Treatment	DLA	DLC	DLD	DRA	DRC	DRD	VLA	VLC	VLD	VRA	VRC	VRD	INT	Total Lung Score	LLS
3111	Placebo	0.00	19.00	5.00	1.00	13.00	6.00	1.50	8.50	2.50	0.00	8.00	4.50	1.00	70.00	5.93
3114	Placebo	0.00	16.50	1.00	0.00	10.00	1.50	1.00	10.00	0.50	0.00	6.50	1.00	0.00	48.00	4.06
3116	Placebo	0.00	4.50	1.50	0.00	13.00	3.00	0.00	7.00	1.00	0.00	8.00	4.50	3.50	46.00	3.90
3120	Placebo	1.00	23.00	10.50	5.00	22.00	5.00	4.50	20.00	13.00	3.50	21.00	4.50	3.00	136.00	11.52
3121	Placebo	9.50	31.50	2.50	7.00	22.50	13.00	9.00	30.00	2.50	17.00	37.00	15.50	8.00	205.00	17.36
3122	Placebo	0.00	29.00	7.00	0.00	13.50	7.50	0.00	17.00	5.50	0.00	16.50	6.00	2.00	104.00	8.81
3126	Placebo	1.00	29.00	4.50	0.00	23.50	6.00	6.00	25.50	7.50	0.00	38.00	4.00	1.00	146.00	12.36
3128	Placebo	1.50	23.50	4.00	4.50	34.00	9.00	8.00	22.50	2.00	5.50	28.50	10.00	9.00	162.00	13.72
3132	Placebo	6.00	27.00	38.00	4.50	27.00	28.00	12.00	24.00	20.00	3.50	34.00	22.00	5.50	251.50	21.30
3133	Placebo	0.00	22.00	17.50	0.00	23.00	9.00	3.00	19.00	12.00	0.00	12.00	11.00	2.50	131.00	11.09
3142	Placebo	0.00	8.50	7.50	2.00	7.00	3.00	1.00	6.00	5.00	1.50	4.50	3.50	0.00	49.50	4.19
3143	Placebo	1.00	7.00	6.00	1.00	13.00	5.00	0.50	8.00	4.50	1.00	12.00	3.00	0.00	62.00	5.25
3156	Placebo	5.50	28.50	6.50	13.50	27.00	21.50	3.00	23.50	4.50	21.00	55.00	17.00	14.00	240.50	20.36
3159	Placebo	2.00	21.50	16.50	2.00	25.00	8.00	2.50	16.50	9.00	4.00	17.50	4.00	1.50	130.00	11.01
3163	Placebo	0.00	23.50	9.00	1.00	9.00	3.00	1.00	16.00	7.00	1.50	8.00	4.00	3.00	86.00	7.28
3164	Placebo	0.00	11.00	6.50	1.00	12.00	2.50	2.00	8.50	3.50	0.50	10.00	3.00	2.00	62.50	5.29
3172	Placebo	2.00	12.00	2.50	1.50	22.00	8.00	3.00	10.50	2.50	1.50	26.00	4.00	3.50	99.00	8.38
3182	Placebo	1.50	35.50	10.00	4.00	24.00	6.50	6.00	30.00	5.50	6.00	26.00	7.00	9.00	171.00	14.48
3185	Placebo	1.00	19.00	4.00	10.00	27.00	6.50	5.00	16.00	3.00	13.00	35.50	7.00	4.50	151.50	12.83
3191	Placebo	1.00	22.00	9.50	3.00	18.50	9.00	1.00	18.00	8.50	3.50	18.00	6.50	8.00	126.50	10.71
3113	Vaccinate	0.00	2.00	2.00	0.00	1.00	0.00	0.00	1.00	1.00	0.00	1.00	0.00	0.00	8.00	0.68
3115	Vaccinate	0.00	0.00	3.00	0.50	0.50	0.50	0.00	2.00	3.50	1.00	1.00	2.00	0.50	14.50	1.23
3117	Vaccinate	0.00	2.50	1.50	1.00	1.50	2.50	0.00	3.50	3.00	0.00	1.50	2.00	0.00	19.00	1.61
3118	Vaccinate	0.00	2.00	0.50	0.50	3.00	1.00	0.00	1.50	0.00	0.00	4.00	1.00	1.50	15.00	1.27
3123	Vaccinate	1.50	10.50	4.50	0.50	6.00	3.00	1.50	8.00	0.00	0.00	3.50	3.00	0.50	42.50	3.60
3127	Vaccinate	0.00	1.50	3.00	0.00	1.50	2.50	0.00	1.50	1.00	0.00	1.00	1.00	0.00	13.00	1.10
3129	Vaccinate	0.00	2.50	1.00	0.00	1.00	1.50	0.00	1.50	0.00	0.00	1.00	0.00	0.00	8.50	0.72
3130	Vaccinate	0.00	11.00	13.00	1.00	12.00	19.00	0.00	8.50	12.00	1.00	10.00	12.00	2.50	102.00	8.64
3136	Vaccinate	0.00	1.00	2.50	0.00	2.00	1.50	0.00	1.50	0.00	0.00	3.00	1.00	0.00	12.50	1.06
3140	Vaccinate	0.00	4.50	1.50	1.00	9.00	6.00	0.00	3.00	3.00	1.50	7.50	5.00	1.50	43.50	3.68
3144	Vaccinate	0.00	6.00	4.00	0.50	3.00	1.50	0.00	5.00	2.00	0.00	4.50	1.50	0.50	28.50	2.41
3145	Vaccinate	0.00	3.00	3.50	2.00	4.00	1.50	0.00	4.00	5.00	3.00	5.00	1.50	1.00	33.50	2.84
3154	Vaccinate	0.50	4.50	2.00	1.50	4.00	0.50	0.50	3.00	1.50	1.00	4.50	1.00	0.50	25.00	2.12
3155	Vaccinate	0.00	2.50	1.00	0.50	5.00	1.00	1.00	5.00	1.00	1.00	5.00	1.50	0.00	24.50	2.07
3162	Vaccinate	0.00	2.50	2.00	0.00	2.50	0.00	0.00	3.00	1.00	0.00	2.00	0.00	0.00	13.00	1.10
3166	Vaccinate	4.50	14.50	7.00	3.50	11.50	5.00	3.00	14.00	7.00	3.00	14.00	10.50	8.00	105.50	8.93
3179	Vaccinate	0.00	2.00	4.00	3.00	6.00	4.00	0.50	3.00	1.50	3.00	2.00	3.00	1.00	33.00	2.79
3180	Vaccinate	0.00	16.00	4.50	1.00	9.00	1.00	1.00	11.00	6.00	1.00	11.00	2.00	1.50	65.00	5.50
3186	Vaccinate	0.50	2.50	3.50	1.50	4.00	1.00	1.50	2.00	2.00	1.50	3.00	1.00	1.00	25.00	2.12
3188	Vaccinate	0.50	2.50	3.50	2.00	2.00	0.00	0.50	2.50	2.50	2.50	2.00	0.00	1.00	21.50	1.82

Code

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INT =	Intermediate Lobe		

Table 2: Lung Lesion Scoring (LLS) by 2nd Scorer

Pig ID	Treatment	DLA	DLC	DLD	DRA	DRC	DRD	VLA	VLC	VLD	VRA	VRC	VRD	INT	Total Lung Score	LLS
3111	Placebo	0.00	12.50	3.00	1.00	10.00	4.50	1.50	9.50	4.50	1.00	10.50	4.50	2.00	64.50	5.46
3114	Placebo	0.00	13.00	1.50	0.00	7.00	1.50	1.00	12.50	0.50	0.50	6.00	1.00	1.00	45.50	3.85
3116	Placebo	1.00	9.00	2.50	0.00	12.00	2.50	1.50	8.50	4.00	0.00	20.00	5.00	4.00	70.00	5.93
3120	Placebo	1.00	21.50	9.50	3.00	22.00	3.50	4.00	19.50	9.50	3.00	21.00	3.50	2.00	123.00	10.41
3121	Placebo	9.00	38.50	2.50	14.00	26.00	12.00	10.00	27.00	2.00	12.00	45.00	15.50	7.00	220.50	18.67
3122	Placebo	0.50	28.50	5.00	0.50	13.50	7.50	0.50	19.00	3.50	1.00	13.00	4.50	2.00	99.00	8.38
3126	Placebo	4.50	30.00	6.00	0.00	28.50	7.00	10.00	24.00	9.50	0.00	41.00	7.00	3.50	171.00	14.48
3128	Placebo	4.50	24.00	5.00	3.50	23.00	24.50	9.50	25.00	3.50	5.50	28.00	20.00	11.50	187.50	15.88
3132	Placebo	8.00	33.00	31.00	4.00	20.50	18.00	12.00	27.50	19.50	4.50	42.00	18.00	10.50	248.50	21.04
3133	Placebo	1.50	21.00	16.00	0.50	11.00	5.00	4.50	20.00	8.50	0.00	15.00	6.00	1.50	110.50	9.36
3142	Placebo	0.00	14.00	6.00	2.00	6.50	3.00	0.50	8.00	4.50	2.50	4.00	5.00	0.50	56.50	4.78
3143	Placebo	0.50	12.50	4.00	1.00	15.00	4.50	1.00	7.00	4.50	2.00	15.00	4.50	0.50	72.00	6.10
3156	Placebo	5.00	50.00	22.00	6.00	34.00	8.00	11.00	29.50	11.50	4.00	36.50	5.50	7.00	230.00	19.48
3159	Placebo	2.00	23.50	10.50	3.50	24.00	9.00	3.00	25.00	11.00	4.00	16.00	5.00	1.50	138.00	11.69
3163	Placebo	0.50	22.50	11.00	2.00	15.00	5.00	1.50	17.00	8.50	3.00	11.50	6.00	5.00	108.50	9.19
3164	Placebo	0.00	8.50	4.50	0.50	12.50	9.00	2.00	8.00	3.50	0.50	14.00	6.00	1.50	70.50	5.97
3172	Placebo	1.50	14.00	2.50	2.00	24.00	4.00	5.00	11.50	2.50	2.50	21.00	5.00	5.00	100.50	8.51
3182	Placebo	2.50	31.00	6.00	5.00	27.50	6.50	4.00	21.00	6.50	9.00	38.00	6.00	6.50	169.50	14.35
3185	Placebo	1.00	21.50	6.50	6.50	25.00	5.50	4.00	17.50	2.50	8.00	28.50	8.00	6.00	140.50	11.90
3191	Placebo	1.00	21.00	8.50	4.50	18.00	5.50	3.00	17.50	7.00	4.50	23.00	5.50	8.00	127.00	10.75
3113	Vaccinate	0.00	3.00	1.00	0.00	1.50	0.50	0.00	2.00	1.00	0.00	0.50	0.00	0.00	9.50	0.80
3115	Vaccinate	0.50	3.00	2.00	0.50	1.00	0.50	1.00	2.00	4.00	0.50	2.50	3.00	1.00	21.50	1.82
3117	Vaccinate	0.00	3.00	0.00	0.50	1.50	2.00	0.00	3.00	3.00	0.00	3.00	2.50	0.00	18.50	1.57
3118	Vaccinate	0.50	2.50	1.00	1.00	3.00	0.50	0.00	2.50	0.00	0.50	4.00	2.00	1.50	19.00	1.61
3123	Vaccinate	2.00	13.00	3.00	1.50	5.00	4.00	1.50	9.00	2.00	0.00	4.50	3.00	0.50	49.00	4.15
3127	Vaccinate	0.00	4.50	2.50	0.00	2.00	2.00	0.00	4.00	0.50	0.00	3.00	1.00	0.50	20.00	1.69
3129	Vaccinate	0.00	2.50	2.00	0.00	1.50	1.00	0.00	3.00	1.00	0.00	2.50	1.00	0.50	15.00	1.27
3130	Vaccinate	0.00	11.50	11.00	1.00	11.50	13.00	0.00	11.00	9.50	2.00	14.00	13.50	2.50	100.50	8.51
3136	Vaccinate	0.00	1.00	1.50	0.00	2.00	0.50	0.00	2.00	0.50	0.00	2.50	1.00	0.00	11.00	0.93
3140	Vaccinate	0.00	6.50	3.50	3.00	6.00	5.50	0.00	7.00	4.00	4.00	6.00	5.00	1.50	52.00	4.40
3144	Vaccinate	0.50	5.50	4.00	1.00	3.50	2.00	1.00	4.00	2.00	2.00	5.50	1.50	0.50	33.00	2.79
3145	Vaccinate	0.00	2.50	4.50	2.00	5.50	1.50	0.00	3.00	4.50	2.00	6.00	2.50	0.50	34.50	2.92
3154	Vaccinate	1.00	5.50	2.00	1.50	7.00	0.50	2.00	6.00	2.00	0.00	6.00	0.50	1.00	35.00	2.96
3155	Vaccinate	1.50	6.00	2.00	0.50	7.50	2.50	1.00	5.00	1.50	1.50	7.00	2.00	0.50	38.50	3.26
3162	Vaccinate	0.00	1.50	1.00	0.00	2.00	0.50	0.50	2.00	1.00	0.00	3.00	0.00	0.00	11.50	0.97
3166	Vaccinate	3.00	12.50	5.50	3.50	13.00	7.50	8.00	15.00	7.00	6.00	14.00	10.00	7.00	112.00	9.48
3179	Vaccinate	0.50	4.00	4.00	4.00	8.00	3.50	1.00	4.50	3.00	3.50	5.50	4.00	1.00	46.50	3.94
3180	Vaccinate	1.50	12.00	5.00	1.50	15.00	1.50	1.50	3.00	6.00	2.00	13.50	4.50	2.00	69.00	5.84
3186	Vaccinate	1.00	3.00	2.50	1.00	2.00	1.50	1.50	3.00	2.00	1.00	2.00	1.00	0.00	21.50	1.82
3188	Vaccinate	0.00	5.00	2.50	2.00	3.50	0.00	0.50	3.50	2.00	3.00	2.00	0.50	0.50	25.00	2.12

Code

DLA =	Dorsal Left Apical Lobe	VLA =	Ventral Left Apical Lobe
DLC =	Dorsal Left Cardiac Lobe	VLC =	Ventral Left Cardiac Lobe
DLD =	Dorsal Left Diaphragmatic Lobe	VLD =	Ventral Left Diaphragmatic Lobe
DRA =	Dorsal Right Apical Lobe	VRA =	Ventral Right Apical Lobe
DRC =	Dorsal Right Cardiac Lobe	VRC =	Ventral Right Cardiac Lobe
DRD =	Dorsal Right Diaphragmatic Lobe	VRD =	Ventral Right Diaphragmatic Lobe
INT =	Intermediate Lobe		

Study Type	Safety
Pertaining to	All
Study Purpose	Demonstrate safety of product under typical use conditions.
Product Administration	2 doses administered intramuscularly (IM) 3 weeks apart.
Study Animals	748 pigs, 3-5 days of age, distributed among 3 study sites.
Challenge Description	Not applicable
Interval observed after challenge	Animals were observed for systemic and/or local injection site reactions, and various adverse events (AEs) per VeDDRA guidance for 21 days after each vaccination, or until resolution.
Results	

Site	Total Number animals	Max. Size of injection site reaction			1st or 2nd Vaccination	Injection site reactions not observed
		<1.5 cm	1.5 to 5 cm	5 to 10 cm		
1	240	0	0	0	1	240
	226	33	19	1	2	173
2	247	8	0	0	1	239
	235	22	5	0	2	208
3	259	20	2	0	1	237
	253	7	2	0	2	244
Total All Sites	746	28	2	0	1	716
	714	62	26	1	2	625

VeDDRA Code	Total Animals	Percent of All Animals
No adverse events	525	70.20%
Anorexia	55	7.40%
Death	24	3.20%
Lameness	20	2.70%
Loss of Condition	12	1.60%
Diarrhea	11	1.50%
Unthrifty	7	0.90%
Anaphylaxis^	3	0.40%
Central Nervous System Disorder*	3	0.40%
Lethargy	3	0.40%
Respiratory Tract Infection*	3	0.40%
Arthritis	2	0.30%
Meningitis	2	0.30%
Musculoskeletal Disorder*	2	0.30%
Trauma*	2	0.30%
Abdominal Caviry Hernia	1	0.10%
Abscess*	1	0.10%
*Not otherwise specified		
^Related to IVP		

USDA Approval Date	December 13, 2021

SLatypova_mRNA_DNA vax in animals.pdf
Uploaded by: Alexandra Latypova
Position: FAV

Genetic vaccines (mRNA/DNA) in animal use

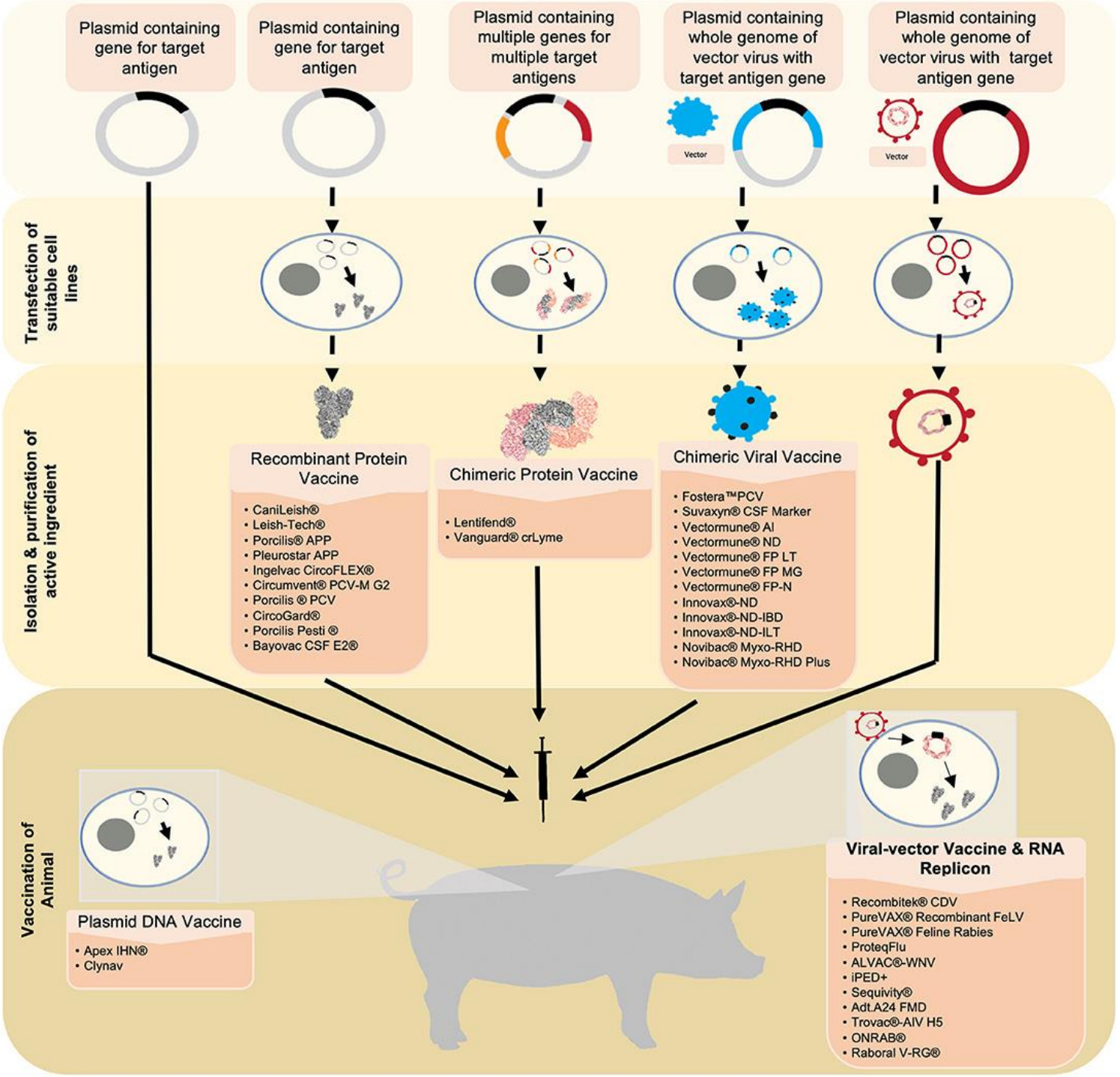
Implications for animal health, human health, our combined microbiome and environment

Special considerations for use as “Countermeasures under Public Health Emergency”

Sasha Latypova, latypova@hotmail.com

Summary

- Genetic biologics (DNA/RNA) have been licensed in the US for both human and veterinary vaccines, and as a new pesticide.
- Safety concerns include transfection of cells and genomes with non-self, non-species genetic codes, shedding risks, GMO status and transparent labeling.
- Ease of contamination and adulteration, difficulty of timely detection of same without highly specialized equipment and staff.
- Approval of “platform technologies” enables rapid production of biologics that are impossible to test for safety before mass deployment.



DNA plasmids are a common starting raw material for “new generation” of genetic vaccines

DNA plasmids “transfect” cells – transfer genetic code into another cell’s genome

- Viral vectors utilize engineered viruses that express the gene of interest. VV vaccines release the recombinant genes into the host cells.
- RNA replicon vaccines utilize RNA segment that encodes the desired antigens encapsulated in a vesicle carrier

Forcing Animal to Express NON-Self Proteins

- DNA vaccines are pushed as a method to control the uncontrollable – illness/death due to intense commercial farming methods:
  - Overcrowding, unnatural stressful conditions
  - Pollution with biologic and chemical waste

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Genetic DNA/RNA Vaccines for Animals/Fish

- 2005, APEX-IHN (Novartis/Elanco) for Atlantic salmon against Infectious Hematopoietic Necrosis Virus (IHNV), British Colombia.
- West Nile Innovator - DNA (Fort Dodge Animal Health/Pfizer) for West Nile virus in condors and horses.
- Oncept (Merial) against dog melanoma.
- In 2017, CLYNAV (Elanco), a polyprotein-encoding DNA vaccine against Salmon Pancreas Disease Virus (SPDV) infection in Atlantic salmon was authorized by the European Medicines Agency (EMA).
- Sequivity (Merck) in swine (2017) – Emergency use in Canada, fully licensed in US (USDA, 2021). “Platform” for making farm-specific injections based on RNA-particle technology.

Risks to human genome/biome are not properly studied, waived off as “small chance”… claim rapid degradation of DNA plasmids (in mice)…

6. Safety aspects

Some potential risks have been associated with DNA vaccination. With respect to the vaccinated host, these include integration into genome and disruption of biological processes, and potential unwanted immune responses such as auto-immunity or tolerance to the pathogen [175,176]. Limited data is available for fish, but no significant adverse effects on the host have been identified in initial safety testing in humans [177].

The risks to the consumer concerns the potential ingestion of any residual plasmid from food products, containing elements such as human viral promoter regions (such as the CMV promoter) or antibiotic resistance genes that could potentially have harmful consequences if integrating into the consumers' genome or taken up by their gut microflora. However, this risk is considered negligible since the consumer is one step removed from the presentation of vaccine to the vaccinated animal, and at the site of vaccine injection there is a rapid degradation of the plasmid, within 90 min after vaccination in mice [178]. Fast degradation of the plasmid has also been observed in fish [82]. Con-

Collins et al, “DNA Vaccines in Fish and Aquaculture” https://doi.org/10.1016/j.fsi.2018.07.012

DNA Plasmids Found in Fish Muscle 320 Days Post Vaccination!

Table 8. Persistence of plasmids in epaxial muscle of rainbow trout collected at different days post-vaccination (dpv) during the field trial.

Trial	Time Point (dpv)	Plasmid Detection pVax1-vhsG-Positive	pVax1-ihnG-Positive
Potency test	90	5 /5	5/5
Field trial	120	1/5	1/5
	160	3/5	3/5
	180	3/5	2/5
	210	2/5	2/5
	230	3/5	3/5
	260	4/5	0/5
	280	0/5	0/5
	320	6/15	6/15

Efficacy of DNA Vaccines in Protecting Rainbow Trout against VHS and IHN under Intensive Farming Conditions

by Andrea Marsella [1,*], Francesco Pascoli [1], Tobia Pretto [1], Alessandra Buratin [1], Lorena Biasini [1], Miriam Abbadi [1], Luana Cortinovis [1], Paola Berto [1], Amedeo Manfrin [1], Marco Vanelli [2], Simona Perulli [2], Jesper S. Rasmussen [3], Dagoberto Sepúlveda [3], Niccolò Vendramin [3], Niels Lorenzen [3] and Anna Toffan [1]

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* Author to whom correspondence should be addressed.

Vaccines **2022**, *10*(12), 2062; **https://doi.org/10.3390/vaccines10122062**

Both, vaccine or its recipients could become GMO, if genetic/biome integration is possible…

Vaccine products?

However, under EU legislation, DNA vaccines appear not to be considered as GMOs given the recent example of CLYNAV, a DNA vaccine against SPDV (see below). EU Directive 2001/18/EC defines "organisms" as any biological entity capable of replication or of transferring genetic material. GMOs are defined as organisms, with the exception of human beings, in which the genetic material has been altered in a way that does not occur naturally by mating and/or natural recombination. These definitions do not unambiguously exclude a plasmid, given that plasmids can replicate in bacterial cells and can transfer genetic material between bacteria, and that modified viral vectors, which also are incapable of replicating on their own, can be considered as GMOs. Nevertheless, the EU Commission has ratified the Cartagena Protocol (biosafety of GMOs in the environment) where it is stated that plasmids or naked genetic material are not considered as organisms [197] based on the criteria that the plasmid cannot replicate on its own. Given the decision that the DNA vaccine CLYNAV is not a GMO, then, unless a plasmid is deliberately modified to promote integration into a host genome, or to replicate in a eukaryotic host, it is unlikely to be considered a GMO under EU regulations.

Vaccinated animals? Humans?

The next consideration is whether DNA vaccinated animals are considered GMOs. Under Directive 2001/18/EC, Annex 1A, Part 1 lists techniques of genetic modification. Among others, this includes the insertion of nucleic acid material into plasmid vector systems, followed by administration of these into a host organism in which they do not naturally occur and where they are capable of continued replication. Secondly, techniques involving the direct introduction into an organism of replicating heritable material prepared outside the organism by micro- and macro-injection and microencapsulation. Therefore, the wording of EU directive 2001/18/EC does not specifically exclude the classification of DNA vaccinated fish as GMOs. However, in relation to DNA vaccines the plasmid will not replicate in the eukaryotic host, unless specifically modified to do so. Also, integration of the vaccine DNA into host cell (somatic or germinal) genomes is considered an unlikely event, as long as the plasmid is not specifically designed for this ([188]; Danish Medical Agency). Among European countries, only

Collins et al, "DNA Vaccines in Fish and Aquaculture" https://doi.org/10.1016/j.fsi.2018.07.012

Merck Sequivity RNA “platform” for pigs

- USDA approved for swine influenza in December 2021
- Synthetic (not-natural) RNA in nanoparticle
- No information available on the chemical composition of nanoparticle, nor its toxicities by itself:
  - No biodistribution studies available
  - No genotoxicity studies available
  - No carcinogenicity studies available
  - No published safety studies available in peer reviewed literature
- Collect and centralize genomic surveillance data from farms:
  - How is the data used? Who can access it? For what purposes?

MERCK Animal Health

SEQUIVITY®

USDA Label, Safety Summary (p.18)

Adverse Events Summary 21 days

VeDDRA Code	Total Animals	Percent of All Animals
No adverse events	525	70.20%
Anorexia	55	7.40%
Death	24	3.20%
Lameness	20	2.70%
Loss of Condition	12	1.60%
Diarrhea	11	1.50%
Unthrifty	7	0.90%
Anaphylaxis^	3	0.40%
Central Nervous System Disorder*	3	0.40%
Lethargy	3	0.40%
Respiratory Tract Infection*	3	0.40%
Arthritis	2	0.30%
Meningitis	2	0.30%
Musculoskeletal Disorder*	2	0.30%
Trauma*	2	0.30%
Abdominal Caviry Hernia	1	0.10%
Abscess*	1	0.10%
*Not otherwise specified		
^Related to IVP		

USDA Approval Date	December 13, 2021

30%!

https://www.aphis.usda.gov/wcm/connect/

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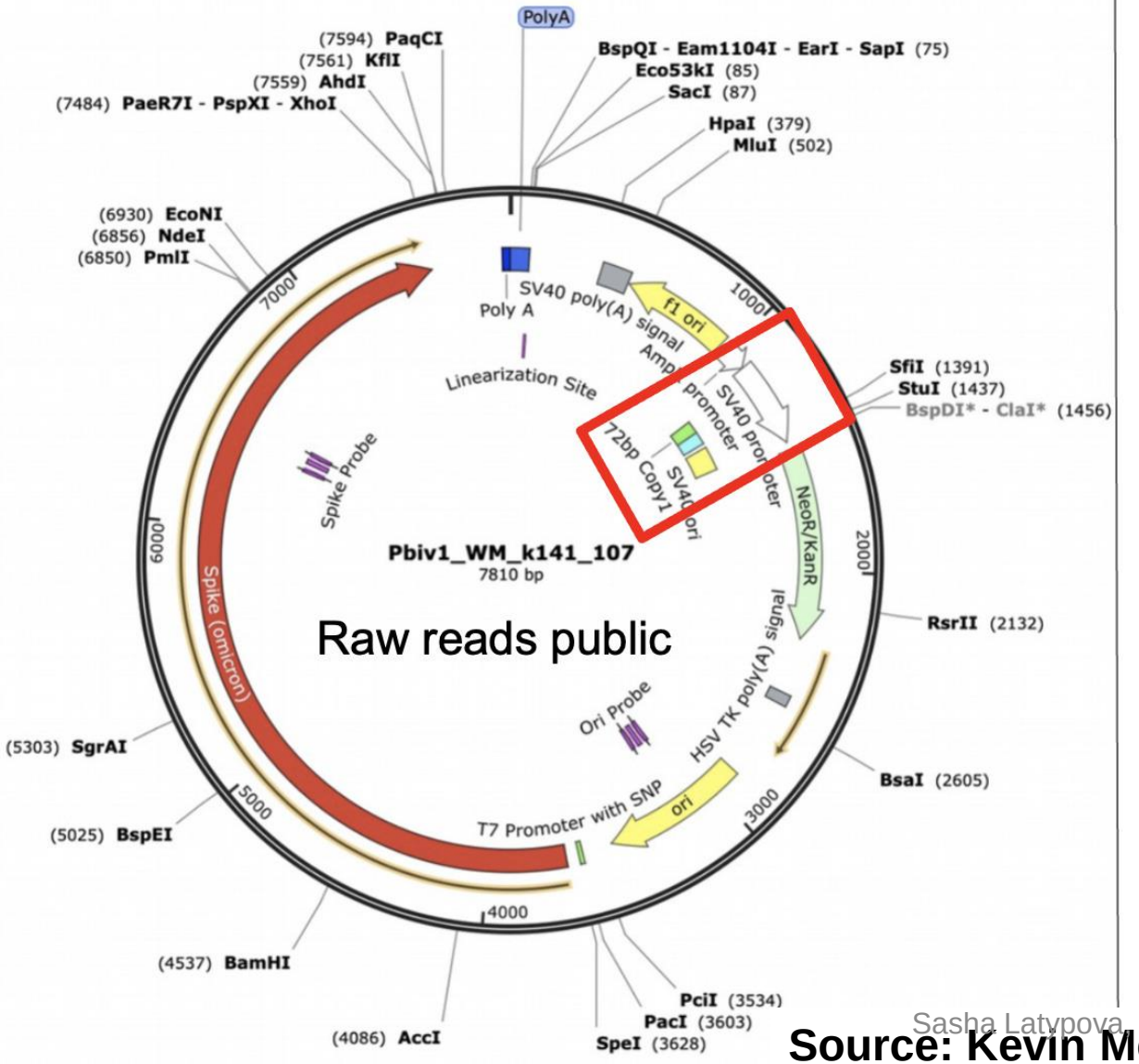
EPA Fast Tracked Ledprona – RNAi Pesticide

- Novel pesticide based on RNA interference (RNAi) technology - mechanism used by plants and insects to regulate gene expression.
- The EPA granted Ledprona an Experimental Use Permit (EUP), allowing GreenLight Biosciences 2 years to gather data from limited test plots.
- **Astonishingly, the agency also gave Ledprona 3 years of commercial use—before the standard testing period is even complete!**
- The pesticide could trigger unintended immune responses in humans. **Environmental risks: harm off-target insect species, disrupting ecosystems in unforeseen ways.**

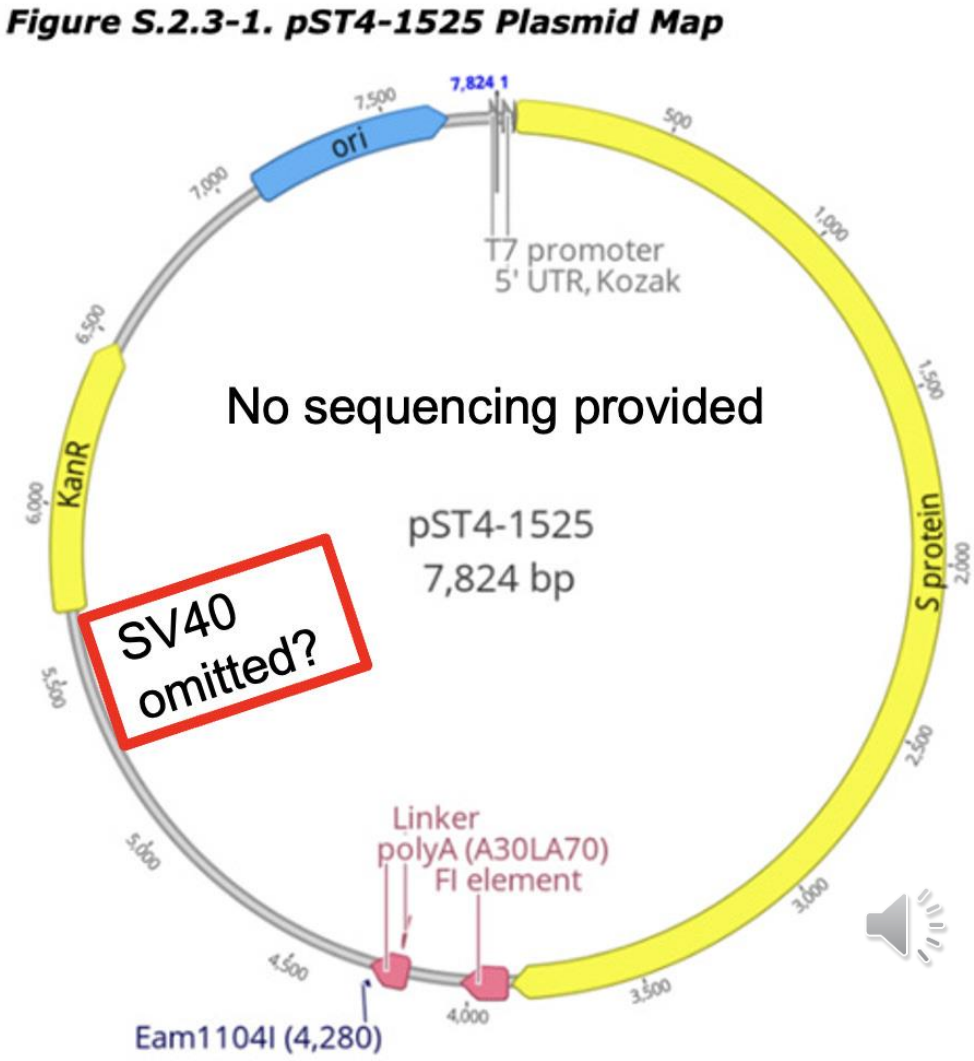
Ease of Adulteration, Contamination and Weaponization

Detection requires high-tech gene sequencing labs, equipment and expertise

Independent Illumina sequencing



What was disclosed to the EMA



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Source: Kevin McKernan, *Preprint DOI [10.31219/osf.io/b9t7m](https://doi.org/10.31219/osf.io/b9t7m)

Persistent Damage to the Gut Microbiome following Messenger RNA SARS-CoV-2 Vaccine

Sabine Hazan[1], Sonya Davé[2], Thomas J. Borody[3]

[1]ProgenaBiome, LLC, Ventura, CA, USA, [2]Microbiome Research Foundation, Ventura, CA, USA, [3]Centre for Digestive Diseases, Five Dock, NSW, AUS

Abstract
E0141
(S2108)

Introduction

- The human gut microbiome is an essential determinant of human health.
- *Bifidobacterium* decline is associated with inflammatory bowel disease, obesity, neurological disorders, *C. difficile* infection and severe COVID-19 (1-3).
- Long-term effect of messenger RNA vaccines for SARS-CoV-2 on the human gut microbiome is unknown.
- The purpose of this study was to explore longitudinal changes in the Relative Abundance of *Bifidobacterium* after mRNA SARS-CoV-2 vaccination.

Methods

We longitudinally recorded the Relative Abundance of *Bifidobacterium* in four subjects before receiving a mRNA vaccine (Pfizer or Moderna) for SARS-CoV-2, approximately one post-vaccination, as well as 6-9 months post-vaccination. Additional SARS-CoV-2 vaccines were given during that period, totaling 2 to 3 doses. Samples were collected at the time points mentioned. No dietary changes or new medications were introduced throughout the study period. Metagenomic next generation sequencing-based methods were applied to samples obtained from fecal collection. DNA was extracted, and the library prepped, enriched and sequenced on an Illumina Nextseq 550 system. This study was IRB approved.

Results

Subject	Change in Relative Abundance of *Bifidobacterium* (% of pre-vaccine level)	
	1 month post-vaccine	6-9 months post-vaccine
1	38%	15%
2	258%	0%
3	49%	35%
4	90%	60%

Table 1. Change in Relative Abundance of *Bifidobacterium* after SARS-CoV-2 mRNA vaccination.

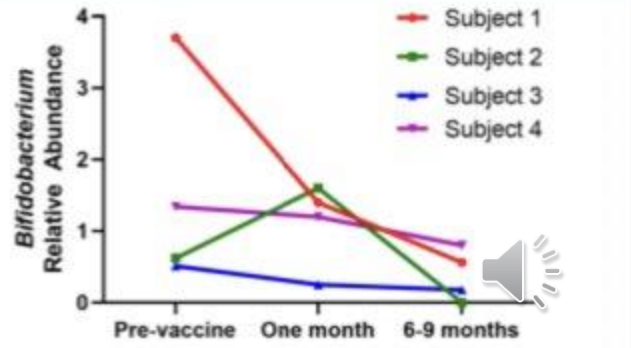

Figure 1. Decline in Relative Abundance of *Bifidobacterium* after SARS-CoV-2 mRNA vaccination.

Discussion

- At 1 month post-vaccination, 3 of 4 subjects experienced a decrease in Relative Abundance of *Bifidobacterium* below pre-vaccination levels.
- At 6-9 months post-vaccination, all subjects experienced a decrease in Relative Abundance of *Bifidobacterium* below pre-vaccination levels.
- No subjects exhibited significant post-vaccine complications.
- The lasting decrease in *Bifidobacterium* levels may contribute to SARS-CoV-2 infection post vaccination.
- Gut dysbiosis after mRNA SARS-CoV-2 vaccination may be a future indication for restoration of *Bifidobacterium* via oral or fecal transplant routes.

References

1. Ruiz L, et al. *Front Microbiol*. 2017;8:2345.
2. Suganya K, Koo BS. *Int J Mol Sci*. 2020;21(20):7551.
3. Hazan S, et al. *BMJ Open Gastro*. 2022;9(1):e000871.

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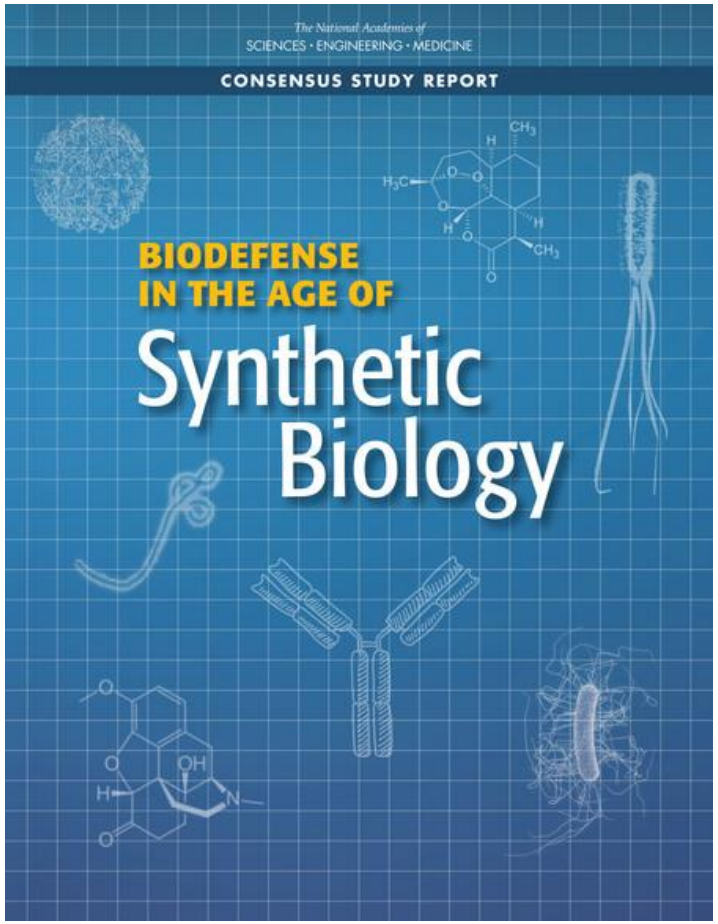

Chapter 6: Assessment of Concerns Related to Bioweapons that Alter the Human Host

"Human health is highly dependent upon the human microbiome—the microorganisms that live on and within us, especially those associated with the gut, oral cavity, nasopharyngeal space, and skin. These populations of microbes are likely far easier to manipulate than the human host itself, making the microbiome a potentially accessible vector for attack".

Vectors of biological attack discussed:

- Delivery of harmful cargo via microbiome (RNA and plasmid DNA or viral vectors) via injections or horizontal transfer (shedding)
- Enhancement of the attack via other pathways – animal vaccines, food: "domestic animals could be used as carriers for engineered agents transmitted via the microbiome".

Contributor(s): National Academies of Sciences, Engineering, and Medicine; Division on Earth and Life Studies; Board on Chemical Sciences and Technology; Board on Life Sciences; Committee on Strategies for Identifying and Addressing Potential Biodefense Vulnerabilities Posed by Synthetic Biology

mRNA-Technology is seen as gold standard for the future

World Health Organization

SEVENTH MEETING OF THE INTERGOVERNMENTAL NEGOTIATING BODY TO DRAFT AND NEGOTIATE A WHO CONVENTION, AGREEMENT OR OTHER INTERNATIONAL INSTRUMENT ON PANDEMIC PREVENTION, PREPAREDNESS AND RESPONSE
Provisional agenda item x

A/INB/7/x
October 2023

DRAFT

Negotiating Text of the WHO convention, agreement or other international instrument on pandemic prevention, preparedness and response (WHO Pandemic Agreement)

Advanced unedited version - 16 October 2023

- $$$$ for WHO Biodefense
- Required collection of DNA samples from countries
- Identification of most toxic agents and sharing with WHO
- Mandatory RNA/DNA injections for “new pathogens” manufactured in 100 days (no safety!)

The mRNA vaccine technology transfer hub

Quelle:
https://www.who.int/initiatives/the-mrna-vaccine-technology-transfer-hub

United States already subject to WHO decision when to announce a PHEIC

15 US states v HHS Petition for Rulemaking – was filed 1/18/2023, dismissed, not being appealed

- "…Oklahoma, Alabama, Arizona, Arkansas, Florida, Georgia, Indiana, Louisiana, Mississippi, Missouri, Montana, Nebraska, South Carolina, Texas, and Utah […] petition the U.S. Department of Health and Human Services (HHS) to amend its definition of "public health emergency" in 42 C.F.R. § 70.1. See 5 U.S.C. § 553(e).
- The Rule exceeds the agency's authority and infringes on U.S. and State sovereignty by unlawfully delegating to the World Health Organization (WHO) the authority to invoke health emergency powers solely based on decisions of the WHO.
- HHS admitted that the declaration by the WHO or notification to t
  Emergency of International Concern is a "way for HHS/CDC to d
  precommunicable stage of a quarantinable communicable dis
  public health emergency if transmitted to other individuals." Id. at
  disclaiming any need to use definitions (3), (4), and (5) [definitions made by WHO] of public health emergency, HHS proceeded to finalize a rule containing those definitions."

Declaration of "pandemic" based on theoretical/modeled potential without need to show any actual mass illness/deaths or economic impact

Questions we should all be asking:

- Is the “emergency” real or only/largely based on PCR and computer models?
- Is there hard evidence or real illness? real economic impact?
- Why the need for total genetic surveillance?
- Why are cell/nucleus/gene transfectants being pushed as the solution for respiratory illness?
- What are the long-term effects of genetic agents on animal microbiome, health and nutritional quality of animal products?
- What are the effects of shedding synthetic DNA/RNA and their byproducts into the food products or environment (other species, or humans that work with transfected animals or transfectants)?

Appendix

Table 1. Overview of licensed fish vaccines that have been used in global aquaculture.

Disease	Pathogen	Major Fish Host	Vaccine Type	Antigens/Targets	Delivery Methods	Country/Region *	Further Information
Viral Diseases							
Infectious hematopoietic necrosis	IHNV *Rhabdovirus*	Salmonids	DNA	G Glycoprotein	IM	Canada	https://www.dfo-mpo.gc.ca/aquaculture/rp-pr/acrdp-pcrda/projects-projets/P-07-04-010-eng.html
Infectious pancreatic necrosis	IPNV *Birnavirus*	Salmonids, sea bass, sea bream, turbot, Pacific cod	Inactivated	Inactivated IPNV	IP	Norway, Chile, UK	www.pharmaq.no
			Subunit	VP2 and VP3 Capsid Proteins	Oral	Canada, USA	www.aquavac-vaccines.com
			Subunit	VP2 Proteins	IP	Canada, Chile, Norway	http://www.msd-animal-health.no/
Infectious salmon anemia	ISAV *Orthomyxovirus*	Atlantic salmon	Inactivated	Inactivated ISAV	IP	Norway, Chile, Ireland, Finland, Canada	www.pharmaq.no
Pancreatic disease virus	SAV *alphaviruses*	Salmonids	Inactivated	Inactivated SAV	IP	Norway, Chile, UK	https://www.merck-animal-health.co
Spring viremia of carp virus	SVCV *Rhabdovirus*	Carp	Subunit	G Glycoprotein	IP	Belgium	[22]
			Inactivated	Inactivated SVCV	IP	Czech Republic	[23]
Koi herpesvirus disease	KHV *Herpesvirus*	Carp	Attenuated	Attenuated KHV	IMM or IP	Israel	[22]
Infectious spleen and kidney necrosis	ISKNV *Iridovirus*	Asian seabass, grouper, Japanese yellowtail	Inactivated	Inactivated ISKNV	IP	Singapore	https://www.aquavac-vaccines.com/
Bacterial diseases							
Enteric redmouth disease (ERM)	*Yersinia ruckeri*	Salmonids	Inactivated	Inactivated *Y. ruckeri*	IMM or oral	USA, Canada, Europe	http://www.msd-animal-health.ie/products_ni_vet/aquavac-erm-oral/overview.aspx; https://www.msd-animal-health-hub.co.uk
Vibriosis	*Vibrio anguillarum; Vibrio ordalii; Vibrio salmonicida*	Salmonids, ayu, grouper, sea bass, sea bream, yellowtail, cod, halibut	Inactivated	Inactivated *Vibriosis* spp.	IP or IMM	USA, Canada, Japan, Europe, Australia	https://www.merck-animal-health.com/species/aquaculture/trout.aspx;
Furunculosis	*Aeromonas salmonicida* subsp. *salmonicida*	Salmonids	Inactivated	Inactivated *A. salmonicida* spp.	IP or IMM	USA, Canada, Chile, Europe, Australia	https://www.msd-animal-health-me.com/species/aqua.aspx
Bacterial kidney disease (BKD)	*Renibacterium salmoninarum*	Salmonids	Avirulent live culture	*Arthrobacter davidanieli*	IP	Canada, Chile, USA	[24]
Enteric septicemia of catfish (ESC)	*Edwarsiella ictaluri*	Catfish	Inactivated	Inactivated *E. ictaluri*	IP	Vietnam	https://www.pharmaq.no/

Table 1. *Cont.*

Disease	Pathogen	Major Fish Host	Vaccine Type	Antigens/Targets	Delivery Methods	Country/Region *	Further Information
Columnaris disease	*Flavobacterium columnaris*	All freshwater finfish species, bream, bass, turbot, salmon	Attenuated	Attenuated *F. columnare*	IMM	USA	[25]
Pasteurellosis	*Pasteurela piscicida*	Sea bass, sea bream, sole	Inactivated	Inactivated *P. pscicida*	IMM	USA, Europe, Taiwan, Japan	ALPHA JECT 2000
Lactococciosis	*Lactococcus garviae*	Rainbow trout, amberjack, yellowtail	Inactivated	Inactivated *L. garviae*	IP	Spain	https://www.hipra.com/
Streptococcus infections	*Streptococcus* spp.	Tilapia, yellow tail, rainbow trout, ayu, sea bass, sea bream	Inactivated	Inactivated *S. agalactiae* (biotype 1)	IP	Taiwan Province of China, Japan, Brazil, Indonesia	https://www.aquavac-vaccines.com/products/aquavac-strep-sa1/
				Inactivated *S. agalactiae* (biotype 2)	IP		https://www.aquavac-vaccines.com/products/aquavac-strep-sa/
				Inactivated *S. iniae*	IP or IMM		https://www.aquavac-vaccines.com/products/aquavac-strep-si/
Salmonid rickettsial septicemia	*Piscirickettsia salmonis*	Salmonids	Inactivated	Inactivated *P. salmonis*	IP	Chile	Evensen, 2016; https://www.pharmaq.no/products/injectable/
Motile *Aeromonas* septicemia (MAS)	*Aeromonas* spp.	Striped catfish	Inactivated	*A. hydrophila* (serotype A and B)	IP	Vietnam	https://www.pharmaq.no/; ALPHAJECT Panga 2
Wound Disease	*Moritella viscosa*	Salmonids	Inactivated	Inactivated *M. viscosa*	IP	Norway, UK, Ireland, Iceland	https://www.pharmaq.no
Tenacibaculosis	*Tenacibaculum maritimum*	Turbot	Inactivated	Inactivated *T. maritimum*	IP	Spain	https://www.hipra.com/

IHNV: Infectious hematopoietic necrosis virus; IPNV: Infectious pancreatic necrosis virus; ISAV: Infectious salmon anemia virus; SVCV: Spring viremia of carp virus; KHV: Koi herpesvirus; ISKNV: Infectious spleen and kidney necrosis virus; IM: Intramuscular injection; IP: Intraperitoneal injection; IMM: Immersion; * denotes country or region where the vaccine is licensed and sold.

24-03-06 SB 911 testimony.pdf
Uploaded by: Brian Finglass
Position: FAV

3/6/2024

To: The Honorable members of the Senate Finance Committee

Re: Support for SB911

Dear Committee members:

i am writing to support SB 911.

Our relationship to food is a sacred relationship. Many of us honor God through the food we eat and share with our family and friends. We express this honor by not consuming food whose seed has been genetically modified or consuming food that uses any ingredient or process that involves genetic modification. It is extremely important that the citizens of Maryland be able to easily avoid the purchase of these items through clear labeling. I also believe that the labeling requirement should apply to any undisclosed ingredients that fall under the GRAS (generally regarded as safe) rules that may utilize genetic modification in their production.

Only after the consumer is properly informed through clear labeling, can they then make an informed decision if they want to purchase the product.

Thank you for considering my testimony in support of SB 911.

Brian Finglass

SB 911 Testimony.pdf
Uploaded by: Gopi Vijaya
Position: FAV

SB 911

Testimony

Good afternoon, members of the committee. My name is Dr. Gopi Vijaya. I am a Physicist by background and I have served as the scientific and legislative advisor for grassroots organizations in Utah for several years. I would like to speak in strong support of SB 911.

Many of you may know of the recent Federal rules regarding the labeling of food that took effect in 2022. Based on the clear necessity for labeling that was perceived by the Federal government, they have asked manufacturers to label everything artificially modified food as "bioengineered", even allowing the use of QR codes. What you may *not* know about is how this rule is has been tied up in litigation, and it immediately was found to be confusing and discriminatory for those without a smartphone. Not only that, the federal law does not address a different but actual need that is urgently pressing on us today: a way to inform the public that their food can have components in them that are created using new technologies that can affect gene expression. Please note that the bill in front of you today is not about medical therapy, but about the food we consume day after day, which allows for any such genetic effect to multiply and accumulate.

As the legislators of Maryland, you are in a position to clear the air on this subject, and provide a simple yet clear labeling standard that food manufacturers have to adhere to. This is especially important as there has been a recent surge in introducing novel gene-altering technologies, such as the mRNA platform, into food. What's more, clinical trials that involve applying these technologies to animals, for example, are not open to the public. I repeat: they are NOT open to the public. You cannot find them on clinicaltrials.gov. As we speak, gene-altering technologies are also being fast-tracked in developing plants as "mRNA factories".

This situation creates a need-to-know: the customer has the right to know what is going into the body, especially with these fast-tracked technologies where the short-term data is not clear and the long-term data is simply absent. The consumers MUST be allowed to choose whether they would like to roll the dice on consuming food based on gene-altering technologies. And that is our sincere request to you: please allow us to be informed on this, and pass SB 911.

Maryland SB911 genetic food labeling Lindsay.pdf
Uploaded by: Janci Lindsay
Position: FAV

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BILL SB 911: Food Drugs and Cosmetics-Gene Structure-and Function-Modifying Products-Labeling

Premise of testimony for labeling: Genetic Vaccine Platform Used in Animals for Meat and Dairy Consumption Pose an Unreasonable Risk to Consumers, Workers and the Environment, Must at Least Have Labeling While Health Risk Studies and Shedding Studies are Being Done

Testimony by Janci C. Lindsay, PhD., Director of Toxicology and Molecular Biology, Toxicology Support. Services, LLC.

1. **There are a number of new generation genetic vaccines which have been approved by USDA for use in various animals meant for human consumption. Several of these use plasmid DNA as the direct vaccine or in the process of making the vaccine.**
2. **Manufactures and proponents assert that safety studies for the use of this technology in our food supply such as—genotoxicity, carcinogenicity, shedding and secondary transfection, have been done but when pressed for these studies come up empty handed.**
3. **These genetic vaccines are in fact "Gene Therapies" or "Genetic Biologics", as acknowledged by SEC filings and patent related to the technologies and as such carry the long known risks of insertional mutagenesis leading to cancers like leukemias and lymphomas and also lethal auto immune reactions from the action of having "self-cells" express foreign proteins which are the target of the immune system.**
4. **USDA has ruled that you cannot introduce meat into the stream of commerce which has cancer. These shots increase the cancer risk to the animals who receive them and their vectors increase the risk of adverse health effects to humans who could be secondarily transfected.**
5. **Interspecies variation in bio-distribution and degradation must be taken into consideration and not swept off as bio-identical. Example: mice inoculated with a plasmid DNA vaccine supposedly had no more detectable plasmid after 90 minutes while the plasmids used in another DNA vaccine for salmon were present for one year post shot!**

6. **Genetic vaccines have the potential to shed to livestock handlers and those who work in the meat slaughter and packing industries posing a risk of non-consentual transfection and possible increased risk for adverse effects including increased cancer risk. This can occur:**
    a. **During inoculation with the genetic vaccines**
    b. **Working with meat products during slaughter and packaging**
    c. **Working with animal waste during cleaning and housing work.**

7. **Genetic vaccines in LNPs can cross gut barrier of consumer and transfect host cells and potentially gut bacteria causing secondary transfection and expression of vaccine antigen.**

8. **Genetic vaccine present in milk from inoculation of Mother can transfect consumer of milk products. Heat does not always kill these elements especially DNA.**

9. **Genetic vaccines can enter the environment in soil bacteria and can be consumed by other animals besides target animals leading to antibiotic resistance risk (plasmids) and risk to animals and environment through off-target transfection.**

10. **These technologies are still experimental and extensive toxicology, genotoxicity, carcinogenicity and reproductive toxicology studies on these products have not been done—**

11. **The Genetic biologics/vaccines can shed to other people and the environment and cause unintended transfection of other organisms. This must be studied before their large scale use in the food we eat!**

References

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- **Romano G, Marino IR, Pentimalli F, Adamo V, Giordano A. Insertional mutagenesis and development of malignancies induced by integrating gene delivery systems: implications for the design of safer gene-based interventions in patients. Drug News Perspect. 2009 May;22(4):185-96. doi: 10.1358/dnp.2009.22.4.1367704. PMID: 19536363.**
- **Mulroney, T.E., Pöyry, T., Yam-Puc, J.C.** ***et al.*** ***N*^{1}****-methylpseudouridylation of mRNA causes +1 ribosomal frameshifting.** ***Nature*** **(2023). https://doi.org/10.1038/s41586-023-06800-3**

Sequivity label USDA.pdf
Uploaded by: Janci Lindsay
Position: FAV

Summary of Studies Supporting USDA Product Licensure

Establishment Name	Intervet Inc.
USDA Vet Biologics Establishment Number	165A
Product Code	19A5.R8
True Name	Swine Influenza Vaccine, N1 & N2, RNA Particle
Tradename(s) / Distributor or Subsidiary (if different from manufacturer)	Sequivity - Merck Animal Health
Date of Compilation Summary	June 24, 2022

Disclaimer: Do not use the following studies to compare one product to another. Slight differences in study design and execution can render the comparisons meaningless.

<table>
<tr><td>Study Type</td><td>Efficacy</td></tr>
<tr><td>Pertaining to</td><td>Swine Influenza Virus, H1N1</td></tr>
<tr><td>Study Purpose</td><td>Demonstrate efficacy against swine influenza virus, H1N1, 12-weeks after 2nd vaccination to establish the duration of immunity.</td></tr>
<tr><td>Product Administration</td><td>Two doses, administered intramuscularly, three weeks apart.
NA1 (A/swine/IA/A01410307/2014 (H1N1)) – NA6 (A/swine/MN/A01483170/2014 (H1N1))
NA4 (A/swine/MI/A02077465/2015 (H1N2)) – NA2 (A/swine/IL/A01475495/2014 (H1N2))</td></tr>
<tr><td>Study Animals</td><td>Commercial pigs, three days of age, 32 vaccinates and 30 controls (placebo vaccinated).</td></tr>
<tr><td>Challenge Description</td><td>All pigs were challenged 12 weeks post second vaccination with swine influenza strain A/swine/Indiana/A02429505/2019 (H1N1).</td></tr>
<tr><td>Interval observed after challenge</td><td>Lung lesion scores were assessed 5 days post challenge on a subgroup of 20 vaccinates and 18 controls.</td></tr>
<tr><td>Results</td><td>Five number summary for lung lesion scores*:
<table><tr><th>Group</th><th>Number</th><th>Minimum</th><th>Q1</th><th>Median</th><th>Q3</th><th>Maximum</th></tr><tr><td>Vaccinate</td><td>20</td><td>0.3</td><td>0.7</td><td>1.2</td><td>2.8</td><td>6.9</td></tr><tr><td>Placebo</td><td>18</td><td>3.8</td><td>6.0</td><td>8.9</td><td>13.1</td><td>24.7</td></tr></table>
*Lesion scores were calculated as the percentage of total lung area

Raw data are shown below.</td></tr>
<tr><td>USDA Approval Date</td><td>June 10, 2020</td></tr>
</table>

Table 1: Lung Lesion Scoring (LLS) by 1st Scorer

Pig ID	Treatment	DLA	DLC	DLD	DRA	DRC	DRD	VLA	VLC	VLD	VRA	VRC	VRD	INT	Total Lung Score	LLS
2904	Vaccinate	0.0	1.0	0.0	0.0	0.0	0.0	0.0	1.5	0.0	0.0	0.0	0.0	0.0	2.5	0.21
2908	Vaccinate	0.0	14.0	5.0	0.5	14.5	1.5	0.0	10.0	2.0	0.0	15.0	1.0	2.5	66.0	5.59
2913	Vaccinate	0.0	2.0	0.0	0.0	2.0	0.0	0.0	2.0	0.0	0.0	1.5	0.0	0.0	7.5	0.64
2914	Vaccinate	0.0	2.0	1.0	0.0	2.0	0.0	0.0	1.5	0.0	0.0	1.5	1.5	0.0	9.5	0.80
2915	Vaccinate	0.0	8.5	1.5	0.0	9.5	0.0	0.0	2.5	0.0	0.0	4.0	1.5	0.0	27.5	2.33
2920	Vaccinate	0.0	4.5	2.0	0.0	4.5	2.5	1.0	3.0	1.5	0.5	6.0	0.5	1.5	27.5	2.33
2924	Vaccinate	0.0	0.5	0.0	0.0	2.0	0.0	0.0	1.0	0.0	0.0	2.5	0.0	0.0	6.0	0.51
2927	Vaccinate	0.0	2.0	0.0	0.0	1.0	1.0	0.0	2.0	0.0	0.0	1.0	0.5	0.5	8.0	0.68
2932	Vaccinate	0.0	0.5	0.0	1.0	0.5	0.0	0.0	0.0	0.0	0.0	1.5	1.5	1.5	6.5	0.55
2935	Vaccinate	0.0	3.0	2.0	0.0	1.5	0.0	0.0	3.5	2.0	0.0	1.0	1.0	0.0	14.0	1.19
2945	Vaccinate	0.0	2.5	1.5	1.5	2.0	1.0	0.5	2.0	1.0	1.5	2.0	1.0	1.0	17.5	1.48
2947	Vaccinate	0.0	2.0	1.0	0.5	1.5	1.0	0.0	0.5	0.0	0.5	2.0	0.5	1.5	11.0	0.93
2957	Vaccinate	0.0	1.5	0.0	0.0	2.0	0.0	0.0	1.5	0.0	0.0	1.5	0.0	0.0	6.5	0.55
2959	Vaccinate	0.0	3.0	2.5	0.0	4.0	1.5	0.0	1.0	1.5	0.0	2.0	1.0	0.0	16.5	1.40
2972	Vaccinate	2.5	5.0	5.5	2.5	5.0	7.0	2.0	4.0	0.0	4.0	7.0	2.5	2.5	49.5	4.19
2975	Vaccinate	0.0	6.0	4.0	0.0	6.5	0.5	0.0	4.5	3.0	0.0	7.5	3.5	1.0	36.5	3.09
2983	Vaccinate	0.0	2.5	0.0	0.0	1.5	0.0	0.0	2.0	0.0	0.0	2.5	0.0	0.0	8.5	0.72
2986	Vaccinate	0.0	8.0	2.5	9.0	8.5	5.0	0.0	9.0	3.0	8.5	14.0	3.0	2.0	72.5	6.14
2987	Vaccinate	1.5	1.5	0.0	1.0	4.5	0.0	1.0	2.0	1.5	0.0	5.0	1.0	0.0	19.0	1.61
2990	Vaccinate	0.0	6.5	0.0	4.0	9.0	1.0	0.0	4.5	1.0	3.0	8.0	1.5	2.0	40.5	3.43
2901	Placebo	2.5	18.5	4.0	3.0	24.0	1.5	5.5	21.5	2.0	4.5	27.5	1.0	3.5	119.0	10.08
2910	Placebo	0.5	23.0	3.0	1.0	11.5	1.0	1.5	12.0	8.0	1.5	19.0	2.0	2.0	86.0	7.28
2916	Placebo	1.0	12.0	0.0	2.5	4.5	0.0	2.0	4.5	0.0	1.0	5.5	0.5	1.5	35.0	2.96
2918	Placebo	0.0	3.0	2.0	1.5	6.0	7.0	2.5	2.5	2.0	3.0	9.0	2.5	5.5	46.5	3.94
2919	Placebo	0.0	21.5	4.0	2.5	13.5	3.0	1.5	11.5	2.0	0.0	10.5	2.5	3.5	76.0	6.44
2922	Placebo	2.5	16.0	8.5	7.0	28.0	17.0	8.0	16.0	4.5	9.5	40.0	7.5	5.0	169.5	14.35
2923	Placebo	3.5	31.5	26.0	5.5	27.0	5.5	11.5	25.0	18.5	5.0	40.0	3.0	10.5	212.5	17.99
2933	Placebo	5.0	8.0	14.5	7.0	16.0	8.5	9.0	11.0	12.0	14.0	22.0	6.5	8.0	141.5	11.98
2934	Placebo	1.0	22.0	3.0	1.0	11.0	1.0	1.5	11.5	2.5	1.0	13.5	0.0	1.0	70.0	5.93
2941	Placebo	0.5	12.5	3.0	5.0	5.5	2.5	1.5	8.0	1.5	7.5	15.0	2.0	6.0	70.5	5.97
2946	Placebo	1.5	6.0	3.5	15.5	15.5	13.0	2.0	9.0	2.0	19.5	23.5	8.0	5.5	124.5	10.54
2952	Placebo	1.5	23.5	14.5	8.5	22.0	5.5	8.0	14.5	8.5	11.0	38.0	2.5	4.5	162.5	13.76
2956	Placebo	2.5	23.0	4.0	6.0	28.0	5.0	1.0	22.0	2.0	5.5	35.0	4.0	4.5	142.5	12.07
2977	Placebo	10.0	26.0	20.0	12.5	25.0	27.0	18.5	30.5	26.0	21.0	60.0	20.0	10.5	307.0	25.99
2982	Placebo	0.0	11.5	4.0	3.5	10.0	5.0	4.0	4.5	3.5	7.5	14.0	2.0	1.0	70.5	5.97
2984	Placebo	1.5	31.0	15.0	8.5	17.0	3.0	3.5	16.5	26.0	5.0	33.0	3.0	3.0	166.0	14.06
2993	Placebo	0.0	5.5	3.0	6.5	6.5	0.0	3.5	10.5	1.5	6.0	7.0	1.5	2.0	53.5	4.53
2994	Placebo	2.0	23.5	3.0	7.0	7.5	0.0	7.0	16.0	3.0	7.5	11.5	5.0	4.0	97.0	8.21

Code

DLA =	Dorsal Left Apical Lobe	VLA =	Ventral Left Apical Lobe
DLC =	Dorsal Left Cardiac Lobe	VLC =	Ventral Left Cardiac Lobe
DLD =	Dorsal Left Diaphragmatic Lobe	VLD =	Ventral Left Diaphragmatic Lobe
DRA =	Dorsal Right Apical Lobe	VRA =	Ventral Right Apical Lobe
DRC =	Dorsal Right Cardiac Lobe	VRC =	Ventral Right Cardiac Lobe
DRD =	Dorsal Right Diaphragmatic Lobe	VRD =	Ventral Right Diaphragmatic Lobe
INT =	Intermediate Lobe		

Table 2: Lung Lesion Scoring (LLS) by 2nd Scorer

Pig ID	Treatment	DLA	DLC	DLD	DRA	DRC	DRD	VLA	VLC	VLD	VRA	VRC	VRD	INT	Total Lung Score	LLS
2904	Vaccinate	0.0	2.0	0.0	0.0	0.0	0.0	0.0	1.5	0.0	0.0	0.0	0.0	0.0	3.5	0.30
2908	Vaccinate	0.0	16.5	2.0	0.5	19.0	1.0	0.5	10.5	1.0	1.0	13.5	1.5	0.5	67.5	5.72
2913	Vaccinate	0.0	1.5	0.0	0.0	1.5	1.0	0.0	2.5	0.0	0.0	2.0	0.0	0.0	8.5	0.72
2914	Vaccinate	0.0	3.5	0.5	0.0	4.5	0.5	0.0	2.0	1.0	0.5	3.0	1.0	0.5	17.0	1.44
2915	Vaccinate	0.0	12.0	1.0	0.0	6.0	1.0	0.5	3.0	1.5	0.0	5.0	0.0	0.5	30.5	2.58
2920	Vaccinate	0.0	8.0	2.0	0.5	5.5	2.0	1.0	6.0	0.5	1.0	5.5	2.0	1.5	35.5	3.01
2924	Vaccinate	0.0	0.5	1.0	0.0	1.5	0.0	0.0	1.0	0.0	0.5	2.0	0.0	0.0	6.5	0.55
2927	Vaccinate	0.0	3.0	1.0	0.0	1.5	1.0	0.0	2.0	0.0	0.0	1.5	0.5	0.5	11.0	0.93
2932	Vaccinate	0.0	1.0	1.5	0.5	0.5	0.5	0.0	1.0	0.0	0.5	0.5	1.5	1.0	8.5	0.72
2935	Vaccinate	0.5	1.5	2.0	0.0	1.5	0.0	0.0	3.5	2.0	0.0	3.0	0.5	0.5	15.0	1.27
2945	Vaccinate	0.0	3.0	1.0	1.5	2.0	1.0	1.0	2.5	0.5	1.5	1.0	0.0	1.0	16.0	1.35
2947	Vaccinate	0.0	1.0	0.5	0.0	1.5	0.5	0.0	0.5	0.0	0.0	1.0	0.5	0.5	6.0	0.51
2957	Vaccinate	0.0	1.0	0.0	0.0	1.5	0.0	0.0	2.5	0.0	0.0	1.5	0.0	0.0	6.5	0.55
2959	Vaccinate	0.0	2.0	2.5	0.0	4.0	0.0	0.0	1.0	1.0	0.5	2.0	1.0	0.0	14.0	1.19
2972	Vaccinate	1.0	4.0	4.0	1.0	4.0	7.0	1.5	4.0	3.0	1.5	3.5	6.0	2.0	42.5	3.60
2975	Vaccinate	0.0	8.5	0.0	0.0	6.5	1.5	0.0	7.5	3.0	0.0	8.5	1.5	0.5	37.5	3.18
2983	Vaccinate	0.0	2.0	0.0	0.0	2.0	0.0	0.0	4.0	0.0	0.0	1.5	0.0	0.5	10.0	0.85
2986	Vaccinate	1.0	13.5	4.0	10.0	8.5	5.5	0.0	9.5	3.0	9.0	17.0	6.0	3.5	90.5	7.66
2987	Vaccinate	1.0	2.0	1.5	1.0	2.5	0.0	1.0	3.0	1.5	1.0	5.5	1.0	0.0	21.0	1.78
2990	Vaccinate	0.5	7.0	3.5	4.0	9.5	2.5	0.0	10.5	1.0	1.5	8.5	2.5	0.5	51.5	4.36
2901	Placebo	3.5	24.0	2.5	3.0	17.5	1.5	6.0	23.0	4.0	8.0	28.5	2.0	1.0	124.5	10.54
2910	Placebo	2.0	23.5	6.0	3.0	11.5	2.0	7.0	20.5	4.5	2.5	14.5	3.5	1.5	102.0	8.64
2916	Placebo	2.5	16.0	1.0	3.0	5.0	0.0	3.5	12.0	0.0	2.5	6.5	1.0	1.0	54.0	4.57
2918	Placebo	0.0	6.0	4.0	1.5	6.0	4.5	3.5	4.0	3.5	3.0	11.0	3.0	2.0	52.0	4.40
2919	Placebo	0.0	19.5	3.0	1.5	10.5	3.0	1.5	14.5	2.5	1.0	12.5	2.5	2.5	74.5	6.31
2922	Placebo	3.0	16.5	9.0	5.0	29.5	12.0	4.5	16.0	4.0	9.5	38.0	7.0	5.0	159.0	13.46
2923	Placebo	3.0	26.5	19.5	4.5	29.0	2.0	6.0	21.5	9.5	3.0	40.0	3.0	3.0	170.5	14.44
2933	Placebo	5.0	10.0	10.0	4.5	11.0	5.0	10.5	9.0	6.5	12.0	18.0	6.0	2.0	109.5	9.27
2934	Placebo	0.0	24.0	5.0	1.0	12.0	0.5	2.0	17.5	2.5	1.0	9.5	0.0	0.5	75.5	6.39
2941	Placebo	1.0	5.5	2.5	3.0	6.0	0.5	0.5	6.0	1.0	4.5	12.0	3.0	4.5	50.0	4.23
2946	Placebo	0.5	9.0	5.0	13.5	10.0	8.0	4.0	9.5	1.5	17.5	14.0	7.0	7.0	106.5	9.02
2952	Placebo	3.5	23.5	6.5	7.5	28.5	4.0	7.5	22.0	5.0	8.5	30.5	3.5	6.0	156.5	13.25
2956	Placebo	3.5	28.0	3.0	3.5	30.5	3.5	3.0	21.0	1.5	5.0	32.0	6.0	1.0	141.5	11.98
2977	Placebo	9.5	22.5	17.0	13.0	36.5	21.5	11.5	33.5	25.0	12.0	45.5	22.5	7.5	277.5	23.50
2982	Placebo	0.0	11.0	5.5	4.5	15.0	2.5	2.0	5.0	3.0	5.5	13.0	2.5	1.0	70.5	5.97
2984	Placebo	4.0	31.0	18.0	6.0	19.0	3.0	3.5	18.0	15.0	3.0	35.5	3.0	4.5	163.5	13.84
2993	Placebo	0.0	8.0	4.0	4.5	8.0	0.0	4.0	8.0	2.0	5.0	7.5	2.0	1.5	54.5	4.61
2994	Placebo	2.0	21.0	3.0	7.5	11.0	0.0	7.5	18.0	2.0	6.0	12.0	3.5	1.5	95.0	8.04

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<tr><td>Study Type</td><td>Efficacy</td></tr>
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NA4 (A/swine/MI/A02077465/2015 (H1N2)) – NA2 (A/swine/IL/A01475495/2014 (H1N2))</td></tr>
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Raw data are shown below.</td></tr>
<tr><td>USDA Approval Date</td><td>June 5, 2020</td></tr>
</table>

Table 1: Lung Lesion Scoring (LLS) by 1st Scorer

Pig ID	Treatment	DLA	DLC	DLD	DRA	DRC	DRD	VLA	VLC	VLD	VRA	VRC	VRD	INT	Total Lung Score	LLS
5700	Placebo	2.00	31.50	15.50	5.00	28.00	6.00	8.50	38.00	12.50	4.50	52.50	4.50	3.50	212.00	17.95
5701	Placebo	2.00	30.00	20.50	7.50	22.00	30.50	6.00	28.00	12.00	8.00	33.50	27.00	11.50	238.50	20.19
5707	Placebo	1.50	29.50	3.00	0.00	27.50	14.00	3.00	28.00	2.00	0.00	46.50	17.00	17.00	189.00	16.00
5709	Placebo	2.00	13.50	4.00	1.00	17.00	4.00	2.50	10.00	5.00	1.00	14.00	7.00	3.50	84.50	7.15
5725	Placebo	0.00	17.50	6.00	0.00	16.00	2.50	0.00	10.00	3.00	0.00	11.50	3.00	1.00	70.50	5.97
5730	Placebo	3.00	13.00	6.00	1.00	9.00	6.50	5.00	7.00	4.00	0.00	7.50	5.00	0.00	67.00	5.67
5734	Placebo	0.00	7.00	0.00	1.00	3.00	2.50	3.00	5.00	0.50	1.00	4.00	1.50	1.50	30.00	2.54
5739	Placebo	3.00	17.50	2.00	1.00	22.50	12.00	6.50	17.00	2.50	1.00	32.50	16.00	6.50	140.00	11.85
5744	Placebo	0.00	23.00	5.50	0.00	25.50	13.00	1.50	15.00	5.00	1.50	31.50	9.00	8.00	138.50	11.73
5751	Placebo	1.00	24.00	12.50	5.50	25.00	8.50	3.00	18.50	19.00	4.00	33.50	7.50	3.50	165.50	14.01
5757	Placebo	1.50	22.00	13.00	2.00	21.50	7.50	2.50	15.00	8.00	1.00	17.00	7.00	1.50	119.50	10.12
5759	Placebo	4.50	31.50	35.00	9.00	27.50	19.50	6.00	20.50	13.50	8.00	26.50	23.00	5.50	230.00	19.48
5762	Placebo	8.00	15.00	2.50	2.00	28.00	43.50	7.00	15.50	3.50	2.50	24.00	35.00	11.50	198.00	16.77
5763	Placebo	1.00	21.00	18.50	2.50	16.00	17.50	3.50	13.00	9.50	3.50	10.00	15.50	2.50	134.00	11.35
5766	Placebo	1.00	7.50	2.00	1.50	9.00	7.50	2.50	10.00	0.50	1.00	8.50	7.00	2.00	60.00	5.08
5772	Placebo	4.50	16.00	2.00	0.00	25.50	5.00	3.50	16.50	2.50	1.00	34.00	5.50	7.50	123.50	10.46
5778	Placebo	0.00	15.00	5.50	1.00	16.50	4.00	0.50	11.00	4.50	0.50	12.00	4.00	5.00	79.50	6.73
5781	Placebo	3.00	23.00	10.00	4.00	12.50	7.00	4.00	29.00	5.50	2.50	13.00	11.00	3.50	128.00	10.84
5787	Placebo	0.00	13.50	3.00	0.00	27.50	7.00	1.50	6.00	1.50	1.00	26.50	5.50	6.50	99.50	8.43
5796	Placebo	0.00	2.50	1.50	0.00	2.50	0.00	0.00	2.00	0.00	0.00	2.00	0.00	0.00	10.50	0.89
5703	Vaccinate	2.00	3.00	2.00	2.00	4.50	2.00	2.00	2.00	1.00	1.50	4.00	1.50	0.00	27.50	2.33
5704	Vaccinate	0.00	4.00	1.50	0.00	2.50	0.00	0.00	2.50	0.50	0.00	0.50	0.00	0.00	11.50	0.97
5705	Vaccinate	0.00	8.00	7.00	2.00	6.50	7.00	0.00	6.00	4.00	2.00	7.00	4.00	6.50	60.00	5.08
5710	Vaccinate	0.00	1.00	0.00	0.00	8.00	4.00	0.00	1.50	0.00	0.00	5.50	0.00	1.00	21.00	1.78
5722	Vaccinate	0.00	2.50	1.50	1.00	1.50	0.50	0.00	2.00	1.00	0.00	1.00	2.00	0.00	13.00	1.10
5731	Vaccinate	0.00	4.00	4.50	0.00	3.50	3.00	0.00	3.50	1.50	0.00	3.50	1.50	0.00	25.00	2.12
5738	Vaccinate	0.00	1.50	0.50	0.00	2.00	0.50	0.00	3.50	0.00	0.00	2.50	0.50	0.00	11.00	0.93
5740	Vaccinate	0.00	2.00	1.00	0.00	2.50	1.00	0.00	2.00	1.00	0.00	1.50	1.00	0.00	12.00	1.02
5745	Vaccinate	0.00	3.00	1.00	0.00	3.50	2.00	0.00	3.00	0.00	0.00	3.00	0.00	0.00	15.50	1.31
5752	Vaccinate	0.00	2.00	0.00	0.00	2.00	0.00	0.00	1.50	0.00	0.00	2.50	0.00	0.00	8.00	0.68
5754	Vaccinate	1.00	2.00	1.50	1.50	3.00	0.50	0.00	3.00	2.00	1.50	3.50	1.50	1.50	22.50	1.91
5755	Vaccinate	0.00	3.00	0.00	0.50	2.50	0.00	0.00	2.50	0.00	0.00	2.50	0.00	0.00	11.00	0.93
5758	Vaccinate	0.00	5.00	4.50	0.50	6.00	2.00	0.00	5.00	3.50	0.50	5.00	3.00	0.00	35.00	2.96
5761	Vaccinate	0.00	12.00	7.50	0.00	8.00	5.00	0.00	4.50	3.00	0.00	7.50	7.00	3.50	58.00	4.91
5765	Vaccinate	0.00	8.00	6.50	0.50	7.00	3.50	0.00	5.50	4.00	1.00	5.00	2.50	1.50	45.00	3.81
5773	Vaccinate	0.00	1.50	1.00	0.00	1.00	0.00	0.00	1.50	0.50	0.00	0.00	0.00	0.00	5.50	0.47
5784	Vaccinate	1.00	7.00	1.50	1.50	9.00	2.00	1.00	6.00	2.00	1.50	8.00	2.50	2.50	45.50	3.85
5786	Vaccinate	0.00	4.00	0.00	0.00	2.50	1.50	0.00	3.50	0.00	0.00	3.00	1.50	0.50	16.50	1.40
5793	Vaccinate	0.00	1.50	0.00	0.00	1.00	0.00	0.00	2.00	0.00	0.00	1.00	0.00	0.00	5.50	0.47
5798	Vaccinate	0.00	2.00	0.00	0.00	1.50	0.00	0.00	2.50	0.00	0.00	1.50	0.00	0.00	7.50	0.64

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Table 2: Lung Lesion Scoring (LLS) by 2nd Scorer

Pig ID	Treatment	DLA	DLC	DLD	DRA	DRC	DRD	VLA	VLC	VLD	VRA	VRC	VRD	INT	Total Lung Score	LLS
5700	Placebo	4.50	34.00	8.00	2.00	27.50	5.50	3.00	36.00	6.50	18.50	51.00	17.00	2.00	215.50	18.25
5701	Placebo	1.50	43.00	12.00	4.00	37.50	25.00	6.00	37.50	24.00	6.00	32.00	10.50	4.50	243.50	20.62
5707	Placebo	1.50	35.00	3.00	0.00	37.50	13.00	5.00	25.00	2.00	1.00	45.00	17.50	17.50	203.00	17.19
5709	Placebo	2.00	15.00	4.50	1.50	22.00	3.50	3.00	11.00	6.00	1.50	15.50	7.50	2.50	95.50	8.09
5725	Placebo	0.50	13.50	4.50	0.00	12.50	2.50	0.00	9.00	2.00	0.00	12.00	2.50	1.50	60.50	5.12
5730	Placebo	1.50	7.00	6.50	0.50	9.50	2.50	3.50	6.50	3.00	1.00	6.00	4.50	0.50	52.50	4.45
5734	Placebo	1.00	6.50	1.00	0.00	3.00	1.50	3.00	4.50	0.50	1.50	5.00	2.00	0.50	30.00	2.54
5739	Placebo	3.50	14.50	1.50	1.00	20.50	8.00	6.00	12.50	3.50	1.00	30.00	16.00	3.50	121.50	10.29
5744	Placebo	0.50	19.50	5.50	1.50	26.50	10.00	1.50	15.00	3.50	1.00	34.00	10.50	2.00	131.00	11.09
5751	Placebo	1.00	16.00	10.00	4.00	28.00	2.00	3.50	11.00	9.50	3.00	30.50	8.00	1.00	127.50	10.80
5757	Placebo	2.00	24.50	13.50	1.50	16.50	4.00	2.00	16.50	7.50	1.00	26.00	7.50	1.00	123.50	10.46
5759	Placebo	4.00	28.00	14.50	8.50	35.50	16.00	7.50	24.00	10.00	16.00	33.00	18.50	4.00	219.50	18.59
5762	Placebo	6.50	20.00	4.00	2.50	31.50	33.50	7.00	20.00	2.00	6.50	19.50	41.50	10.00	204.50	17.32
5763	Placebo	2.50	19.00	14.00	1.50	14.50	13.50	3.00	14.50	7.00	3.50	14.00	10.50	2.00	119.50	10.12
5766	Placebo	1.00	14.50	1.00	0.50	10.00	2.50	1.00	9.00	0.50	1.00	11.50	6.00	2.00	60.50	5.12
5772	Placebo	2.00	13.50	2.50	0.50	23.00	4.50	3.50	12.00	2.50	0.50	34.00	5.00	3.50	107.00	9.06
5778	Placebo	1.50	16.00	3.50	2.00	11.50	2.00	2.00	9.50	3.00	1.00	14.00	4.50	1.50	72.00	6.10
5781	Placebo	1.50	26.00	4.50	2.50	11.00	3.50	3.50	17.00	4.00	2.00	15.00	8.00	2.00	100.50	8.51
5787	Placebo	0.00	11.00	2.50	0.00	21.50	4.00	1.50	7.50	1.50	1.00	26.00	4.50	3.00	84.00	7.11
5796	Placebo	0.00	2.00	1.50	0.00	2.00	0.50	0.00	2.00	0.00	0.00	1.50	0.00	1.00	10.50	0.89
5703	Vaccinate	0.50	3.00	2.00	2.00	7.50	1.00	1.50	2.50	1.00	1.50	6.00	1.00	0.50	30.00	2.54
5704	Vaccinate	0.00	5.00	1.50	0.00	2.00	0.50	0.00	5.00	0.50	0.50	2.00	0.50	0.00	17.50	1.48
5705	Vaccinate	0.00	13.50	6.50	1.50	9.00	5.00	1.00	10.00	3.50	2.00	10.00	6.00	3.00	71.00	6.01
5710	Vaccinate	0.00	1.50	0.50	0.00	5.00	2.00	1.00	1.50	0.50	0.50	5.50	2.00	0.50	20.50	1.74
5722	Vaccinate	0.00	2.00	1.00	1.00	2.00	1.00	0.00	2.00	1.50	0.50	2.00	1.50	0.50	15.00	1.27
5731	Vaccinate	0.00	3.50	2.50	0.00	2.00	1.50	0.00	4.50	1.50	0.00	2.50	2.00	0.00	20.00	1.69
5738	Vaccinate	0.00	2.00	0.50	0.00	2.00	0.50	0.00	3.50	0.50	0.00	2.50	0.00	0.50	12.00	1.02
5740	Vaccinate	0.00	1.50	1.50	0.00	1.50	1.00	0.00	0.50	1.00	0.00	1.50	1.00	0.00	9.50	0.80
5745	Vaccinate	0.00	2.50	1.50	0.00	2.00	2.00	0.00	3.00	1.50	0.50	3.50	1.50	0.00	18.00	1.52
5752	Vaccinate	0.00	0.50	0.00	0.00	1.50	0.00	0.00	0.50	0.00	0.00	1.50	0.00	0.00	4.00	0.34
5754	Vaccinate	0.50	1.50	0.50	1.00	4.50	0.50	0.50	3.50	1.00	1.50	5.00	1.00	1.00	22.00	1.86
5755	Vaccinate	0.00	2.50	0.00	1.00	1.50	0.50	0.50	2.00	0.50	0.00	1.50	0.00	0.00	10.00	0.85
5758	Vaccinate	0.00	7.50	1.50	0.00	7.00	2.00	0.00	6.50	2.50	1.00	9.00	2.50	0.50	40.00	3.39
5761	Vaccinate	2.00	14.50	6.50	0.50	12.00	5.50	1.00	7.50	3.50	0.50	7.00	7.50	0.50	68.50	5.80
5765	Vaccinate	0.00	7.00	5.00	1.00	6.50	3.50	1.00	5.50	4.00	0.50	4.50	3.50	0.50	42.50	3.34
5773	Vaccinate	0.00	1.50	0.50	0.00	1.00	0.00	0.00	1.00	1.00	0.00	0.50	0.00	0.50	6.00	0.51
5784	Vaccinate	1.00	6.00	1.00	2.00	6.50	1.00	0.00	4.50	1.50	1.50	6.00	2.00	2.00	35.00	2.96
5786	Vaccinate	0.00	2.00	1.00	0.00	2.50	1.00	0.00	4.00	1.50	0.00	2.00	1.00	0.50	15.50	1.31
5793	Vaccinate	0.00	2.00	0.50	0.00	1.00	0.50	0.00	2.50	0.50	0.50	1.50	0.00	0.50	9.50	0.80
5798	Vaccinate	0.00	1.50	0.00	0.00	1.50	0.00	0.00	2.00	0.00	0.00	2.50	0.00	0.00	7.50	0.64

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<tr><td>Product Administration</td><td>Two doses, administered intramuscularly, three weeks apart.
NA1 (A/swine/IA/A01410307/2014 (H1N1)) – NA6 (A/swine/MN/A01483170/2014 (H1N1))
NA4 (A/swine/MI/A02077465/2015 (H1N2)) – NA2 (A/swine/IL/A01475495/2014 (H1N2))</td></tr>
<tr><td>Study Animals</td><td>Commercial pigs, three days of age at 1st vaccination; 32 vaccinates and 32 controls (placebo vaccinated).</td></tr>
<tr><td>Challenge Description</td><td>All pigs were challenged 38 days post second vaccination with swine influenza strain A/swine/Illinois/A01475495/2014 (H1N2)</td></tr>
<tr><td>Interval observed after challenge</td><td>Lung lesion scores were assessed 5 days post challenge on a subgroup of 20 vaccinates and 20 controls.</td></tr>
<tr><td>Results</td><td>Five number summary for lung lesion scores*:
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<tr><th>Group</th><th>Number</th><th>Minimum</th><th>Q1</th><th>Median</th><th>Q3</th><th>Maximum</th></tr>
<tr><td>Vaccinate</td><td>20</td><td>0.5</td><td>0.7</td><td>1.2</td><td>3.1</td><td>6.9</td></tr>
<tr><td>Placebo</td><td>20</td><td>5</td><td>9.1</td><td>11.8</td><td>22.1</td><td>37.3</td></tr>
</table>
*Lesion scores were calculated as the percentage of total lung area

Raw data are shown below.</td></tr>
<tr><td>USDA Approval Date</td><td>August 12, 2020</td></tr>
</table>

Table 1: Lung Lesion Scoring (LLS) by 1st Scorer

Pig ID	Treatment	DLA	DLC	DLD	DRA	DRC	DRD	VLA	VLC	VLD	VRA	VRC	VRD	INT	Total Lung Score	LLS
3006	Vaccinate	0.00	1.50	1.00	0.00	1.00	1.50	0.00	1.00	0.00	0.00	1.50	0.00	0.00	7.50	0.64
3009	Vaccinate	0.00	2.00	1.00	0.00	3.50	1.00	0.00	2.50	1.00	0.00	2.50	1.50	0.00	15.00	1.27
3014	Vaccinate	0.00	2.50	1.50	1.00	5.00	0.00	0.00	3.50	2.00	1.00	3.50	0.00	0.00	20.00	1.69
3015	Vaccinate	0.00	5.00	4.50	0.50	4.00	1.50	0.50	4.50	3.00	0.00	5.50	1.50	0.00	30.50	2.58
3024	Vaccinate	0.00	5.00	2.00	0.00	0.00	0.00	0.00	4.50	0.00	0.00	0.00	0.00	0.50	12.00	1.02
3027	Vaccinate	0.00	3.50	1.50	0.00	5.00	0.00	0.00	2.00	1.50	1.00	3.50	0.00	0.00	18.00	1.52
3036	Vaccinate	0.00	10.00	5.00	8.00	12.00	5.50	1.00	8.50	2.00	7.50	9.00	5.00	2.50	76.00	6.44
3037	Vaccinate	0.00	1.50	0.00	0.00	1.50	0.00	0.00	1.50	1.50	0.00	1.00	1.00	0.00	8.00	0.68
3041	Vaccinate	0.00	3.50	1.00	0.00	1.50	0.00	0.00	3.00	0.00	0.00	2.00	0.00	0.00	11.00	0.93
3042	Vaccinate	0.00	1.50	3.50	0.00	1.00	0.00	0.00	2.00	0.00	0.00	1.00	0.00	0.00	9.00	0.76
3046	Vaccinate	0.00	1.50	2.00	0.00	1.50	0.00	0.00	0.50	0.00	0.00	1.50	0.00	0.00	7.00	0.59
3047	Vaccinate	1.00	7.00	4.50	0.50	7.50	4.00	1.00	4.50	4.00	1.50	7.00	3.00	1.00	46.50	3.94
3052	Vaccinate	0.00	2.00	0.00	1.00	2.00	1.00	0.00	3.50	0.00	1.00	2.00	1.00	0.00	13.50	1.14
3056	Vaccinate	0.00	2.00	0.00	0.00	1.50	1.00	0.00	2.00	0.00	0.00	2.00	0.00	0.00	8.50	0.72
3066	Vaccinate	0.00	19.00	6.50	1.00	9.00	1.50	0.00	15.00	4.50	2.00	14.00	1.50	3.50	77.50	6.56
3067	Vaccinate	1.00	4.00	1.50	0.00	5.50	1.00	0.00	5.00	2.00	0.00	5.00	1.50	0.00	26.50	2.24
3068	Vaccinate	0.00	6.50	8.00	1.00	5.00	5.00	0.00	4.50	2.00	0.50	3.50	1.50	2.00	39.50	3.34
3070	Vaccinate	0.00	5.00	9.50	2.50	3.50	6.50	1.00	6.50	5.00	2.00	10.50	6.50	2.00	60.50	5.12
3076	Vaccinate	0.00	3.50	2.00	0.00	1.00	2.50	0.00	4.50	0.50	0.00	2.50	1.50	0.00	18.00	1.52
3078	Vaccinate	0.00	6.50	5.00	1.50	2.50	5.00	0.00	6.00	3.50	1.00	3.00	4.00	0.00	38.00	3.22
3003	Placebo	4.00	21.00	7.50	2.50	20.00	5.00	7.00	17.50	6.00	3.00	30.50	4.50	14.00	142.50	12.07
3005	Placebo	0.00	8.50	7.00	0.00	14.00	0.00	0.00	8.00	5.50	1.00	10.50	3.00	3.00	60.50	5.12
3017	Placebo	2.00	10.00	13.00	3.00	17.50	6.50	2.00	8.50	5.00	2.50	11.00	7.50	1.00	89.50	7.58
3020	Placebo	4.50	25.00	21.50	21.50	27.50	5.50	5.50	34.00	9.50	17.00	32.00	4.00	7.50	215.00	18.20
3021	Placebo	0.00	10.50	20.50	1.00	30.00	2.50	3.00	14.00	10.50	1.50	32.50	6.50	5.50	138.00	11.69
3022	Placebo	0.00	16.50	3.00	1.50	15.50	1.50	4.00	14.00	1.00	1.50	18.50	2.50	3.50	83.00	7.03
3034	Placebo	1.50	12.50	10.50	1.50	17.00	12.50	2.50	9.00	6.50	2.00	21.00	5.50	6.50	108.50	9.19
3039	Placebo	0.00	8.00	10.50	10.00	17.00	4.50	1.50	10.50	3.00	8.50	23.00	7.00	2.50	106.00	8.98
3043	Placebo	12.00	37.50	13.50	9.50	24.00	11.00	11.50	52.00	19.00	26.00	57.00	6.50	19.00	298.50	25.28
3044	Placebo	0.00	16.00	11.00	0.00	31.50	9.50	3.00	11.50	4.50	0.00	37.50	4.50	12.50	141.50	11.98
3045	Placebo	14.50	42.50	36.00	10.50	31.00	16.50	26.50	52.00	63.00	9.00	68.00	31.50	34.50	435.50	36.88
3049	Placebo	4.50	33.00	12.00	7.00	18.00	24.50	9.00	28.50	12.00	12.50	47.00	20.00	13.00	241.00	20.41
3058	Placebo	12.00	23.00	31.50	13.50	28.50	18.50	16.00	24.00	36.50	15.00	43.50	20.50	16.50	299.00	25.32
3061	Placebo	0.00	23.00	3.00	9.50	22.50	17.50	1.50	14.00	2.00	7.50	19.00	10.00	4.00	133.50	11.30
3064	Placebo	5.00	38.50	20.00	4.50	29.50	15.00	16.00	52.00	16.50	8.00	47.00	18.00	8.00	278.00	23.54
3065	Placebo	0.00	18.00	9.00	2.00	21.50	9.00	1.00	14.50	4.00	2.00	15.00	5.50	3.50	105.00	8.89
3069	Placebo	2.00	18.00	15.50	5.50	15.50	19.50	4.50	9.50	11.00	5.50	28.50	13.00	7.00	155.00	13.12
3072	Placebo	6.00	25.50	21.50	10.50	27.50	38.50	10.00	23.50	27.00	18.50	43.00	36.50	24.50	312.50	26.46
3081	Placebo	6.50	24.00	37.00	1.00	31.50	24.50	13.00	32.00	31.50	4.50	46.00	35.00	15.00	301.50	25.53
3082	Placebo	3.50	17.00	29.00	1.00	19.50	26.50	10.00	12.00	36.00	1.00	41.50	20.00	20.50	237.50	20.11

Code

DLA =	Dorsal Left Apical Lobe	VLA =	Ventral Left Apical Lobe
DLC =	Dorsal Left Cardiac Lobe	VLC =	Ventral Left Cardiac Lobe
DLD =	Dorsal Left Diaphragmatic Lobe	VLD =	Ventral Left Diaphragmatic Lobe
DRA =	Dorsal Right Apical Lobe	VRA =	Ventral Right Apical Lobe
DRC =	Dorsal Right Cardiac Lobe	VRC =	Ventral Right Cardiac Lobe
DRD =	Dorsal Right Diaphragmatic Lobe	VRD =	Ventral Right Diaphragmatic Lobe
INT =	Intermediate Lobe		

Table 2: Lung Lesion Scoring (LLS) by 2nd Scorer

Pig ID	Treatment	DLA	DLC	DLD	DRA	DRC	DRD	VLA	VLC	VLD	VRA	VRC	VRD	INT	Total Lung Score	LLS
3006	Vaccinate	0.00	1.50	0.50	0.00	1.50	1.00	0.00	1.00	0.00	0.50	1.00	0.00	0.00	7.00	0.59
3009	Vaccinate	0.00	2.00	1.00	0.00	4.00	1.00	0.00	1.50	1.00	0.00	2.00	1.00	0.50	14.00	1.19
3014	Vaccinate	0.00	0.50	1.50	0.00	2.50	0.00	0.00	1.00	2.50	0.00	1.50	0.00	0.50	10.00	0.85
3015	Vaccinate	0.50	3.50	1.50	0.00	3.00	1.50	0.50	4.50	2.50	0.00	3.00	1.50	0.00	22.00	1.86
3024	Vaccinate	0.00	2.50	0.50	0.00	0.00	0.00	0.00	1.50	1.00	0.00	0.00	0.00	0.00	5.50	0.47
3027	Vaccinate	0.00	1.00	2.00	0.00	2.50	0.00	0.00	2.00	0.00	0.00	2.00	0.00	0.00	9.50	0.80
3036	Vaccinate	0.00	9.00	2.50	4.50	6.50	5.00	0.00	9.50	2.00	6.00	8.00	4.00	1.50	58.50	4.95
3037	Vaccinate	0.00	1.00	0.00	0.00	1.50	0.00	0.00	0.00	0.00	0.00	2.50	0.00	0.00	5.00	0.42
3041	Vaccinate	1.00	3.50	0.50	0.00	2.00	0.00	0.00	3.00	0.00	0.00	1.50	0.50	0.00	12.00	1.02
3042	Vaccinate	0.00	0.00	2.50	0.00	0.00	0.00	0.00	2.50	0.00	0.00	0.00	0.00	0.00	5.00	0.42
3046	Vaccinate	0.00	1.00	2.00	0.00	0.50	0.00	0.00	0.50	1.00	0.50	0.00	0.00	0.00	5.50	0.47
3047	Vaccinate	0.50	4.50	2.50	0.00	7.00	3.50	0.00	4.00	2.00	0.00	7.50	4.50	0.50	36.50	3.09
3052	Vaccinate	0.00	2.00	0.50	0.50	2.00	0.00	0.00	3.00	0.00	1.50	1.00	1.50	0.00	12.00	1.02
3056	Vaccinate	0.00	1.50	0.00	0.00	1.00	0.00	0.00	1.50	0.50	0.00	2.00	0.00	0.00	6.50	0.55
3066	Vaccinate	0.00	24.00	7.00	1.50	9.50	2.50	1.50	17.50	5.00	2.50	11.00	2.00	2.00	86.00	7.28
3067	Vaccinate	1.00	8.00	3.00	0.00	9.00	1.00	0.50	5.50	2.50	0.00	9.50	1.00	1.00	42.00	3.56
3068	Vaccinate	0.00	7.00	5.50	1.50	6.00	3.00	0.50	7.00	3.00	2.00	9.50	1.50	2.00	48.50	4.11
3070	Vaccinate	0.50	5.00	8.50	1.00	6.00	4.00	0.00	5.50	5.00	2.00	7.00	7.00	2.50	54.00	4.57
3076	Vaccinate	0.00	2.00	3.00	0.00	1.50	0.50	0.50	1.50	0.00	0.00	2.00	1.50	0.00	12.50	1.06
3078	Vaccinate	0.00	4.50	5.50	0.50	2.00	3.50	0.00	4.00	2.50	0.50	2.00	5.00	0.00	30.00	2.54
3003	Placebo	2.00	19.00	4.00	3.50	28.00	3.50	6.50	19.50	6.00	3.00	24.50	4.50	12.50	136.50	11.56
3005	Placebo	0.00	11.50	5.50	0.00	11.00	0.00	0.00	10.00	3.00	1.00	10.50	4.00	1.50	58.00	4.91
3017	Placebo	1.50	5.50	9.00	1.50	26.50	8.00	4.50	9.00	8.00	3.00	20.50	10.00	1.50	108.50	9.19
3020	Placebo	4.50	26.50	13.50	9.00	27.00	3.00	8.50	30.50	12.00	20.00	37.00	4.50	5.00	201.00	17.02
3021	Placebo	0.00	11.00	13.50	0.00	26.50	2.00	2.50	13.50	8.50	2.00	33.00	5.00	3.50	121.00	10.25
3022	Placebo	0.00	11.50	2.00	3.00	11.50	0.50	1.00	13.00	0.50	0.50	16.00	2.00	2.00	63.50	5.38
3034	Placebo	2.00	11.50	5.50	1.50	30.00	7.00	1.00	11.50	4.00	1.50	21.50	5.50	6.50	109.00	9.23
3039	Placebo	0.50	8.00	6.50	9.50	18.50	2.00	2.00	9.50	7.00	10.00	22.00	10.00	0.00	105.50	8.93
3043	Placebo	10.00	32.50	15.50	17.50	37.00	11.00	15.50	48.50	20.00	30.50	53.50	10.50	24.50	326.50	27.65
3044	Placebo	0.00	21.50	6.00	0.00	28.00	7.00	4.00	11.00	6.00	0.50	33.00	7.50	13.00	137.50	11.64
3045	Placebo	16.50	34.00	44.00	8.50	36.50	28.00	25.00	52.00	72.00	10.00	57.00	32.50	29.50	445.50	37.72
3049	Placebo	3.50	32.50	13.00	6.00	19.00	16.50	7.50	31.00	13.00	10.00	32.00	10.00	7.50	201.50	17.06
3058	Placebo	10.00	25.50	18.00	5.50	22.50	12.00	14.50	29.50	28.50	10.50	38.50	17.50	14.00	246.50	20.87
3061	Placebo	0.00	21.50	3.00	6.50	26.50	8.00	2.00	15.50	3.50	5.00	21.00	7.00	2.00	121.50	10.29
3064	Placebo	4.50	30.50	15.00	4.50	41.50	16.00	9.00	36.50	14.00	9.00	33.00	17.00	7.00	237.50	20.11
3065	Placebo	0.50	12.00	6.50	3.50	18.00	8.50	1.00	12.00	4.00	3.50	22.00	6.50	1.50	99.50	8.43
3069	Placebo	2.00	12.00	10.00	4.50	17.50	11.50	2.50	9.50	6.00	2.50	32.00	11.50	3.00	124.50	10.54
3072	Placebo	7.50	29.00	19.00	8.00	30.00	14.00	10.00	26.50	17.00	8.50	40.00	33.50	25.00	268.00	22.69
3081	Placebo	4.00	22.00	17.00	1.50	36.00	27.00	12.00	24.00	30.00	6.50	45.00	33.50	10.50	269.00	22.78
3082	Placebo	4.50	13.50	14.50	0.00	29.00	14.00	6.00	17.50	26.00	1.50	30.00	15.50	15.50	187.50	15.88

Code

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DLC =	Dorsal Left Cardiac Lobe	VLC =	Ventral Left Cardiac Lobe
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DRA =	Dorsal Right Apical Lobe	VRA =	Ventral Right Apical Lobe
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INT =	Intermediate Lobe		

<table>
<tr><td>Study Type</td><td>Efficacy</td></tr>
<tr><td>Pertaining to</td><td>Swine Influenza Virus, H1N2</td></tr>
<tr><td>Study Purpose</td><td>Demonstrate efficacy against swine influenza virus, H1N2</td></tr>
<tr><td>Product Administration</td><td>Two doses, administered intramuscularly, three weeks apart.
NA1 (A/swine/IA/A01410307/2014 (H1N1)) – NA6 (A/swine/MN/A01483170/2014 (H1N1))
NA4 (A/swine/MI/A02077465/2015 (H1N2)) – NA2 (A/swine/IL/A01475495/2014 (H1N2))</td></tr>
<tr><td>Study Animals</td><td>Commercial pigs, three days of age at 1st vaccination; 31 vaccinates and 32 controls (placebo vaccinated).</td></tr>
<tr><td>Challenge Description</td><td>All pigs were challenged 34 days post second vaccination with swine influenza strain A/swine/Oklahoma/A01409770/2014 (H1N2, $N2_{1998}$ clade)</td></tr>
<tr><td>Interval observed after challenge</td><td>Lung lesion scores were assessed 5 days post challenge on a subgroup of 20 vaccinates and 20 controls.</td></tr>
<tr><td>Results</td><td>Five number summary for lung lesion scores*:
<table><tr><th>Group</th><th>Number</th><th>Minimum</th><th>Q1</th><th>Median</th><th>Q3</th><th>Maximum</th></tr><tr><td>Vaccinate</td><td>20</td><td>0.1</td><td>0.3</td><td>0.6</td><td>1.2</td><td>6.9</td></tr><tr><td>Placebo</td><td>20</td><td>1.9</td><td>4.3</td><td>7.2</td><td>9.8</td><td>17.2</td></tr></table>
*Lesion scores were calculated as the percentage of total lung area

Raw data are shown below.</td></tr>
<tr><td>USDA Approval Date</td><td>February 16, 2021</td></tr>
</table>

Table 1: Lung Lesion Scoring (LLS) by 1st Scorer

Pig ID	Treatment	DLA	DLC	DLD	DRA	DRC	DRD	VLA	VLC	VLD	VRA	VRC	VRD	INT	Total Lung Score	LLS
3	Placebo	2.00	2.50	2.00	1.50	9.50	1.00	3.50	3.00	1.50	3.00	15.00	2.50	4.50	51.50	4.36
5	Placebo	1.00	18.50	29.50	4.50	24.50	51.50	5.50	19.00	15.50	6.00	20.50	19.00	8.00	223.00	18.88
12	Placebo	1.50	8.50	2.50	8.00	6.00	1.00	2.00	8.50	3.00	7.00	6.00	3.00	2.00	59.00	5.00
16	Placebo	2.00	23.00	2.50	6.00	16.50	2.00	5.50	11.50	2.00	6.00	18.00	0.00	6.50	101.50	8.59
23	Placebo	2.00	8.50	1.50	3.00	10.50	3.00	3.00	4.50	1.50	2.00	12.00	3.00	2.50	57.00	4.83
25	Placebo	0.50	1.50	1.00	1.00	3.50	1.00	1.50	1.50	1.50	2.00	3.50	0.00	0.00	18.50	1.57
29	Placebo	1.50	13.50	0.00	2.50	21.00	3.50	2.50	11.00	0.00	2.00	16.50	1.50	5.50	81.00	6.86
32	Placebo	6.50	27.00	6.50	7.00	23.50	12.00	10.50	19.00	8.50	7.50	33.50	9.50	6.00	177.00	14.99
38	Placebo	0.00	6.50	4.00	2.00	5.00	5.00	1.50	4.00	3.00	2.50	6.50	2.50	0.00	42.50	3.60
39	Placebo	1.50	19.00	7.50	6.00	19.50	2.00	4.50	10.00	9.50	6.50	12.50	6.50	4.50	109.50	9.27
49	Placebo	3.00	25.00	2.00	7.50	26.00	7.50	3.00	32.50	8.00	6.00	51.00	10.50	8.50	190.50	16.13
50	Placebo	1.50	32.00	6.50	7.00	18.00	3.50	1.00	31.50	5.00	8.50	24.00	1.50	6.00	146.00	12.36
66	Placebo	0.50	9.00	0.00	3.50	6.50	0.50	0.00	11.50	0.50	4.00	8.50	1.00	5.00	50.50	4.28
68	Placebo	1.50	17.50	4.50	7.00	12.00	9.00	4.00	11.50	9.00	10.00	13.00	2.00	9.50	110.50	9.36
75	Placebo	0.50	15.50	6.00	7.50	23.50	21.50	9.00	20.50	18.00	7.00	32.50	15.00	13.00	189.50	16.05
76	Placebo	0.00	5.50	1.50	3.00	7.00	4.50	0.00	6.00	1.50	3.00	6.50	3.50	1.50	43.50	3.68
87	Placebo	0.50	16.00	3.50	2.50	19.00	1.00	2.00	12.50	0.50	3.00	15.50	2.50	5.00	83.50	7.07
88	Placebo	0.00	6.00	2.50	1.50	20.50	3.00	1.00	11.50	2.50	4.00	19.50	2.00	1.50	75.50	6.39
97	Placebo	0.00	0.00	0.50	8.50	24.00	10.50	0.00	0.00	0.00	8.00	23.00	8.00	5.00	87.50	7.41
99	Placebo	0.00	0.00	0.00	0.00	20.00	0.00	0.00	0.00	0.00	0.00	20.00	0.00	2.00	42.00	3.56
1	Vaccinate	0.00	8.00	6.50	0.00	16.50	11.50	0.00	8.00	8.50	0.00	19.50	8.50	1.00	88.00	7.45
6	Vaccinate	0.00	0.00	0.00	0.50	0.00	0.00	0.00	0.00	0.50	0.00	0.00	0.00	0.00	1.00	0.08
10	Vaccinate	1.00	4.50	1.50	1.00	1.50	1.00	0.50	2.50	1.00	0.00	0.00	1.50	0.50	16.50	1.40
13	Vaccinate	0.00	0.50	0.50	0.00	0.50	0.00	0.00	0.50	0.00	0.00	0.50	0.00	0.00	2.50	0.21
20	Vaccinate	0.00	1.50	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	1.00	0.00	0.00	3.50	0.30
24	Vaccinate	0.50	3.00	2.50	0.50	2.50	2.00	0.50	2.50	1.00	0.50	1.00	0.00	0.00	16.50	1.40
27	Vaccinate	0.00	1.50	2.00	0.00	3.00	1.50	0.00	1.00	0.50	0.00	3.00	1.00	0.00	13.50	1.14
28	Vaccinate	0.00	1.00	0.50	0.00	0.00	0.00	0.00	1.00	1.00	0.00	0.00	0.00	0.00	3.50	0.30
35	Vaccinate	0.00	1.50	2.00	0.00	1.00	0.00	0.00	1.00	1.50	0.00	1.00	0.50	0.00	8.50	0.72
37	Vaccinate	0.00	5.00	2.50	1.50	4.50	5.00	0.00	8.50	1.50	1.50	5.00	2.00	0.50	37.50	3.18
51	Vaccinate	0.00	3.50	0.00	0.50	1.50	0.50	0.00	1.00	1.00	0.50	1.00	0.50	0.50	10.50	0.89
55	Vaccinate	0.00	1.00	0.00	0.00	0.50	0.00	0.00	1.00	0.00	0.00	0.50	0.00	0.50	3.50	0.30
64	Vaccinate	0.00	2.50	1.00	0.00	4.50	0.00	0.50	2.50	0.50	0.50	3.50	0.00	1.50	17.00	1.44
69	Vaccinate	0.00	0.00	0.00	0.00	1.50	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	2.50	0.21
72	Vaccinate	0.00	1.00	0.00	0.00	2.00	0.00	0.00	1.00	0.00	0.00	1.50	0.00	0.00	5.50	0.47
77	Vaccinate	0.00	1.00	0.00	0.50	1.00	0.00	0.00	0.50	0.00	0.00	0.50	0.00	0.00	3.50	0.30
89	Vaccinate	1.00	16.50	2.50	0.00	3.50	0.00	0.00	4.50	1.00	0.00	3.00	0.50	1.00	33.50	2.84
90	Vaccinate	0.00	0.00	0.00	1.50	0.50	0.00	0.00	0.00	0.00	2.00	0.00	0.00	0.00	4.00	0.34
98	Vaccinate	0.00	1.50	1.00	0.00	1.50	0.50	0.00	1.50	0.50	0.00	1.00	1.00	0.50	9.00	0.76
100	Vaccinate	0.00	1.00	0.00	0.50	1.50	0.00	0.00	0.50	0.00	0.00	3.50	0.00	0.00	7.00	0.59

Code

DLA =	Dorsal Left Apical Lobe	VLA =	Ventral Left Apical Lobe
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INT =	Intermediate Lobe		

Table 2: Lung Lesion Scoring (LLS) by 2nd Scorer

Pig ID	Treatment	DLA	DLC	DLD	DRA	DRC	DRD	VLA	VLC	VLD	VRA	VRC	VRD	INT	Total Lung Score	LLS
3	Placebo	2.50	1.00	1.00	2.00	14.00	1.00	3.50	3.00	1.00	4.00	15.00	1.00	3.00	52.00	4.40
5	Placebo	1.50	20.00	17.50	3.50	16.00	42.50	7.00	18.00	8.50	4.00	16.00	21.50	8.00	184.00	15.58
12	Placebo	1.50	10.00	2.50	6.00	4.50	0.50	2.00	10.00	2.00	6.00	4.50	3.50	1.00	54.00	4.57
16	Placebo	3.00	16.00	2.00	11.00	11.50	1.50	5.00	15.00	1.00	10.50	17.50	1.50	4.00	99.50	8.43
23	Placebo	2.00	7.00	1.50	2.50	7.50	3.00	3.00	6.00	0.50	2.50	3.50	3.00	1.00	43.00	3.64
25	Placebo	0.50	2.00	2.00	2.00	7.00	1.50	1.00	1.50	1.50	2.00	4.50	0.50	1.00	27.00	2.29
29	Placebo	1.00	9.50	0.50	2.00	19.00	2.50	0.00	14.00	1.00	2.50	26.50	4.00	5.00	87.50	7.41
32	Placebo	9.00	23.50	8.00	3.00	24.50	7.50	10.50	18.50	7.00	10.00	36.00	9.00	1.00	167.50	14.18
38	Placebo	0.50	4.00	2.50	2.00	3.00	1.50	1.50	4.00	1.50	2.00	5.00	2.00	0.50	30.00	2.54
39	Placebo	2.50	18.50	6.00	5.50	13.50	3.00	3.50	14.50	6.00	7.00	20.50	2.00	2.50	105.00	8.89
49	Placebo	2.00	30.50	3.50	5.00	20.50	6.00	4.00	31.00	8.50	13.00	48.00	10.50	5.00	187.50	15.88
50	Placebo	1.00	30.50	3.50	5.00	19.50	1.00	1.00	31.00	3.00	6.50	24.50	2.50	12.00	141.00	11.94
66	Placebo	1.00	14.00	1.50	6.50	14.50	0.00	0.50	8.50	0.50	6.50	10.00	1.00	5.50	70.00	5.93
68	Placebo	1.00	13.50	4.50	6.00	6.00	4.50	2.50	10.00	5.50	12.00	12.50	2.50	5.00	85.50	7.24
75	Placebo	1.50	13.00	6.00	6.50	28.50	8.00	6.00	19.50	19.00	10.50	36.00	20.00	17.00	191.50	16.22
76	Placebo	0.50	5.00	0.50	2.00	5.00	2.00	0.00	5.50	0.50	3.00	5.50	2.00	1.00	32.50	2.75
87	Placebo	1.50	20.00	5.00	2.00	11.00	2.00	4.00	14.00	0.50	3.00	15.50	3.50	4.00	86.00	7.28
88	Placebo	0.00	7.00	4.00	2.50	13.50	5.50	1.00	12.00	2.50	4.50	22.00	3.50	3.00	81.00	6.86
97	Placebo	0.50	0.00	1.00	6.50	25.50	7.00	0.00	0.50	0.50	6.00	32.00	5.50	2.00	87.00	7.37
99	Placebo	0.00	1.00	0.00	0.00	22.50	0.00	0.00	1.00	0.00	0.50	15.50	0.00	3.50	44.00	3.73
1	Vaccinate	0.00	5.00	8.50	0.50	15.00	10.50	0.50	4.00	4.50	1.50	15.50	8.00	1.00	74.50	6.31
6	Vaccinate	0.00	0.00	0.50	0.50	0.00	0.00	0.00	0.00	0.50	0.00	0.00	0.50	0.50	2.50	0.21
10	Vaccinate	0.50	3.50	1.50	1.00	3.50	1.00	1.00	4.00	1.00	0.50	0.50	1.00	0.50	19.50	1.65
13	Vaccinate	0.00	0.50	0.50	0.00	0.50	0.50	0.00	0.50	0.50	0.50	0.50	0.00	0.50	4.50	0.38
20	Vaccinate	0.00	1.50	0.00	0.00	0.50	0.00	0.00	1.50	0.00	0.00	1.00	0.00	0.00	4.50	0.38
24	Vaccinate	0.00	1.00	1.50	0.00	1.00	0.00	0.50	3.50	1.00	0.00	2.00	0.50	0.50	11.50	0.97
27	Vaccinate	0.50	1.50	0.50	0.00	2.00	0.50	1.00	1.00	1.50	0.00	2.00	0.50	0.50	11.50	0.97
28	Vaccinate	0.00	1.00	1.00	0.00	0.00	1.00	0.00	1.00	1.00	0.00	1.00	0.00	0.00	6.00	0.51
35	Vaccinate	0.00	1.50	0.50	0.50	0.50	0.00	0.00	1.00	1.50	0.00	0.50	1.00	0.00	7.00	0.59
37	Vaccinate	0.00	8.50	3.50	1.00	4.00	3.50	1.00	9.00	1.50	2.00	8.00	2.50	0.50	45.00	3.81
51	Vaccinate	0.00	2.50	1.00	1.00	1.50	1.00	0.00	2.50	1.00	1.00	2.00	1.00	1.00	15.50	1.31
55	Vaccinate	0.00	0.50	0.00	0.00	0.50	0.00	0.50	1.00	0.00	0.50	0.50	0.00	0.00	3.50	0.30
64	Vaccinate	0.00	2.00	0.50	0.50	2.00	0.00	0.50	1.50	0.50	0.50	2.50	0.00	1.50	12.00	1.02
69	Vaccinate	0.00	0.00	0.50	0.00	0.50	0.00	0.00	1.00	0.00	0.00	1.00	0.00	0.50	3.50	0.30
72	Vaccinate	0.00	1.50	0.00	0.00	2.50	0.00	0.00	1.50	0.00	0.00	1.50	0.00	0.50	7.50	0.64
77	Vaccinate	0.00	1.50	0.00	0.50	1.00	0.00	0.00	0.50	0.50	0.00	0.50	0.00	0.00	4.50	0.38
89	Vaccinate	2.00	8.00	3.00	0.50	4.00	0.00	0.50	5.50	1.50	0.50	4.50	0.50	0.50	31.00	2.62
90	Vaccinate	0.50	0.00	0.50	1.00	0.00	0.00	0.00	0.00	0.00	2.00	0.00	0.00	0.00	4.00	0.34
98	Vaccinate	0.00	1.00	1.50	0.50	1.50	0.50	0.00	1.50	0.50	0.50	1.00	2.00	0.50	11.00	0.93
100	Vaccinate	0.00	1.00	0.00	0.50	1.50	0.00	0.00	1.00	0.00	0.50	2.00	0.50	0.00	7.00	0.59

Code

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<table>
<tr><td>Study Type</td><td>Efficacy</td></tr>
<tr><td>Pertaining to</td><td>Swine Influenza Virus, H3N2</td></tr>
<tr><td>Study Purpose</td><td>Demonstrate efficacy against swine influenza virus, H3N2</td></tr>
<tr><td>Product Administration</td><td>Two doses, administered intramuscularly, three weeks apart.
NA1 (A/swine/IA/A01410307/2014 (H1N1)) – NA6 (A/swine/MN/A01483170/2014 (H1N1))
NA4 (A/swine/MI/A02077465/2015 (H1N2)) – NA2 (A/swine/IL/A01475495/2014 (H1N2))</td></tr>
<tr><td>Study Animals</td><td>Commercial pigs, three days of age at 1st vaccination; 32 vaccinates and 32 controls (placebo vaccinated).</td></tr>
<tr><td>Challenge Description</td><td>All pigs were challenged 34 days post second vaccination with swine influenza strain A/swine/Missouri/A01840724/2015 (H3N2, $N2_{2002}$ clade)</td></tr>
<tr><td>Interval observed after challenge</td><td>Lung lesion scores were assessed 5 days post challenge on a subgroup of 20 vaccinates and 20 controls.</td></tr>
<tr><td>Results</td><td>Five number summary for lung lesion scores*:
<table>
<tr><th>Group</th><th>Number</th><th>Minimum</th><th>Q1</th><th>Median</th><th>Q3</th><th>Maximum</th></tr>
<tr><td>Vaccinate</td><td>20</td><td>0.7</td><td>1.4</td><td>2.3</td><td>3.5</td><td>9.2</td></tr>
<tr><td>Placebo</td><td>20</td><td>4</td><td>5.7</td><td>10.5</td><td>13.7</td><td>21.2</td></tr>
</table>
*Lesion scores were calculated as the percentage of total lung area

Raw data are shown below.</td></tr>
<tr><td>USDA Approval Date</td><td>September 24, 2020</td></tr>
</table>

Table 1: Lung Lesion Scoring (LLS) by 1st Scorer

Pig ID	Treatment	DLA	DLC	DLD	DRA	DRC	DRD	VLA	VLC	VLD	VRA	VRC	VRD	INT	Total Lung Score	LLS
3111	Placebo	0.00	19.00	5.00	1.00	13.00	6.00	1.50	8.50	2.50	0.00	8.00	4.50	1.00	70.00	5.93
3114	Placebo	0.00	16.50	1.00	0.00	10.00	1.50	1.00	10.00	0.50	0.00	6.50	1.00	0.00	48.00	4.06
3116	Placebo	0.00	4.50	1.50	0.00	13.00	3.00	0.00	7.00	1.00	0.00	8.00	4.50	3.50	46.00	3.90
3120	Placebo	1.00	23.00	10.50	5.00	22.00	5.00	4.50	20.00	13.00	3.50	21.00	4.50	3.00	136.00	11.52
3121	Placebo	9.50	31.50	2.50	7.00	22.50	13.00	9.00	30.00	2.50	17.00	37.00	15.50	8.00	205.00	17.36
3122	Placebo	0.00	29.00	7.00	0.00	13.50	7.50	0.00	17.00	5.50	0.00	16.50	6.00	2.00	104.00	8.81
3126	Placebo	1.00	29.00	4.50	0.00	23.50	6.00	6.00	25.50	7.50	0.00	38.00	4.00	1.00	146.00	12.36
3128	Placebo	1.50	23.50	4.00	4.50	34.00	9.00	8.00	22.50	2.00	5.50	28.50	10.00	9.00	162.00	13.72
3132	Placebo	6.00	27.00	38.00	4.50	27.00	28.00	12.00	24.00	20.00	3.50	34.00	22.00	5.50	251.50	21.30
3133	Placebo	0.00	22.00	17.50	0.00	23.00	9.00	3.00	19.00	12.00	0.00	12.00	11.00	2.50	131.00	11.09
3142	Placebo	0.00	8.50	7.50	2.00	7.00	3.00	1.00	6.00	5.00	1.50	4.50	3.50	0.00	49.50	4.19
3143	Placebo	1.00	7.00	6.00	1.00	13.00	5.00	0.50	8.00	4.50	1.00	12.00	3.00	0.00	62.00	5.25
3156	Placebo	5.50	28.50	6.50	13.50	27.00	21.50	3.00	23.50	4.50	21.00	55.00	17.00	14.00	240.50	20.36
3159	Placebo	2.00	21.50	16.50	2.00	25.00	8.00	2.50	16.50	9.00	4.00	17.50	4.00	1.50	130.00	11.01
3163	Placebo	0.00	23.50	9.00	1.00	9.00	3.00	1.00	16.00	7.00	1.50	8.00	4.00	3.00	86.00	7.28
3164	Placebo	0.00	11.00	6.50	1.00	12.00	2.50	2.00	8.50	3.50	0.50	10.00	3.00	2.00	62.50	5.29
3172	Placebo	2.00	12.00	2.50	1.50	22.00	8.00	3.00	10.50	2.50	1.50	26.00	4.00	3.50	99.00	8.38
3182	Placebo	1.50	35.50	10.00	4.00	24.00	6.50	6.00	30.00	5.50	6.00	26.00	7.00	9.00	171.00	14.48
3185	Placebo	1.00	19.00	4.00	10.00	27.00	6.50	5.00	16.00	3.00	13.00	35.50	7.00	4.50	151.50	12.83
3191	Placebo	1.00	22.00	9.50	3.00	18.50	9.00	1.00	18.00	8.50	3.50	18.00	6.50	8.00	126.50	10.71
3113	Vaccinate	0.00	2.00	2.00	0.00	1.00	0.00	0.00	1.00	1.00	0.00	1.00	0.00	0.00	8.00	0.68
3115	Vaccinate	0.00	0.00	3.00	0.50	0.50	0.50	0.00	2.00	3.50	1.00	1.00	2.00	0.50	14.50	1.23
3117	Vaccinate	0.00	2.50	1.50	1.00	1.50	2.50	0.00	3.50	3.00	0.00	1.50	2.00	0.00	19.00	1.61
3118	Vaccinate	0.00	2.00	0.50	0.50	3.00	1.00	0.00	1.50	0.00	0.00	4.00	1.00	1.50	15.00	1.27
3123	Vaccinate	1.50	10.50	4.50	0.50	6.00	3.00	1.50	8.00	0.00	0.00	3.50	3.00	0.50	42.50	3.60
3127	Vaccinate	0.00	1.50	3.00	0.00	1.50	2.50	0.00	1.50	1.00	0.00	1.00	1.00	0.00	13.00	1.10
3129	Vaccinate	0.00	2.50	1.00	0.00	1.00	1.50	0.00	1.50	0.00	0.00	1.00	0.00	0.00	8.50	0.72
3130	Vaccinate	0.00	11.00	13.00	1.00	12.00	19.00	0.00	8.50	12.00	1.00	10.00	12.00	2.50	102.00	8.64
3136	Vaccinate	0.00	1.00	2.50	0.00	2.00	1.50	0.00	1.50	0.00	0.00	3.00	1.00	0.00	12.50	1.06
3140	Vaccinate	0.00	4.50	1.50	1.00	9.00	6.00	0.00	3.00	3.00	1.50	7.50	5.00	1.50	43.50	3.68
3144	Vaccinate	0.00	6.00	4.00	0.50	3.00	1.50	0.00	5.00	2.00	0.00	4.50	1.50	0.50	28.50	2.41
3145	Vaccinate	0.00	3.00	3.50	2.00	4.00	1.50	0.00	4.00	5.00	3.00	5.00	1.50	1.00	33.50	2.84
3154	Vaccinate	0.50	4.50	2.00	1.50	4.00	0.50	0.50	3.00	1.50	1.00	4.50	1.00	0.50	25.00	2.12
3155	Vaccinate	0.00	2.50	1.00	0.50	5.00	1.00	1.00	5.00	1.00	1.00	5.00	1.50	0.00	24.50	2.07
3162	Vaccinate	0.00	2.50	2.00	0.00	2.50	0.00	0.00	3.00	1.00	0.00	2.00	0.00	0.00	13.00	1.10
3166	Vaccinate	4.50	14.50	7.00	3.50	11.50	5.00	3.00	14.00	7.00	3.00	14.00	10.50	8.00	105.50	8.93
3179	Vaccinate	0.00	2.00	4.00	3.00	6.00	4.00	0.50	3.00	1.50	3.00	2.00	3.00	1.00	33.00	2.79
3180	Vaccinate	0.00	16.00	4.50	1.00	9.00	1.00	1.00	11.00	6.00	1.00	11.00	2.00	1.50	65.00	5.50
3186	Vaccinate	0.50	2.50	3.50	1.50	4.00	1.00	1.50	2.00	2.00	1.50	3.00	1.00	1.00	25.00	2.12
3188	Vaccinate	0.50	2.50	3.50	2.00	2.00	0.00	0.50	2.50	2.50	2.50	2.00	0.00	1.00	21.50	1.82

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Table 2: Lung Lesion Scoring (LLS) by 2nd Scorer

Pig ID	Treatment	DLA	DLC	DLD	DRA	DRC	DRD	VLA	VLC	VLD	VRA	VRC	VRD	INT	Total Lung Score	LLS
3111	Placebo	0.00	12.50	3.00	1.00	10.00	4.50	1.50	9.50	4.50	1.00	10.50	4.50	2.00	64.50	5.46
3114	Placebo	0.00	13.00	1.50	0.00	7.00	1.50	1.00	12.50	0.50	0.50	6.00	1.00	1.00	45.50	3.85
3116	Placebo	1.00	9.00	2.50	0.00	12.00	2.50	1.50	8.50	4.00	0.00	20.00	5.00	4.00	70.00	5.93
3120	Placebo	1.00	21.50	9.50	3.00	22.00	3.50	4.00	19.50	9.50	3.00	21.00	3.50	2.00	123.00	10.41
3121	Placebo	9.00	38.50	2.50	14.00	26.00	12.00	10.00	27.00	2.00	12.00	45.00	15.50	7.00	220.50	18.67
3122	Placebo	0.50	28.50	5.00	0.50	13.50	7.50	0.50	19.00	3.50	1.00	13.00	4.50	2.00	99.00	8.38
3126	Placebo	4.50	30.00	6.00	0.00	28.50	7.00	10.00	24.00	9.50	0.00	41.00	7.00	3.50	171.00	14.48
3128	Placebo	4.50	24.00	5.00	3.50	23.00	24.50	9.50	25.00	3.50	5.50	28.00	20.00	11.50	187.50	15.88
3132	Placebo	8.00	33.00	31.00	4.00	20.50	18.00	12.00	27.50	19.50	4.50	42.00	18.00	10.50	248.50	21.04
3133	Placebo	1.50	21.00	16.00	0.50	11.00	5.00	4.50	20.00	8.50	0.00	15.00	6.00	1.50	110.50	9.36
3142	Placebo	0.00	14.00	6.00	2.00	6.50	3.00	0.50	8.00	4.50	2.50	4.00	5.00	0.50	56.50	4.78
3143	Placebo	0.50	12.50	4.00	1.00	15.00	4.50	1.00	7.00	4.50	2.00	15.00	4.50	0.50	72.00	6.10
3156	Placebo	5.00	50.00	22.00	6.00	34.00	8.00	11.00	29.50	11.50	4.00	36.50	5.50	7.00	230.00	19.48
3159	Placebo	2.00	23.50	10.50	3.50	24.00	9.00	3.00	25.00	11.00	4.00	16.00	5.00	1.50	138.00	11.69
3163	Placebo	0.50	22.50	11.00	2.00	15.00	5.00	1.50	17.00	8.50	3.00	11.50	6.00	5.00	108.50	9.19
3164	Placebo	0.00	8.50	4.50	0.50	12.50	9.00	2.00	8.00	3.50	0.50	14.00	6.00	1.50	70.50	5.97
3172	Placebo	1.50	14.00	2.50	2.00	24.00	4.00	5.00	11.50	2.50	2.50	21.00	5.00	5.00	100.50	8.51
3182	Placebo	2.50	31.00	6.00	5.00	27.50	6.50	4.00	21.00	6.50	9.00	38.00	6.00	6.50	169.50	14.35
3185	Placebo	1.00	21.50	6.50	6.50	25.00	5.50	4.00	17.50	2.50	8.00	28.50	8.00	6.00	140.50	11.90
3191	Placebo	1.00	21.00	8.50	4.50	18.00	5.50	3.00	17.50	7.00	4.50	23.00	5.50	8.00	127.00	10.75
3113	Vaccinate	0.00	3.00	1.00	0.00	1.50	0.50	0.00	2.00	1.00	0.00	0.50	0.00	0.00	9.50	0.80
3115	Vaccinate	0.50	3.00	2.00	0.50	1.00	0.50	1.00	2.00	4.00	0.50	2.50	3.00	1.00	21.50	1.82
3117	Vaccinate	0.00	3.00	0.00	0.50	1.50	2.00	0.00	3.00	3.00	0.00	3.00	2.50	0.00	18.50	1.57
3118	Vaccinate	0.50	2.50	1.00	1.00	3.00	0.50	0.00	2.50	0.00	0.50	4.00	2.00	1.50	19.00	1.61
3123	Vaccinate	2.00	13.00	3.00	1.50	5.00	4.00	1.50	9.00	2.00	0.00	4.50	3.00	0.50	49.00	4.15
3127	Vaccinate	0.00	4.50	2.50	0.00	2.00	2.00	0.00	4.00	0.50	0.00	3.00	1.00	0.50	20.00	1.69
3129	Vaccinate	0.00	2.50	2.00	0.00	1.50	1.00	0.00	3.00	1.00	0.00	2.50	1.00	0.50	15.00	1.27
3130	Vaccinate	0.00	11.50	11.00	1.00	11.50	13.00	0.00	11.00	9.50	2.00	14.00	13.50	2.50	100.50	8.51
3136	Vaccinate	0.00	1.00	1.50	0.00	2.00	0.50	0.00	2.00	0.50	0.00	2.50	1.00	0.00	11.00	0.93
3140	Vaccinate	0.00	6.50	3.50	3.00	6.00	5.50	0.00	7.00	4.00	4.00	6.00	5.00	1.50	52.00	4.40
3144	Vaccinate	0.50	5.50	4.00	1.00	3.50	2.00	1.00	4.00	2.00	2.00	5.50	1.50	0.50	33.00	2.79
3145	Vaccinate	0.00	2.50	4.50	2.00	5.50	1.50	0.00	3.00	4.50	2.00	6.00	2.50	0.50	34.50	2.92
3154	Vaccinate	1.00	5.50	2.00	1.50	7.00	0.50	2.00	6.00	2.00	0.00	6.00	0.50	1.00	35.00	2.96
3155	Vaccinate	1.50	6.00	2.00	0.50	7.50	2.50	1.00	5.00	1.50	1.50	7.00	2.00	0.50	38.50	3.26
3162	Vaccinate	0.00	1.50	1.00	0.00	2.00	0.50	0.50	2.00	1.00	0.00	3.00	0.00	0.00	11.50	0.97
3166	Vaccinate	3.00	12.50	5.50	3.50	13.00	7.50	8.00	15.00	7.00	6.00	14.00	10.00	7.00	112.00	9.48
3179	Vaccinate	0.50	4.00	4.00	4.00	8.00	3.50	1.00	4.50	3.00	3.50	5.50	4.00	1.00	46.50	3.94
3180	Vaccinate	1.50	12.00	5.00	1.50	15.00	1.50	1.50	3.00	6.00	2.00	13.50	4.50	2.00	69.00	5.84
3186	Vaccinate	1.00	3.00	2.50	1.00	2.00	1.50	1.50	3.00	2.00	1.00	2.00	1.00	0.00	21.50	1.82
3188	Vaccinate	0.00	5.00	2.50	2.00	3.50	0.00	0.50	3.50	2.00	3.00	2.00	0.50	0.50	25.00	2.12

Code

DLA =	Dorsal Left Apical Lobe	VLA =	Ventral Left Apical Lobe
DLC =	Dorsal Left Cardiac Lobe	VLC =	Ventral Left Cardiac Lobe
DLD =	Dorsal Left Diaphragmatic Lobe	VLD =	Ventral Left Diaphragmatic Lobe
DRA =	Dorsal Right Apical Lobe	VRA =	Ventral Right Apical Lobe
DRC =	Dorsal Right Cardiac Lobe	VRC =	Ventral Right Cardiac Lobe
DRD =	Dorsal Right Diaphragmatic Lobe	VRD =	Ventral Right Diaphragmatic Lobe
INT =	Intermediate Lobe		

Study Type	Safety
Pertaining to	All
Study Purpose	Demonstrate safety of product under typical use conditions.
Product Administration	2 doses administered intramuscularly (IM) 3 weeks apart.
Study Animals	748 pigs, 3-5 days of age, distributed among 3 study sites.
Challenge Description	Not applicable
Interval observed after challenge	Animals were observed for systemic and/or local injection site reactions, and various adverse events (AEs) per VeDDRA guidance for 21 days after each vaccination, or until resolution.
Results	

Site	Total Number animals	Max. Size of injection site reaction			1st or 2nd Vaccination	Injection site reactions not observed
		<1.5 cm	1.5 to 5 cm	5 to 10 cm		
1	240	0	0	0	1	240
	226	33	19	1	2	173
2	247	8	0	0	1	239
	235	22	5	0	2	208
3	259	20	2	0	1	237
	253	7	2	0	2	244
Total All Sites	746	28	2	0	1	716
	714	62	26	1	2	625

VeDDRA Code	Total Animals	Percent of All Animals
No adverse events	525	70.20%
Anorexia	55	7.40%
Death	24	3.20%
Lameness	20	2.70%
Loss of Condition	12	1.60%
Diarrhea	11	1.50%
Unthrifty	7	0.90%
Anaphylaxis^	3	0.40%
Central Nervous System Disorder*	3	0.40%
Lethargy	3	0.40%
Respiratory Tract Infection*	3	0.40%
Arthritis	2	0.30%
Meningitis	2	0.30%
Musculoskeletal Disorder*	2	0.30%
Trauma*	2	0.30%
Abdominal Caviry Hernia	1	0.10%
Abscess*	1	0.10%
*Not otherwise specified		
^Related to IVP		

USDA Approval Date	December 13, 2021

SLatypova_mRNA_DNA vax in animals.pdf
Uploaded by: Janci Lindsay
Position: FAV

Genetic vaccines (mRNA/DNA) in animal use

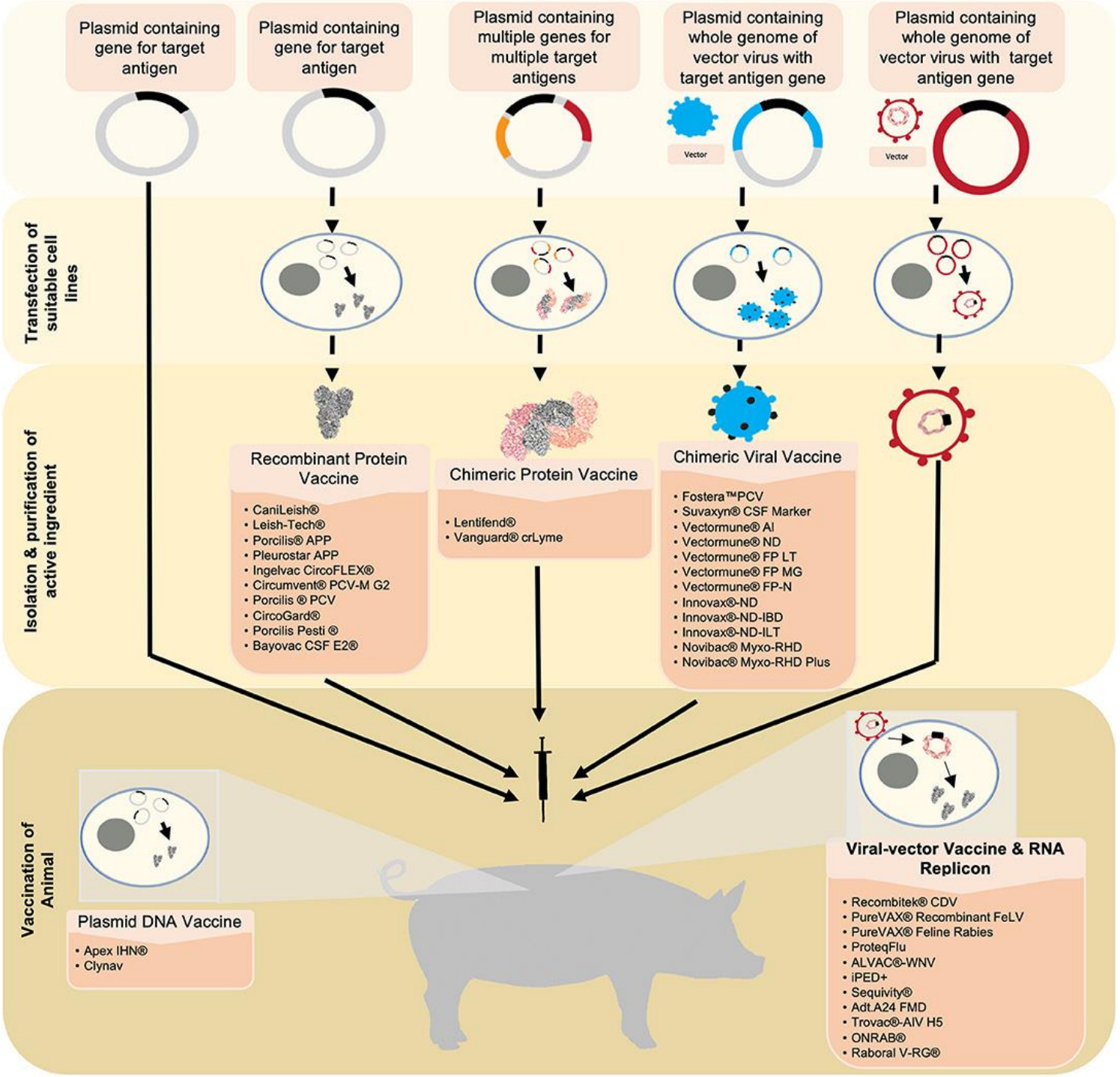
Implications for animal health, human health, our combined microbiome and environment

Special considerations for use as “Countermeasures under Public Health Emergency”

Sasha Latypova, latypova@hotmail.com

Summary

- Genetic biologics (DNA/RNA) have been licensed in the US for both human and veterinary vaccines, and as a new pesticide.
- Safety concerns include transfection of cells and genomes with non-self, non-species genetic codes, shedding risks, GMO status and transparent labeling.
- Ease of contamination and adulteration, difficulty of timely detection of same without highly specialized equipment and staff.
- Approval of “platform technologies” enables rapid production of biologics that are impossible to test for safety before mass deployment.



DNA plasmids are a common starting raw material for “new generation” of genetic vaccines

DNA plasmids “transfect” cells – transfer genetic code into another cell’s genome

- Viral vectors utilize engineered viruses that express the gene of interest. VV vaccines release the recombinant genes into the host cells.
- RNA replicon vaccines utilize RNA segment that encodes the desired antigens encapsulated in a vesicle carrier

Forcing Animal to Express NON-Self Proteins

- DNA vaccines are pushed as a method to control the uncontrollable – illness/death due to intense commercial farming methods:
  - Overcrowding, unnatural stressful conditions
  - Pollution with biologic and chemical waste

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Genetic DNA/RNA Vaccines for Animals/Fish

- 2005, APEX-IHN (Novartis/Elanco) for Atlantic salmon against Infectious Hematopoietic Necrosis Virus (IHNV), British Colombia.
- West Nile Innovator - DNA (Fort Dodge Animal Health/Pfizer) for West Nile virus in condors and horses.
- Oncept (Merial) against dog melanoma.
- In 2017, CLYNAV (Elanco), a polyprotein-encoding DNA vaccine against Salmon Pancreas Disease Virus (SPDV) infection in Atlantic salmon was authorized by the European Medicines Agency (EMA).
- Sequivity (Merck) in swine (2017) – Emergency use in Canada, fully licensed in US (USDA, 2021). “Platform” for making farm-specific injections based on RNA-particle technology.

Risks to human genome/biome are not properly studied, waived off as “small chance”… claim rapid degradation of DNA plasmids (in mice)…

6. Safety aspects

Some potential risks have been associated with DNA vaccination. With respect to the vaccinated host, these include integration into genome and disruption of biological processes, and potential unwanted immune responses such as auto-immunity or tolerance to the pathogen [175,176]. Limited data is available for fish, but no significant adverse effects on the host have been identified in initial safety testing in humans [177].

The risks to the consumer concerns the potential ingestion of any residual plasmid from food products, containing elements such as human viral promoter regions (such as the CMV promoter) or antibiotic resistance genes that could potentially have harmful consequences if integrating into the consumers' genome or taken up by their gut microflora. However, this risk is considered negligible since the consumer is one step removed from the presentation of vaccine to the vaccinated animal, and at the site of vaccine injection there is a rapid degradation of the plasmid, within 90 min after vaccination in mice [178]. Fast degradation of the plasmid has also been observed in fish [82]. Con-

Collins et al, “DNA Vaccines in Fish and Aquaculture” https://doi.org/10.1016/j.fsi.2018.07.012

DNA Plasmids Found in Fish Muscle 320 Days Post Vaccination!

Table 8. Persistence of plasmids in epaxial muscle of rainbow trout collected at different days post-vaccination (dpv) during the field trial.

Trial	Time Point (dpv)	Plasmid Detection pVax1-vhsG-Positive	pVax1-ihnG-Positive
Potency test	90	5 /5	5/5
Field trial	120	1/5	1/5
	160	3/5	3/5
	180	3/5	2/5
	210	2/5	2/5
	230	3/5	3/5
	260	4/5	0/5
	280	0/5	0/5
	320	6/15	6/15

Efficacy of DNA Vaccines in Protecting Rainbow Trout against VHS and IHN under Intensive Farming Conditions

by Andrea Marsella [1,*], Francesco Pascoli [1], Tobia Pretto [1], Alessandra Buratin [1], Lorena Biasini [1], Miriam Abbadi [1], Luana Cortinovis [1], Paola Berto [1], Amedeo Manfrin [1], Marco Vanelli [2], Simona Perulli [2], Jesper S. Rasmussen [3], Dagoberto Sepúlveda [3], Niccolò Vendramin [3], Niels Lorenzen [3] and Anna Toffan [1]

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[3] Unit for Fish and Shellfish Diseases, Institute for Aquatic Resources, Technical University of Denmark, Kemitorvet, Building 202, DK-2800 Kgs. Lyngby, Denmark

* Author to whom correspondence should be addressed.

Vaccines **2022**, *10*(12), 2062; **https://doi.org/10.3390/vaccines10122062**

Both, vaccine or its recipients could become GMO, if genetic/biome integration is possible…

Vaccine products?

However, under EU legislation, DNA vaccines appear not to be considered as GMOs given the recent example of CLYNAV, a DNA vaccine against SPDV (see below). EU Directive 2001/18/EC defines "organisms" as any biological entity capable of replication or of transferring genetic material. GMOs are defined as organisms, with the exception of human beings, in which the genetic material has been altered in a way that does not occur naturally by mating and/or natural recombination. These definitions do not unambiguously exclude a plasmid, given that plasmids can replicate in bacterial cells and can transfer genetic material between bacteria, and that modified viral vectors, which also are incapable of replicating on their own, can be considered as GMOs. Nevertheless, the EU Commission has ratified the Cartagena Protocol (biosafety of GMOs in the environment) where it is stated that plasmids or naked genetic material are not considered as organisms [197] based on the criteria that the plasmid cannot replicate on its own. Given the decision that the DNA vaccine CLYNAV is not a GMO, then, unless a plasmid is deliberately modified to promote integration into a host genome, or to replicate in a eukaryotic host, it is unlikely to be considered a GMO under EU regulations.

Vaccinated animals? Humans?

The next consideration is whether DNA vaccinated animals are considered GMOs. Under Directive 2001/18/EC, Annex 1A, Part 1 lists techniques of genetic modification. Among others, this includes the insertion of nucleic acid material into plasmid vector systems, followed by administration of these into a host organism in which they do not naturally occur and where they are capable of continued replication. Secondly, techniques involving the direct introduction into an organism of replicating heritable material prepared outside the organism by micro- and macro-injection and microencapsulation. Therefore, the wording of EU directive 2001/18/EC does not specifically exclude the classification of DNA vaccinated fish as GMOs. However, in relation to DNA vaccines the plasmid will not replicate in the eukaryotic host, unless specifically modified to do so. Also, integration of the vaccine DNA into host cell (somatic or germinal) genomes is considered an unlikely event, as long as the plasmid is not specifically designed for this ([188]; Danish Medical Agency). Among European countries, only

Collins et al, "DNA Vaccines in Fish and Aquaculture" https://doi.org/10.1016/j.fsi.2018.07.012

Merck Sequivity RNA “platform” for pigs

- USDA approved for swine influenza in December 2021
- Synthetic (not-natural) RNA in nanoparticle
- No information available on the chemical composition of nanoparticle, nor its toxicities by itself:
  - No biodistribution studies available
  - No genotoxicity studies available
  - No carcinogenicity studies available
  - No published safety studies available in peer reviewed literature
- Collect and centralize genomic surveillance data from farms:
  - How is the data used? Who can access it? For what purposes?

MERCK Animal Health

SEQUIVITY®

USDA Label, Safety Summary (p.18)

Adverse Events Summary 21 days

VeDDRA Code	Total Animals	Percent of All Animals
No adverse events	525	70.20%
Anorexia	55	7.40%
Death	24	3.20%
Lameness	20	2.70%
Loss of Condition	12	1.60%
Diarrhea	11	1.50%
Unthrifty	7	0.90%
Anaphylaxis^	3	0.40%
Central Nervous System Disorder*	3	0.40%
Lethargy	3	0.40%
Respiratory Tract Infection*	3	0.40%
Arthritis	2	0.30%
Meningitis	2	0.30%
Musculoskeletal Disorder*	2	0.30%
Trauma*	2	0.30%
Abdominal Caviry Hernia	1	0.10%
Abscess*	1	0.10%
*Not otherwise specified		
^Related to IVP		

USDA Approval Date	December 13, 2021

30%!

https://www.aphis.usda.gov/wcm/connect/

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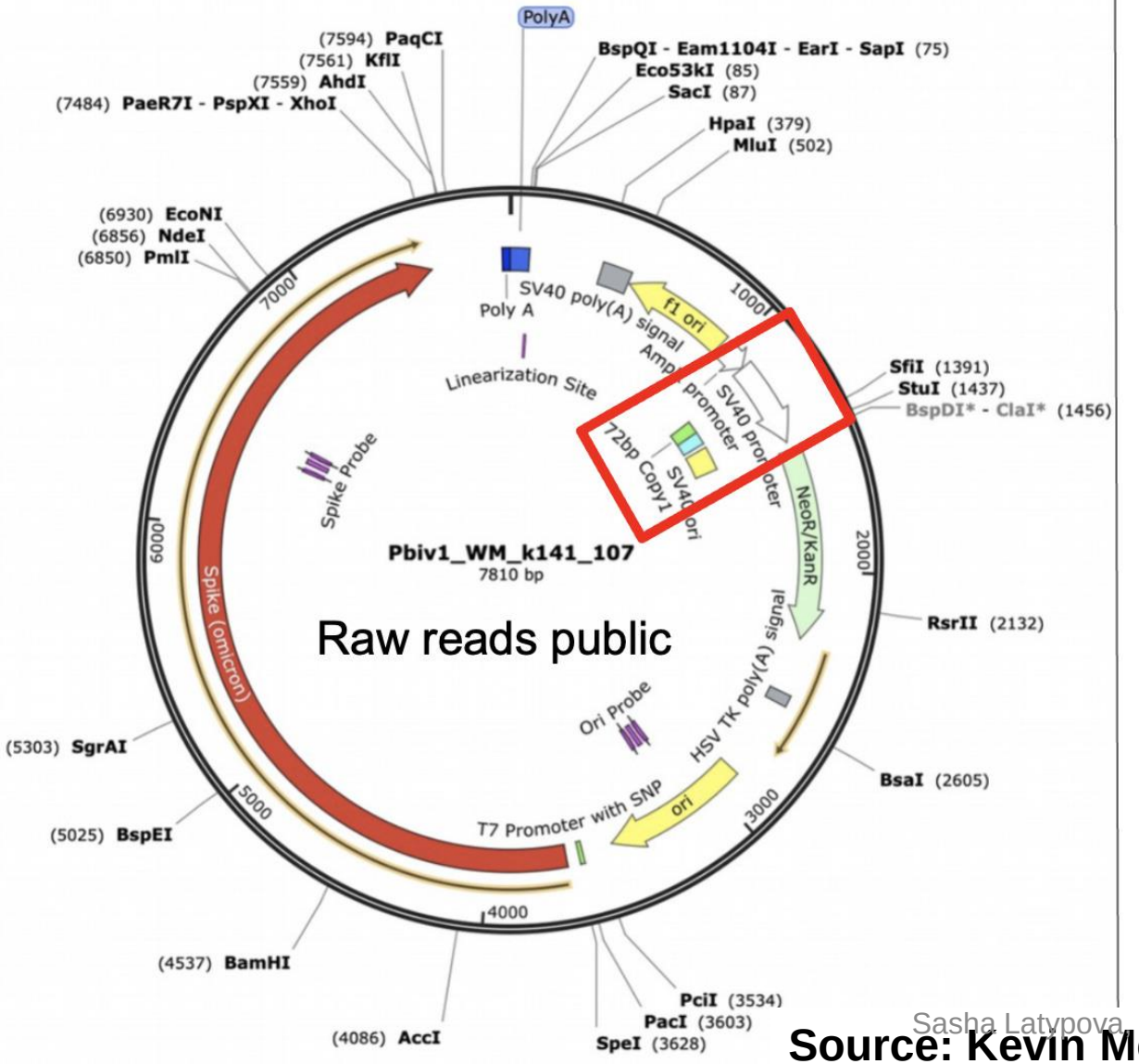
EPA Fast Tracked Ledprona – RNAi Pesticide

- Novel pesticide based on RNA interference (RNAi) technology - mechanism used by plants and insects to regulate gene expression.
- The EPA granted Ledprona an Experimental Use Permit (EUP), allowing GreenLight Biosciences 2 years to gather data from limited test plots.
- **Astonishingly, the agency also gave Ledprona 3 years of commercial use—before the standard testing period is even complete!**
- The pesticide could trigger unintended immune responses in humans. **Environmental risks: harm off-target insect species, disrupting ecosystems in unforeseen ways.**

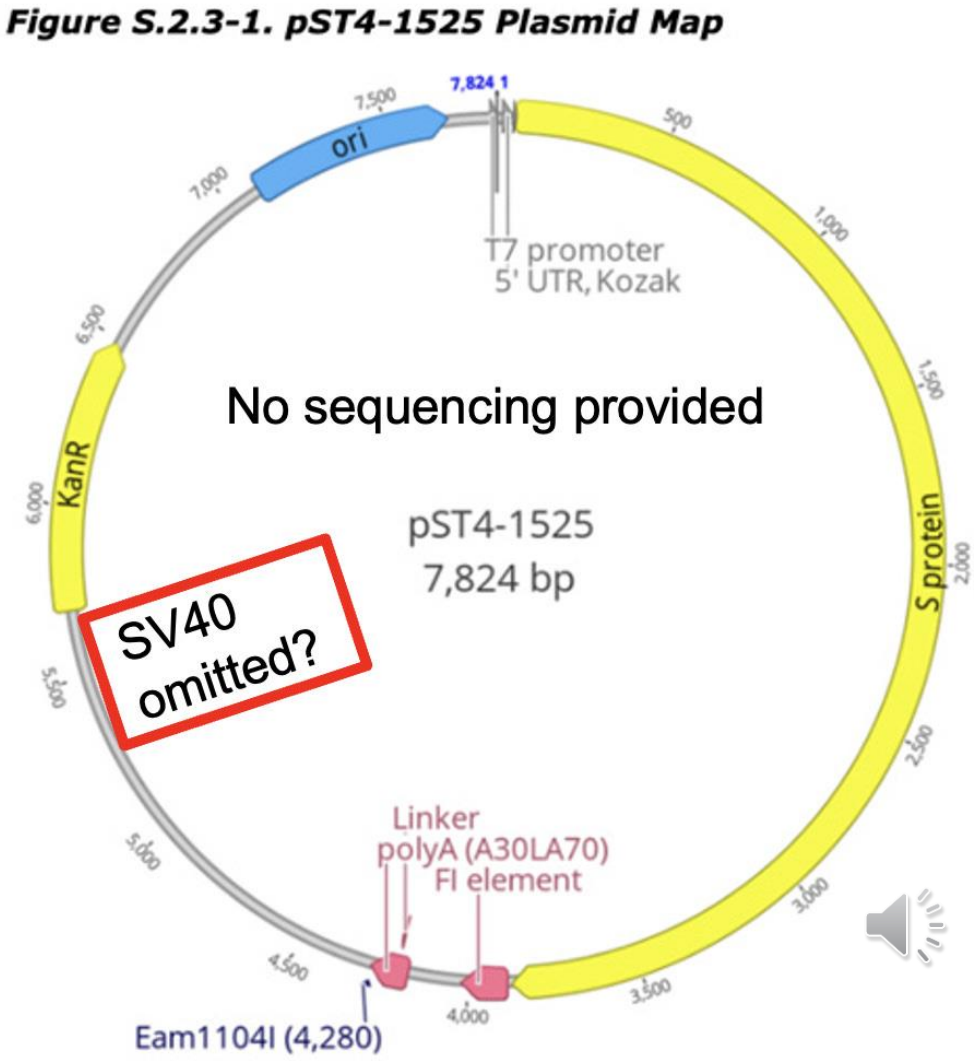
Ease of Adulteration, Contamination and Weaponization

Detection requires high-tech gene sequencing labs, equipment and expertise

Independent Illumina sequencing



What was disclosed to the EMA



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Source: Kevin McKernan, *Preprint DOI [10.31219/osf.io/b9t7m](https://doi.org/10.31219/osf.io/b9t7m)

Persistent Damage to the Gut Microbiome following Messenger RNA SARS-CoV-2 Vaccine

Sabine Hazan[1], Sonya Davé[2], Thomas J. Borody[3]

[1]ProgenaBiome, LLC, Ventura, CA, USA, [2]Microbiome Research Foundation, Ventura, CA, USA, [3]Centre for Digestive Diseases, Five Dock, NSW, AUS

Abstract
E0141
(S2108)

Introduction

- The human gut microbiome is an essential determinant of human health.
- *Bifidobacterium* decline is associated with inflammatory bowel disease, obesity, neurological disorders, *C. difficile* infection and severe COVID-19 (1-3).
- Long-term effect of messenger RNA vaccines for SARS-CoV-2 on the human gut microbiome is unknown.
- The purpose of this study was to explore longitudinal changes in the Relative Abundance of *Bifidobacterium* after mRNA SARS-CoV-2 vaccination.

Methods

We longitudinally recorded the Relative Abundance of *Bifidobacterium* in four subjects before receiving a mRNA vaccine (Pfizer or Moderna) for SARS-CoV-2, approximately one post-vaccination, as well as 6-9 months post-vaccination. Additional SARS-CoV-2 vaccines were given during that period, totaling 2 to 3 doses. Samples were collected at the time points mentioned. No dietary changes or new medications were introduced throughout the study period. Metagenomic next generation sequencing-based methods were applied to samples obtained from fecal collection. DNA was extracted, and the library prepped, enriched and sequenced on an Illumina Nextseq 550 system. This study was IRB approved.

Results

Subject	Change in Relative Abundance of *Bifidobacterium* (% of pre-vaccine level)	
	1 month post-vaccine	6-9 months post-vaccine
1	38%	15%
2	258%	0%
3	49%	35%
4	90%	60%

Table 1. Change in Relative Abundance of *Bifidobacterium* after SARS-CoV-2 mRNA vaccination.

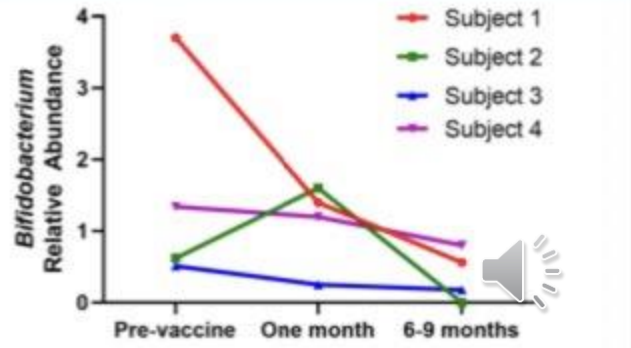

Figure 1. Decline in Relative Abundance of *Bifidobacterium* after SARS-CoV-2 mRNA vaccination.

Discussion

- At 1 month post-vaccination, 3 of 4 subjects experienced a decrease in Relative Abundance of *Bifidobacterium* below pre-vaccination levels.
- At 6-9 months post-vaccination, all subjects experienced a decrease in Relative Abundance of *Bifidobacterium* below pre-vaccination levels.
- No subjects exhibited significant post-vaccine complications.
- The lasting decrease in *Bifidobacterium* levels may contribute to SARS-CoV-2 infection post vaccination.
- Gut dysbiosis after mRNA SARS-CoV-2 vaccination may be a future indication for restoration of *Bifidobacterium* via oral or fecal transplant routes.

References

1. Ruiz L, et al. *Front Microbiol*. 2017;8:2345.
2. Suganya K, Koo BS. *Int J Mol Sci*. 2020;21(20):7551.
3. Hazan S, et al. *BMJ Open Gastro*. 2022;9(1):e000871.

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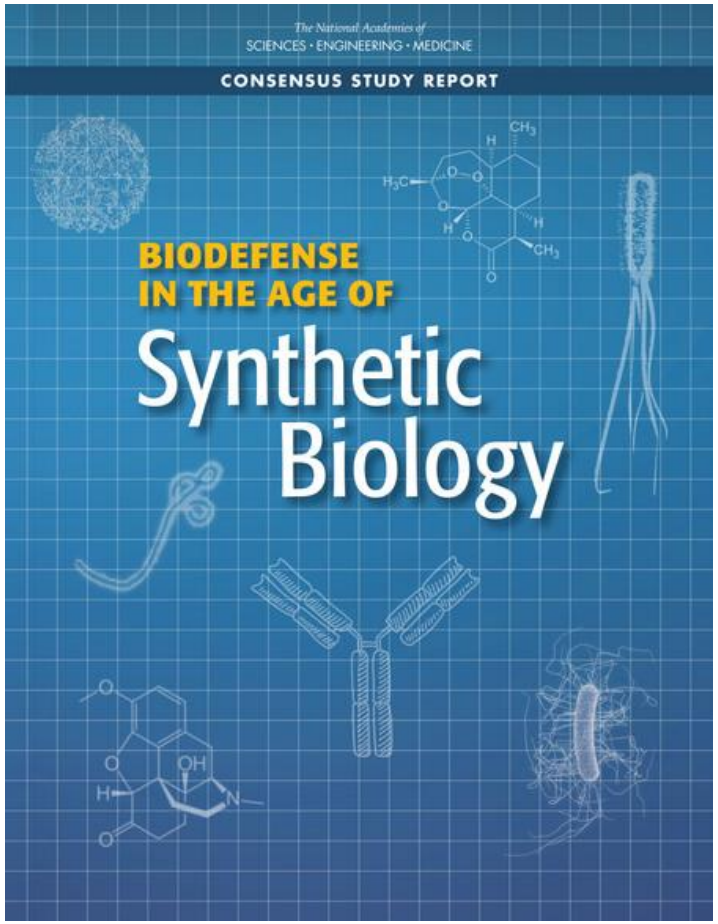

Chapter 6: Assessment of Concerns Related to Bioweapons that Alter the Human Host

"Human health is highly dependent upon the human microbiome—the microorganisms that live on and within us, especially those associated with the gut, oral cavity, nasopharyngeal space, and skin. These populations of microbes are likely far easier to manipulate than the human host itself, making the microbiome a potentially accessible vector for attack".

Vectors of biological attack discussed:

- Delivery of harmful cargo via microbiome (RNA and plasmid DNA or viral vectors) via injections or horizontal transfer (shedding)
- Enhancement of the attack via other pathways – animal vaccines, food: "domestic animals could be used as carriers for engineered agents transmitted via the microbiome".

Contributor(s): National Academies of Sciences, Engineering, and Medicine; Division on Earth and Life Studies; Board on Chemical Sciences and Technology; Board on Life Sciences; Committee on Strategies for Identifying and Addressing Potential Biodefense Vulnerabilities Posed by Synthetic Biology

mRNA-Technology is seen as gold standard for the future

World Health Organization

SEVENTH MEETING OF THE INTERGOVERNMENTAL NEGOTIATING BODY TO DRAFT AND NEGOTIATE A WHO CONVENTION, AGREEMENT OR OTHER INTERNATIONAL INSTRUMENT ON PANDEMIC PREVENTION, PREPAREDNESS AND RESPONSE
Provisional agenda item x

A/INB/7/x
October 2023

DRAFT

Negotiating Text of the WHO convention, agreement or other international instrument on pandemic prevention, preparedness and response (WHO Pandemic Agreement)

Advanced unedited version - 16 October 2023

- $$$$ for WHO Biodefense
- Required collection of DNA samples from countries
- Identification of most toxic agents and sharing with WHO
- Mandatory RNA/DNA injections for “new pathogens” manufactured in 100 days (no safety!)

The mRNA vaccine technology transfer hub

Quelle:
https://www.who.int/initiatives/the-mrna-vaccine-technology-transfer-hub

United States already subject to WHO decision when to announce a PHEIC

15 US states v HHS Petition for Rulemaking – was filed 1/18/2023, dismissed, not being appealed

- "…Oklahoma, Alabama, Arizona, Arkansas, Florida, Georgia, Indiana, Louisiana, Mississippi, Missouri, Montana, Nebraska, South Carolina, Texas, and Utah […] petition the U.S. Department of Health and Human Services (HHS) to amend its definition of "public health emergency" in 42 C.F.R. § 70.1. See 5 U.S.C. § 553(e).
- The Rule exceeds the agency's authority and infringes on U.S. and State sovereignty by unlawfully delegating to the World Health Organization (WHO) the authority to invoke health emergency powers solely based on decisions of the WHO.
- HHS admitted that the declaration by the WHO or notification to t
  Emergency of International Concern is a "way for HHS/CDC to d
  precommunicable stage of a quarantinable communicable dis
  public health emergency if transmitted to other individuals." Id. at
  disclaiming any need to use definitions (3), (4), and (5) [definitions made by WHO] of public health emergency, HHS proceeded to finalize a rule containing those definitions."

Declaration of "pandemic" based on theoretical/modeled potential without need to show any actual mass illness/deaths or economic impact

Questions we should all be asking:

- Is the “emergency” real or only/largely based on PCR and computer models?
- Is there hard evidence or real illness? real economic impact?
- Why the need for total genetic surveillance?
- Why are cell/nucleus/gene transfectants being pushed as the solution for respiratory illness?
- What are the long-term effects of genetic agents on animal microbiome, health and nutritional quality of animal products?
- What are the effects of shedding synthetic DNA/RNA and their byproducts into the food products or environment (other species, or humans that work with transfected animals or transfectants)?

Appendix

Table 1. Overview of licensed fish vaccines that have been used in global aquaculture.

Disease	Pathogen	Major Fish Host	Vaccine Type	Antigens/Targets	Delivery Methods	Country/Region *	Further Information
Viral Diseases							
Infectious hematopoietic necrosis	IHNV *Rhabdovirus*	Salmonids	DNA	G Glycoprotein	IM	Canada	https://www.dfo-mpo.gc.ca/aquaculture/rp-pr/acrdp-pcrda/projects-projets/P-07-04-010-eng.html
Infectious pancreatic necrosis	IPNV *Birnavirus*	Salmonids, sea bass, sea bream, turbot, Pacific cod	Inactivated	Inactivated IPNV	IP	Norway, Chile, UK	www.pharmaq.no
			Subunit	VP2 and VP3 Capsid Proteins	Oral	Canada, USA	www.aquavac-vaccines.com
			Subunit	VP2 Proteins	IP	Canada, Chile, Norway	http://www.msd-animal-health.no/
Infectious salmon anemia	ISAV *Orthomyxovirus*	Atlantic salmon	Inactivated	Inactivated ISAV	IP	Norway, Chile, Ireland, Finland, Canada	www.pharmaq.no
Pancreatic disease virus	SAV *alphaviruses*	Salmonids	Inactivated	Inactivated SAV	IP	Norway, Chile, UK	https://www.merck-animal-health.co
Spring viremia of carp virus	SVCV *Rhabdovirus*	Carp	Subunit	G Glycoprotein	IP	Belgium	[22]
			Inactivated	Inactivated SVCV	IP	Czech Republic	[23]
Koi herpesvirus disease	KHV *Herpesvirus*	Carp	Attenuated	Attenuated KHV	IMM or IP	Israel	[22]
Infectious spleen and kidney necrosis	ISKNV *Iridovirus*	Asian seabass, grouper, Japanese yellowtail	Inactivated	Inactivated ISKNV	IP	Singapore	https://www.aquavac-vaccines.com/
Bacterial diseases							
Enteric redmouth disease (ERM)	*Yersinia ruckeri*	Salmonids	Inactivated	Inactivated *Y. ruckeri*	IMM or oral	USA, Canada, Europe	http://www.msd-animal-health.ie/products_ni_vet/aquavac-erm-oral/overview.aspx; https://www.msd-animal-health-hub.co.uk
Vibriosis	*Vibrio anguillarum; Vibrio ordalii; Vibrio salmonicida*	Salmonids, ayu, grouper, sea bass, sea bream, yellowtail, cod, halibut	Inactivated	Inactivated *Vibriosis* spp.	IP or IMM	USA, Canada, Japan, Europe, Australia	https://www.merck-animal-health.com/species/aquaculture/trout.aspx;
Furunculosis	*Aeromonas salmonicida* subsp. *salmonicida*	Salmonids	Inactivated	Inactivated *A. salmonicida* spp.	IP or IMM	USA, Canada, Chile, Europe, Australia	https://www.msd-animal-health-me.com/species/aqua.aspx
Bacterial kidney disease (BKD)	*Renibacterium salmoninarum*	Salmonids	Avirulent live culture	*Arthrobacter davidanieli*	IP	Canada, Chile, USA	[24]
Enteric septicemia of catfish (ESC)	*Edwarsiella ictaluri*	Catfish	Inactivated	Inactivated *E. ictaluri*	IP	Vietnam	https://www.pharmaq.no/

Table 1. *Cont.*

Disease	Pathogen	Major Fish Host	Vaccine Type	Antigens/Targets	Delivery Methods	Country/Region *	Further Information
Columnaris disease	*Flavobacterium columnaris*	All freshwater finfish species, bream, bass, turbot, salmon	Attenuated	Attenuated *F. columnare*	IMM	USA	[25]
Pasteurellosis	*Pasteurela piscicida*	Sea bass, sea bream, sole	Inactivated	Inactivated *P. pscicida*	IMM	USA, Europe, Taiwan, Japan	ALPHA JECT 2000
Lactococciosis	*Lactococcus garviae*	Rainbow trout, amberjack, yellowtail	Inactivated	Inactivated *L. garviae*	IP	Spain	https://www.hipra.com/
Streptococcus infections	*Streptococcus* spp.	Tilapia, yellow tail, rainbow trout, ayu, sea bass, sea bream	Inactivated	Inactivated *S. agalactiae* (biotype 1)	IP	Taiwan Province of China, Japan, Brazil, Indonesia	https://www.aquavac-vaccines.com/products/aquavac-strep-sa1/
				Inactivated *S. agalactiae* (biotype 2)	IP		https://www.aquavac-vaccines.com/products/aquavac-strep-sa/
				Inactivated *S. iniae*	IP or IMM		https://www.aquavac-vaccines.com/products/aquavac-strep-si/
Salmonid rickettsial septicemia	*Piscirickettsia salmonis*	Salmonids	Inactivated	Inactivated *P. salmonis*	IP	Chile	Evensen, 2016; https://www.pharmaq.no/products/injectable/
Motile *Aeromonas* septicemia (MAS)	*Aeromonas* spp.	Striped catfish	Inactivated	*A. hydrophila* (serotype A and B)	IP	Vietnam	https://www.pharmaq.no/; ALPHAJECT Panga 2
Wound Disease	*Moritella viscosa*	Salmonids	Inactivated	Inactivated *M. viscosa*	IP	Norway, UK, Ireland, Iceland	https://www.pharmaq.no
Tenacibaculosis	*Tenacibaculum maritimum*	Turbot	Inactivated	Inactivated *T. maritimum*	IP	Spain	https://www.hipra.com/

IHNV: Infectious hematopoietic necrosis virus; IPNV: Infectious pancreatic necrosis virus; ISAV: Infectious salmon anemia virus; SVCV: Spring viremia of carp virus; KHV: Koi herpesvirus; ISKNV: Infectious spleen and kidney necrosis virus; IM: Intramuscular injection; IP: Intraperitoneal injection; IMM: Immersion; * denotes country or region where the vaccine is licensed and sold.

testimony sb 911.pdf
Uploaded by: Jeremy Snavely
Position: FAV

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Association of American Physicians and Surgeons, Inc.
A Voice for Private Physicians Since 1943
Omnia pro aegroto

February 28, 2024

Statement in Support of SB 911 - Food, Drugs, and Cosmetics – Gene Structure–and Function–Modifying, Products – Labeling

Thank you for the opportunity to submit a statement in support of SB 911.

The Association of American Physicians and Surgeons – AAPS – is a non-partisan professional association of physicians in all types of practices and specialties across the United States. Since 1943, AAPS has been dedicated to the highest ethical standards of the Oath of Hippocrates and to preserving the sanctity of the patient-physician relationship and the practice of private medicine. Our motto, "omnia pro aegroto" means "all for the patient."

In the AAPS Patient Bill of Rights it is stated that patients must have the right, to be informed about … the risks and benefits of treatment and appropriate alternatives" and the right "to refuse medical treatment." In addition, the AAPS Principles of Medical Ethics, directs physicians to conduct themselves, "at all times with dignity, integrity, honesty and diligence in the practice of the profession to engender the confidence of patients."

SB 911 aligns with these principles, along with the foundational medical concept of informed consent, by requiring that products with the potential for altering individuals' genes be accurately labeled, including disclosure of potential adverse effects and other side effects which may occur with the use of the product.

It is important to note that therapies that involve genetic manipulation, while holding potential promise, are currently still largely experimental. "We are out on the far edge of experimentation," warned New York University ethicist Arthur Caplan when asked about the recent death of a 27-year-old involved in a study involving a gene-editing technique.

Thus, it is exceedingly critical to protect patients' right to understand when they may be subject to gene modification, through exposure from consumer products, medical interventions, or otherwise, given the increased inherent risks involved.

In summary, SB 911 should be adopted. Please stand up for patients and approve this important legislation.

Respectfully submitted,
Jeremy Snavely
Director of Regulatory Affairs, jeremy@aapsonline.org

testimony SB911 ALC 03054.pdf
Uploaded by: Maria Lorenzo-Chang
Position: FAV

March 5, 2024

Dear Members of the Finance Committee,

I am writing in support of SB911 as a mother, daughter, and informed consumer, as I hold a Bachelor's degree in Chemical engineering and a Master's in Food science, and I have worked in the food industry as a product development specialist. My need for extensive research on food was due to not only my professional background but also because of my mother's Parkinson's condition and my son's allergies as a child. Had I known about the correlation between the health of the gut microbiome and brain health sooner, I would have saved years of agony for my deceased mother and all the ones around her who loved her and tried to help her. In addition, I would have avoided years of trying different treatments for my son. Food had a crucial part in my son's healing and my mother's quality of life. I cannot imagine the repercussions an artificial gene-modifying food product could have on my son's health and could have had on my mother's health at the time. My son's and mother's experiences are not anecdotal since most of the adult and young population suffers chronic illnesses.

Dr. John Fagan's analysis of food-like products developed using modern technologies based on synthetic biology is very revealing. Dr. Fagan analyzed a milk-like product that is currently commercialized as a food product, and he identified 92 different compounds, which are not present in regular milk. According to Dr. Fagan, most of these compounds are so uncommon that they have never been classified in science nor assigned a name. Dr. Fagan found them to be predominant in this milk-like product that is currently being commercialized in spite of containing compounds that have not been part of the human diet before. These are very frightening facts. I ponder with great concern the effect of these types of food-like products, which are being commercialized as foods and consumed in different quantities and frequencies by a predominantly susceptible consumer population.

Food is our daily sustenance, our source of nutrition and nourishment. It plays such an essential role in our lives. We are honored to have model organic regenerative and biodynamic farms in Maryland, which exemplify what it means to provide food products that have a positive impact on the consumer, the community and the environment. People have the right to know and decide what they and their families consume. Today, you have the opportunity to protect this right, contribute to the development of a healthier food market defined by informed consumers, and avoid preventable harm to the public.

Sincerely,

Alejandra Lorenzo-Chang

Maryland resident

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Uploaded by: Marsha Blakeslee
Position: FAV

Personal Docs
Personalized Medicine

Marsha Y. Blakeslee, D.O.

Dear Members of the Finance Committee:

My name is Dr. Marsha Blakeslee and I've been in private practice in Severna Park, Maryland, having practiced medicine for just over 30 years. In the course of caring for patients, I deal with a large variety of health conditions and provide counsel on the best way to care for those conditions. Perhaps more importantly, is the ability to provide medical counsel that helps to prevent the development of chronic health conditions.

A huge body of evidence points to the ability to avoid many health conditions by reducing exposures and consumptions that lead to chronic health disorders. There is great evidence that many human medical disorders are the result of what we eat and drink. This includes high blood pressure, diabetes, heart disease and cancers. Knowledge of the contents of products allows consumers the ability to make appropriate choices for their health.

We are in an age of rapid advancement of genetic technologies, using and altering DNA and RNA. While many biotechnological advancements may hold promise for the future, there is also the possibility of great harm. History is littered with the removal from the market of many products which were ultimately found to be dangerous. Clinical practice has taught me that susceptibility to harm is different for every person, since each person's physical, biochemical, and genetic make-up is different. Consuming any food product or animal that contains or has been treated with any new technology that has the capacity to modify the gene structure or function of an individual could result in disastrous health outcomes for some.

For basic human safety, any product of this type must be openly labeled as such, and the labeling should include potential risks to the consumer. We all expect to know the calorie count, carb count, fat grams, gluten or nut content of any product that we consume. We should certainly expect labeling on our foods that may contain products that could have unknown short and long-term potential risks. I would strongly advise that you pass SB911 to provide appropriate labeling of products for the people of the state of Maryland.

Thank you for your time and consideration.

Dr. Marsha Y. Blakeslee

479 Jumpers Hole Road, Suite 304A Severna Park, Maryland 21146
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SB911 Fav Love Maryland PAC.pdf
Uploaded by: MEGAN MONTGOMERY
Position: FAV

SB911

Favorable

Love Maryland PAC

Chair, Vice Chair and members of the Finance Committee,

Good afternoon, my name is Megan Montgomery and I write as the Chair of the Love Maryland PAC to testify favorably for SB911. The Love Maryland PAC is a consumer advocacy organization who advocates for the citizens of Maryland and does not represent any corporate interests. The PAC supports allowing the citizens of Maryland true informed consent for consuming products that are made with any gene altering technology, including but not limited to mRNA. SB911 states that any product made with this technology must be clearly labeled as such. This is the only way to ensure true informed consent.

This gene altering technology is still in its infancy, and we do not know the long-term effects of consuming products made utilizing this technology.

I hope that you vote favorably on SB911. Thank you for your time.

LFRI SB911.pdf
Uploaded by: Mike McKay
Position: FAV

March 5, 2024

In support of SB911

Dear Members of the Health and Government Operations Committee,

My name is Rudy Arredondo. I am a policy analyst and the president and founder of Latino Farmers & Ranchers International, Inc. (LFRI). I have worked twice at the Department of Agriculture as a Civil Rights officer to investigate cases of discrimination against USDA employees (Title V of the Civil Rights Act of 1965, as amended) and USDA programs beneficiaries (Title VI, CRA 1965, as amended). I was appointed commissioner for the Maryland Black and Minority Health Governor's commission as chairman of Task Force on Finance, Access and Indigent Care. In addition, I was a recipient of the United Nations Association (D.C. Chapter) Human Rights Award, the Maryland Governor's Citation for Health, the Maryland House of Delegates Citation for Health Issues Leadership, and the Maryland Senate Citation for Health Leadership.

LFRI represents Latino farmers, ranchers and producers throughout the United States and internationally, including members in Maryland, as a board member of Maryland based farm organization, Future Harvest. Our members are generally small and medium size producers. The mission of LFRI is to protect, preserve, and serve historically discriminated against farm workers, farmers, and ranchers.

Our focus is on sustainable practices, taking a conscious approach on agricultural practices. We use traditional methods, minimizing the use of chemicals.
The application of new technologies in the market at a speed greater than the imperative corresponding regulatory update is of great concern to us. Our members are in direct contact with agricultural elements, animals, and the land on a daily basis. Our members have the right and the responsibility as producers to know if a product that is applied to their animals has a gene structure- or function-modifying capability and its risks to workers and their families, consumers, and the environment.
I have personally experienced, firsthand, the harmful consequences of dealing with frequent exposure to toxic agricultural products. For example, I was in direct contact with pesticides growing up. My family and I were migrant farm workers. I have worked in agriculture since I was five years old, even through college. In addition, I have been exposed to the drift of Agent Orange. I suffered for many years from boils and rashes in the summer, among other health conditions.

The health of my children has been negatively affected as well.
We need proper labeling to make proper choices regarding the use of potentially gene structure- or

function-modifying products. SB911 helps us move in the direction of transparency and informed decision.

Sincerely,

Rudy Arredondo
President/Founder
Latino Farmers & Ranchers International, Inc.
19627 Crystal Rock Dr., #21
Germantown, MD 20874
Email: latinofarmers@gmail.com
Website: www.LFRINC.org

SB911.pdf
Uploaded by: Mike McKay
Position: FAV

MIKE MCKAY
Legislative District 1
Garrett, Allegany, and Washington Counties

Judicial Proceedings Committee

Executive Nominations Committee

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THE SENATE OF MARYLAND
ANNAPOLIS, MARYLAND 21401

Senate Bill 911 – Food, Drugs, and Cosmetics – Gene Structure and Function-Modifying Products – Labeling

February 26, 2024

Dear Chair Beidle, Vice Chair Klausmeier, and Members of the Committee,

The purpose of the bill is to prohibit the sale a gene structure or function modifying product unless it has been properly labeled in large and visible text as such. It should also include all potential side effects and risks it may have on an individual if it is taken/consumed. The bill will also establish penalties for a violation of this act if it were to pass. I thank you all for your time and ask for a favorable vote.

Sincerely,

Senator Mike McKay

Representing the Appalachia Region of Maryland

Serving Garrett, Allegany, and Washington Counties

R-CALF-USA testimony 022824.pdf
Uploaded by: Robert Thornsberry
Position: FAV

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Maryland Legislative Bodies Testimony

It is an honor to provide testimony today. I am Doctor Robert Max Thornsberry, a 1977 graduate of the University of Missouri College of Veterinary Medicine, and a practicing food animal veterinarian. I was appointed the Chairman of the Animal Health Committee by the President of the Board of Directors for the Ranchers and Cattlemen's Action Legal Fund-United Stockgrowers of America (R-CALF-USA), an independent organization advocating for cattlemen, bison producers, and sheep producers across the United States. I was recently tasked with the education of our membership concerning the use of mRNA injections for livestock. Doctor Louis Pasteur with the assistance of his protégée, veterinarian Doctor Edmond Isadore Entinne Nocard, developed successful vaccines for both rabies and Anthrax in the late 1800's. The process of pasteurization of milk and proper canning processes developed by these men literally transformed the concept of food safety across the globe, saving countless lives.

mRNA technology is not new and was first utilized in 1990 as a form of gene therapy in animals[1], but was not utilized in clinical veterinary medicine. The Food and Drug Administration (FDA) still classifies mRNA as a form of gene therapy because it introduces into the animal a nucleotide code on mRNA for specific genes[2]. For that reason, particular scrutiny is required by the FDA for food safety. mRNA injections meet FDA's gene therapy definition, but the FDA has elected not to regulate mRNA injections as gene therapies. Recent agricultural press publications have attempted to quell any food safety concerns[3,4]. Consumers, livestock producers, companion animal parents, and veterinarians desire answers to their questions, not vague reassurances. Regardless of the mRNA technology utilized, mRNA must be contained in lipid nanoparticles (tiny fat globules) when administered by injection. These lipid nanoparticles are known inflammatory agents, activating multiple inflammatory pathways in the recipient animal[5,6,7]. It is now known that injected lipid nanoparticles redistribute throughout the body of the recipient animal, further redistributing their inflammatory properties[8,9]. What is the impact on intravascular blood clotting or the incidence of anaphylactic shock following injection of mRNA in veterinary patients? Concern exists for the shedding by animals of lipid nanoparticles in various body secretions: "Vaccine mRNA-carrying lipid nanoparticles spread after injection throughout the body according to available animal studies and vaccine mRNA (naked or in nanoparticles or in natural exosomes) is found in the bloodstream as well as vaccine antigen in free form or encapsulated in exosomes (shown in human studies). Lipid nanoparticles (or their natural equivalent, exosomes, or extracellular vesicles (EVs)) have been shown to be able to be excreted through body fluids (sweat, sputum, breast milk) and to pass the transplacental barrier. These EVs are also able to penetrate by inhalation and through the skin (healthy or injured) as well as orally through breast milk (and why not during sexual intercourse through semen, as this has not been studied). It is urgent to enforce the legislation on gene therapy that applies to mRNA vaccines and to carry out studies on this subject while the generalization of mRNA vaccines is being considered."[10]

It is now known that the genetic code contained on mRNA may find its way into the DNA of animals through the process of reverse transcription[11]. This means there is the potential for the mRNA carried genetic code to be incorporated into the DNA of a veterinary patient. What significance does this pose for animals? What risk does it pose for companion animal parents to be exposed to mRNA strands contained in extracellular vesicles that are coded for specific veterinary pathogen antigens?

Sequivity[12] is the only provisionally licensed mRNA injection utilized in the United States with approval from the United States Department of Agriculture. This product is utilized in swine as an autogenous (generated from the facility where the viral pathogen is discovered) mRNA product and takes 8 weeks from discovery of the viral pathogen to injection of the genetically coded mRNA specific antigen. This short time from identification of the viral pathogen to injection into an animal does not allow time for efficacy or safety to be evaluated. The process is proprietary to the swine facility where it is injected, under the prescription of a licensed practicing veterinarian. Because of its proprietary nature, no public or published scientific data is available to the veterinary community. No data on efficacy, on potential benefits, on the incidence of adverse reactions, and on subsequent food safety for the consuming public is revealed. What is the withdrawal established for slaughter post administration of the mRNA injection? Meat from swine receiving a Sequivity mRNA injection or injections is being marketed to the consuming public now, with no data available as to its food safety. Exposure to the public is not limited to cooked meat, but also is a concern for those handling raw meat products prior to cooking, exposing homemakers to potential contamination or inhalation of extracellular vesicles containing mRNA genetically coded for specific veterinary pathogen antigens.

For these reasons and the lack of any scientific data to make an informed choice, R-CALF-USA's membership has passed a resolution requiring meat products originating from animals receiving mRNA injections to be so labeled. There is great risk in alarming the meat consumer to the point where they avoid or reduce meat consumption without proper labeling. "The U.S. lost nearly 142,000 farms and 20.1 million ag acres from 2017 to 2022, which Agriculture Secretary Tom Vilsack said should be a "wake-up call" for policymakers."[13] Veterinary medical professionals seek to maintain safe, independent, and profitable food animal clients. We do not need any consumer avoidance or concern related to the use of mRNA.

Respectfully submitted by,

R. M. Thornsberry D.V.M., M.B.A.

P.O. Box 818

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Maryland Testimony References

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13. 2022 Ag Census Released, Ag Secretary Calls Decline in Farms and Acreage a 'Wake-Up Call', 2/13/2024 | 1:50 PM CST, Chris Clayton, DTN Ag Policy Editor, https://www.dtnpf.com/agriculture/web/ag/news/business-inputs/article/2024/02/13/ag-secretary-calls-decline-farms#:~:text=2022%20Ag%20Census,Ag%20Policy%20Editor

SB 911 Letter Tanya food labeling 030424.pdf
Uploaded by: Tanya Carmona Daniels
Position: FAV

March 5, 2024

This letter is in support of SB 911

Dear Legislators,

We, the people are supposed to trust our authorities whose job is to guarantee the wellness of the citizens. It is very alarming to see how schools meals are loaded with heavy metals and GMOs. We are slowly being intoxicated and we have the right to know what we are putting in our bodies.

We are a group of parents of children with autism. Our children were not born with autism. It is clear to us that medical and/or environmental factors negatively impacted our children, who otherwise did not show any signs of autistic characteristics pre intervention. Many of us have proof of it. Had we been fully informed about the risks, we, as parents, would have made a different choice. Children with autism generally have a compromised digestion. Working on restoring gut health is essential, particularly due to the gut health-brain functioning connection. Dietary changes, including the switch to an organic diet, has demonstrated to have a positive effect in children with autism. An improvement in autistic symptoms is observed. The potential artificial genetic alteration through food could be catastrophic to many, including children with autism. Parents need to be fully informed about the potential artificial gene-altering capacity that a food product presents in order to make the best decision for their children's health. The supply of food, our daily source of nutritional nourishment, needs to be protected. Today, you have the opportunity to take a step forward toward this objective.

Thank you,

Tanya Carmona Daniels
In representation of a Group of Parents of Children with Autism

ALAN CV 2022 053122.pdf
Uploaded by: Alan Vinitsky
Position: FWA

Enlightened Medicine

Alan R. Vinitsky, M.D.

On the WEB: www.enlightenedmedicine.net

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PERSONAL

Author, inventor, healer – passionate and caring – Alan R. Vinitsky has established a solid community and internet reputation as a quality primary care physician in pediatrics and internal medicine. His interests include assessing and treating the autonomic nervous system, preventing and curing chronic illness, sports, nutrition, behavior, and growth and development.

EDUCATION

1966-1970	B.S. Zoology, University of Maryland, College Park, Magna Cum Laude, Honors in Zoology and General Honors, Phi Beta Kappa
1970-1974	M.D., University of Pennsylvania School of Medicine, Philadelphia

RESIDENCIES

1974-1976	**Internal Medicine**, Upstate Medical Center, Syracuse, NY
1976-1978	**Pediatrics**, Children's Hospital of Philadelphia

BOARD CERTIFICATION - original

1977	American Board of Internal Medicine
1980	American Board of Pediatrics

EMPLOYMENT

1978-1979	*Hired as an associate Physician in a primary care setting* Demonstrated skillful, sensitive handling of a diversity of patient health problems.
1979-1992	***Solo Practitioner*** Established a solid reputation in the community as a provider of excellent care.
2001-2020	***Referral-based Practitioner***: special interest in autonomic dysfunction, chronic illnesses and conditions
1992-2001	***President****, Vinitsky & Mizrahi Associates, Inc.* Founded a 2-member physician corporation. Continued expert care, broadened interests and expanded services.

FACULTY POSITIONS

1980-2001	***Instructor****, George Washington University for Children's Hospital National Medical Center*
1980-1995	***Instructor****, Georgetown University Dept. of Community Medicine*
1985-1995	***Instructor****, Georgetown University School of Nursing Nurse Practitioner Program*
2019	***Instructor,*** *Purdue University Global, Master of Science in Nursing, Nurse Practitioner Program*

POSITIONS HELD

1982, 1985	**Chairman**, Department of Pediatrics, Shady Grove Adventist Hospital. Responsible for organizing the opening of in-house pediatrics coverage; overseeing the opening of the nursery.
1982, 1985	**Executive Committee**. Served with other medical department heads in hospital management.
1982-2007	**Pediatric Consultant**, The Maternity Center, Bethesda, MD (until center closed 6/30/07)
1986-1994	**Pediatric Review and Audit Committee**. Chart review for quality care. SGAH.
1979-2018	**Shady Grove Adventist Hospital, member, Active Staff** - Privileges in Pediatrics and Internal Medicine.
1980-1992	**Montgomery General Hospital**, Courtesy Staff, Pediatrics.
1980-1995	**Holy Cross Hospital**, Courtesy Staff, Pediatrics.
1986-1996	**Board of Directors, MCNET**. MCNET was a privately owned network of physicians in Montgomery County, Maryland. Decision-making and review of policy for the network.
1999-2001	**Board of Directors**, American Academy of Environmental Medicine
2002-2018	**Medical Education Committee**, member, Shady Grove Adventist Hospital
2013-2019	**Board of Directors,** Global Indoor Health Network
2015-2016	**Board of Directors,** Beautiful Mind Foundation

MEMBERSHIPS

- Montgomery County Medical Society
- Med Chi – Maryland State Medical Society
- American Academy of Environmental Medicine
- National Registry of Who's Who #122807, Life Member

Enlightened Medicine
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- International Lyme and Associated Diseases Society

LECTURES, TEACHING & PUBLIC SPEAKING

- **"Enlightened Medicine**" - Radio talk show host - North American Broadcasting Company, October 1999-February 2000.
- "**Attention Deficit, Otitis, and Enuresis**" Woodmont Academy, Woodbine, MD, January 8, 2000.
- "**When the Environment Plays Tricks in Your Head**" NAMI (National Alliance for the Mentally Ill), Bethesda, MD, April 13, 2000.
- "**Brainstorm! - Air Quality Issues in Workers' Compensation**" Maryland Workers' Compensation Education Association, Ocean City, MD, September 25, 2000.
- "**Brainstorming Chemical Sensitivity**" Governor's Pesticide Council, Annapolis, MD, September 25, 2002.
- American Academy of Environmental Medicine, Phoenix, AZ, November 1, 2003
  - "**The Accordion Reserve – a New Model for Assessing Environmental Health**"
  - "**Assessing and Treating the Autonomic Nervous System – the Accordion Reserve**"
- "**Tourette's Syndrome - Thinking Outside the Box**" Tourette's Syndrome of Greater Washington, February 29, 2004.
- "**The Autonomic Nervous System – Triggering Symptoms and How to Treat Them**" Chemical Sensitivity Diseases Association, May 22, 2004**.**
- **"Dynamic Intervention"** Integrative Medicine Conference on Anti-Aging, Las Vegas, May 15, 2005
- "**Dynamic Intervention" – Clinical Management of the Autonomic Nervous System"** Shady Grove Adventist Hospital Grand Rounds, March 2, 2006.
- "**Dynamic Intervention" – Clinical Management of the Autonomic Nervous System"** Perque, LLC Rockville MD, 2006.
- **"So Doc, How am I going to get better? Why is it taking so long?"** Chemical Sensitivity Diseases Association, March 31, 2007
- **"Comments on Safe Lawn Care" Capitol Steps, Washington, DC,** Launching www.safelawns.org**,** April 4, 2007
- **"Optimum Health vs. Stress – Battle for the Ages"** Perque, LLC, Fairfax, VA, September 26, 2007
- **"Stress in the City (and the Country)"** Health Studies Collegium, Leesburg, VA, November 3, 2007
- **"To Medicate or Not to Medicate"** Health Studies Collegium, Leesburg,VA, November 4, 2007
- **"Stress in the City (and the Country) – Methylation: Jewels of Redemption"** Shady Grove Adventist Hospital Grand Rounds, Rockville, MD, April 17, 2008
- **"Stress in the City (and the Country) – for Dummies"** Israeli Business Network, Rockville, MD, August 13, 2008
- **"Stress in the City (and the Country) – for Dummies"** CAMNET, Rockville, MD, September 24, 2008
- **"Stress in the City (and the Country) – for Dummies"** Perque, LLC, Rockville, MD, September 26, 2008
- **"Treat That Stress, Baby!"** Autism Summit, www.Thriiive.com, April 30, 2010
- **"The Conundrum of Autonomic Healing – Methylation *vs.* Inflammation"** Shady Grove Adventist Hospital Grand Rounds, April 21, 2011
- **"A Chemical Reaction" – viewing and panel discussion, Gaithersburg, MD,** May 5, 2011
- **"The Conundrum of Autonomic Healing – Methylation *vs.* Inflammation"**
  "Loosen the Noose of Chronic Illness and Aging"
  "Case Studies – The Conundrum of Autonomic Healing"
  Keynote Speaker, Health Centers for the Future, Chicago, IL, May 13, 2011
- **"The Conundrum of Autonomic Healing – Methylation *vs.* Inflammation" Keynote Speaker, International College of Applied Kinesiology, Orlando, FL,** June 3, 2011
- **"A Chemical Reaction" – viewing and panel discussion, Potomac, MD,** June 14, 2011
- **"New Horizons in Repair and Healing",** Chemical Sensitivity Diseases Association, November 19, 2011
- **"Senior Moments" –** Chemical Sensitivity Diseases Association, March 29, 2014
- **"Simply Healing Chemical Sensitivities" –** Chemical Sensitivities Diseases Association, October 19, 2019
- **"Repair and Healing over the Spectrum" –** Interview for Global Autism Summit, December 4, 2020
- **"Mystery Case – What Would you Do Next?" –** Case of Autonomic Dysfunction in patient with post-Covid symptoms – SVT and Pericarditis. Presentation to DMV Functional Medicine Practitioner Group Meeting, Tysons Corner Center, McLean, VA 22102. 5/26/2022

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BOOKS, PUBLICATIONS, & ARTICLES

- **"Health Care on the Move"** - written for a real estate magazine, an article emphasizing the stress of relocation on the individual and family.
- **TeleMed** - Interactive Information System. Authored topics on routine child and adult health care, pediatric rashes - diagnosis, fatigue, and respiratory illness.
- **"Why Sweat"** - a review article for a local news flyer, on the virtues of clearing chemicals from the body by exercise, nutrition, and detox sauna.
- **"Babies Grow Best in a Safe Environment"** - Maternity Center newsletter, Spring 2000.
- **"Your Autonomic Nervous System and What it Can Do for You"–** Maternity Center Newsletter, Summer 2003.
- ***Energy – the Essence of Environmental Health*** © Natalie Golos and Alan R. Vinitsky, M.D. 2004, AuthorHouse, Bloomington, IN
- **Putting the Pieces Together. Part I.** *Healthy Aging* 1(5):63-66, 2006**.**
- **Parts of the Puzzle. Part II.** *Healthy Aging* 1(6):75-78, 2006.
- **Tobias H, Vinitsky AR, Bulgarelli RJ, Ghosh-Dastidar S, Colombo J. 2010. Autonomic nervous system monitoring of patients with excess parasympathetic responses to sympathetic challenges – clinical observations.** ***US Neurology*** **5(2):62-66.**
- **McMahon SC, Hope J, Thrasher JD, Rea WJ, Vinitsky AR, Gray MR. 2012. Common toxins in our homes, schools and workplaces. http://globalindoorhealthnetwork.com/files/GIHN_position_statement.pdf**
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MEDIA APPEARANCES

- **"Safe Lawns and Landscapes"** Podcast, hosted by Paul Tukey, founder of **www.safelawns.org**, March 27, 2008
- **"Tom Roselle Live"**, hosted by Dr. Tom Roselle, DC, founder of Roselle Alternative Care Center, Fairfax, VA, June 1, 2008
- **"Protecting Your Health"**, hosted by Dr. Donald Robbins, DMD and Dr. Kathleen Boyle, **www.WebTalkRadio.net**, **"**Can you be healthy if your doctor doesn't hear you?**"** April 18, 2010
- **"A Chemical Reaction", 2010, producer Paul Tukey, Cameo from video of "Comments on Safe Lawn Care", Capitol Steps, April 4, 2007**
- **"New Treatments for Methylation and Chronic Illness",** hosted by Neil Nathan, MD, *The Cutting Edge of Health and Wellness Today*
http://www.voiceamerica.com/episode/85541/new-treatments-for-methylation-and-chronic-illness, May 29, 2015.

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- **"The Accordion Reserve"**, 1998, with Natalie Golos
- **"Playing with Your Aura"**, 1998, with Natalie Golos
- **"The Exercise Sandwich"**, 1999
- **"21st Century Miracle Treatment?"** 2004 (unpublished)

TRADEMARKS

- **"Illumivites",** 2012
- **"MethyLift",** 2013

PRODUCT NAME

"RescuMe", 2013

INVENTION

- **"Reversing Autonomic Nervous System Dysfunction by Potentiating Methylation",** Patent Application 2008/0045448

GM PRODUCTS KARALIS ET AL 03182020.pdf
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Cureus

Open Access Review Article

DOI: 10.7759/cureus.7306

Genetically Modified Products, Perspectives and Challenges

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Abstract

It is a common ground that humans have always modified the genome of both plants and animals. This intrusive process that has existed for thousands of years, many times through mistakes and failures, was initially carried out through the crossing of organisms with desirable features. This was done with the aim of creating and producing new plants and animals that would benefit humans, that is , they would offer better quality food, more opportunities for people to move and transport products, greater returns to work, resistance to diseases, etc. However, creating genetically modified organisms does not proceed without conflicts. One part of the equation concerns objections made by disputants of genetically modified organisms to the manipulation of life, as opposed to defenders who argue that it is essentially an extension of traditional plant cultivation and animal breeding techniques. There are also conflicts regarding the risks to the environment and human health from using genetically modified organisms. Concerns about the risks to the environment and human health from genetically modified products have been the subject of much debate, which has led to the development of regulatory frameworks for the evaluation of genetically modified crops. However, the absence of a globally accepted framework has the effect of slowing down technological development with negative consequences for areas of the world that could benefit from new technologies. So, while genetically modified crops can provide maximum benefits in food safety and in adapting crops to existing climate change, the absence of reforms, as well as the lack of harmonization of the frameworks and regulations about the genetic modifications results in all those expected benefits of using genetically modified crops being suspended. However, it is obvious that the evolution of genetically modified products is not going to stop. For that reason, research on the impact of genetic modification on medical technologies, agricultural production, commodity prices, land use and on the environment in general, should therefore continue.

Categories: Miscellaneous, Environmental Health, Other
Keywords: genetically modified products, environment, genes, diseases, world hunger, substantial equivalence, precautionary clause, safeguard clause, labeling

Received 02/19/2020
Review began 03/05/2020
Review ended 03/11/2020
Published 03/18/2020

Introduction And Background

Biotechnology has developed many procedures that specialize in genetic recombination; the attempt to move genes from one organism to another or to change the genes present in a specific organism results in the expression of new attributes that originally were not there. The above procedures that allow gene alterations of a food or an organism result in Genetically Modified (GM) food or Genetically Modified Organisms (GMO). The concept of gene altering has initiated many debates, with one side criticising the unknown effects and risks on both public health and the environment, and the other supporting the genetic modification's benefits on economy and hunger elimination. This article attempts a literature review on

How to cite this article
Karalis D T, Karalis T, Karalis S, et al. (March 18, 2020) Genetically Modified Products, Perspectives and Challenges. Cureus 12(3): e7306. DOI 10.7759/cureus.7306

Genetically Modified Products, and specifically the possible risks that they pose, the benefits of their production and use, as well as some basics concepts that have been described and analyzed in current published writings.

Review

Possible risks of using genetically modified products

Environmental Hazards

There is strong evidence that genetically modified plants appear to interact with their environment [1]. This means that genes introduced into genetically modified plants may be transferred to other plants or even to other organisms in the ecosystem [2-3]. Gene transfer between plants, especially among related plants, results in genetic contamination and is carried out by the transport of pollen [4]. Because natural wild plant varieties are likely to have a competitive disadvantage against genetically modified crops, they may not be able to survive, resulting in the reduction or disappearance of wild varieties [5]. Changing biodiversity worldwide will result in increased resistance of several species of weeds, others to dominate and others to decline or disappear, thus creating a complete and general deregulation in ecosystems [6]. It is a common belief in scientific circles that research needs to be continued to assess the risks and benefits of crops more accurately and adequately.

Risks to Human Health

There may be allergenic effects - especially in people who are predisposed to allergies - or other adverse effects on human health [7]. Experimental studies in animals have shown weight gain, changes in the pancreas and kidneys, toxic effects to the immune system, changes in blood biochemistry among other effects [8,9]. Moreover, the lack of large-scale long-term epidemiological studies that lead to safe conclusions about the allergenic effects of genetically modified plants makes researchers skeptical about the use of genetically modified products. This is because the introduction of a gene that expresses a non-allergenic protein does not mean that it will produce a product without allergenic action. Also, allergies from genetically modified products may be more intense and dangerous, as the allergenic potential of these foods is stronger than that of conventional plants [10,11].

Resistance to Antibiotics

We must note from the outset that the use of antibiotic-resistant genes has stopped in most mutated products. The main problem now lies in the widespread use of antibiotics in feed which, as a natural consequence, end up in the human body through the consumption of dairy products and meat, and thus create resistant germs in the human digestive system [12]. However, more research and studies are needed to determine the differences between transgenic plants from traditional plants and whether genetically modified plants pose additional risks to the consumer public [13,14].

Benefits of using genetically modified products

Hunger Elimination

One of the arguments put forward by advocates of genetically modified products is to eliminate world hunger, a perception that has encountered various reactions [15-16]. A series of extensive and long-term research has shown that the benefits of growing genetically modified crops in the fight against global food shortages and hunger have been significant. The steady increase in the global population has led researchers to focus on the benefits of developing genetically

modified products, rather than the potential risks they pose each time [17].

Economic Benefits

A number of studies show the economic benefits of using genetically modified products. Between 1996 and 2011, farmers' income worldwide increased by $92 million from the use of genetically modified crops. Part of the revenue is due to the more efficient treatment of weeds and insects, while another part is due to lower overall production costs. The greatest economic benefits have been achieved in the US, Argentina, China and India, while at the same time, production costs have fallen sharply [18]. At this point, however, there are conflicting reports [19].

Insect Resistance

Bacillus thuringiensis (or BT) is a Gram-positive, soil-dwelling bacterium, commonly used as a biological pesticide. During sporulation, many BT strains produce crystal proteins (proteinaceous inclusions), called δ-endotoxins, that have insecticidal action. This has led to their use as insecticides, and more recently, to genetically modified crops using BT genes, such as BT corn. The main target of these plants is to combat the European Corn Borer insect which is responsible for the destruction of maize crops with a loss of up to one billion dollars a year [20].

Nematode Resistance

Parasitic nematodes are responsible for much of the crop losses. They attack many different plants by destroying the root system. Nematodes, which are essentially a worm species, survive in the soil in very difficult conditions for many years. Chemical control of nematodes is prohibited because there is a high environmental risk. The only natural way to deal with this is through crop rotation (the practice of growing a series of dissimilar or different types of crops in the same area in sequenced seasons), but this is often not possible due to the high financial cost [21]. Thus, the introduction of genes from nematode-resistant plants seems to be the only way to deal with the problem [22].

Resistance to Herbicide Round Up

It is common ground that the use of herbicides and pesticides in general causes serious problems for the environment and, consequently, for human health. We know that in areas where wheat is cultivated, that is, where the use of herbicides is increased, the number of child births is clearly decreasing, complications in childbirth occur, and children are born with serious health problems mainly related to mental retardation and autism spectrum [23]. Genetically modified products enable farmers to use a smaller amount of herbicides. Genetically modified soy beans produce an enzyme resistant to the action of the herbicide. The herbicide Round Up destroys the action of a plant enzyme, thereby destroying the plant. Genetically modified plants, however, produce a glyphosate-insensitive form of this enzyme, making it resistant and not affected by the action of the herbicide [24-25]. Researchers are divided on the effects on human health and animals [26].

Cold Resistance

An important advantage of genetically modified plants is the creation of varieties that are resistant to cold temperatures that would normally result in the plant freezing and destroying the plant, thereby losing production. Since the mid-2010s, because of the rapid global change in climate and because plants cannot adapt to rapid temperature changes, scientists have

turned to transgenic plants to address the problem [27].

Heat Resistance

In the near future, continuous global warming (as scientists at least claim) will have disastrous consequences for plants, especially in areas where water shortages are already occurring. Creation of modified genes (Sh2 and Bt2) can help plants withstand high temperatures [28-29].

Basic concepts related to genetically modified products

The Notion of Substantial Equivalence

The concept of substantive equivalence has been introduced in the debate on genetically modified products to ensure that these foods are safe [30]. The principle of substantive equivalence holds that if the genetically modified product contains substantially equivalent ingredients present in the conventional product, then no further safety rules are required. In this way the principle of substantial equivalence is a method of evaluating genetically modified products and finding negative factors (such as allergens due to the presence of new proteins) [31,32].

The Precautionary Principle

According to the precautionary principle, any new genetically modified product should not be made available to consumers unless there is first-hand evidence that the product is safe or if there are serious conflicts and conflicting opinions of researchers on the safety of the product in question [33]. Many researchers, however, have argued that the precautionary principle can act as a deterrent to the evolution of science and society, as it may stop or delay any new technology which is capable of solving environmental or economic problems [34]. We should note, however, that criticisms have been raised about the utility and the way the precautionary principle works [35].

The Safeguard Clause

The safeguard clause allows Member States of the European Union to prevent the circulation and sale of genetically modified products which may be harmful to citizens [36].

The Cartagena Protocol

The purpose of this document is to protect the world's biodiversity by instituting stringent rules on the transfer of genetically modified products from one country to another [37].

Labeling of Genetically Modified Products

The appearance of genetically modified products has resulted in the need for labeling of these products [38]. Genetically modified foods should have a special label indicating that they contain genetically modified ingredients. However, as simple as it sounds, the issue of genetically modified products labeling is particularly complex and difficult, as there are important questions about how labeling will be done [39]. For example, it has been argued that products containing either modified protein or foreign DNA should bear a special label. However, there are genetically modified products that do not contain modified protein or foreign DNA, so there is the debate whether these foods, although modified, require special labeling or not. [40].

Ethical Concerns

The key ethical issue regarding the cultivation of genetically modified plants is that the creation of these crops is essentially an interference with the natural flow of life. The ethical dilemma arises as to how to find the middle ground in the use of genetically modified products, given that different countries have different perceptions of the importance of risk, with many countries banning the use of genetically modified products, while companies producing these products focus on profits, and do not take into account the problems that may or may not arise. The problem here focuses on the high degree of uncertainty about the impact of using genetically modified organisms, while the arrangements proposed are usually shaped by financial and political interventions [41]. Consumer attitude is also of particular importance, as consumers are buying and paying their vote of approval at the same time. Consumers are divided into two categories, the consumers who favor the genetically modified organisms and those who oppose them. Consumers' views are influenced by the information they are offered each time, the existing regulations, the confidence they have in the government in regulating the issues that arise, and what they are prepared to pay [42].

Ethics and the Environment

Environmental ethics plays a dominant role in discussions concerning biotechnology and genetic engineering, as many of the arguments presented against genetic engineering have to do with whether it is morally right to genetically modify organisms and the environment, as this may have serious environmental impacts. This shift is evident even in product ads, where companies say environmental protection is a priority for them [43].

Ethics and Animal Rights

Specifically with regard to animals, modern ethical and philosophical considerations hold that animals, like humans, have rights and that these rights should in no way be violated [44]. Animals need to be treated as living organisms and not as commodities or human services. Introducing genes into animals and carrying out experiments can lead to drastic changes in the physiology and behavior of the animal. The results may not be desirable, and in some cases, they may even be disastrous [45].

Patenting Living (Genetically Modified) Organisms

The creation of new organisms inevitably leads to the need to register them and allocate their ownership. But even in the case of registration of a novel product, the 'owner' of the new organism must ensure that the genetic modification does not cause undesirable effects to the environment and humans, as he will be responsible for any problems that may arise [46].

Conclusions

In recent years there has been enormous technological progress in the creation of genetically modified organisms. There is no doubt that in the future there will be a continuum that will be influenced by both scientific developments and public attitudes towards genetically modified organisms. Creating genetically modified organisms, however, does not proceed without conflicts; there are the disputants of genetically modified organisms who see their production as a manipulation of life, as well as conflicts regarding the risks to the environment and human health. Even though, it is obvious that the evolution of genetically modified crops is not going to stop. Research on the impact of genetically modified crops on agricultural production, commodity prices, land use and the environment in general should therefore continue. Additionally, it is necessary to inform the consumer in order to understand the role of modern

technology in crops and agricultural production, and in particular to understand the importance of genetic modifications. In any case, there should be strict and enforceable rules for the use of genetically modified organisms, an assessment of the potential risks of genetically modified crops and clear references to the effects and the results of genetic modifications, both on the environment and on human health.

Additional Information

Disclosures

Conflicts of interest: In compliance with the ICMJE uniform disclosure form, all authors declare the following: **Payment/services info:** All authors have declared that no financial support was received from any organization for the submitted work. **Financial relationships:** All authors have declared that they have no financial relationships at present or within the previous three years with any organizations that might have an interest in the submitted work. **Other relationships:** All authors have declared that there are no other relationships or activities that could appear to have influenced the submitted work.

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March 7, 2024

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Re: SB911
WRITTEN AND ORAL TESTIMONY

AN ACT concerning FOOD, DRUGS, and COSMETICS – GENE STRUCTURE – AND FUNCTION-MODIFYING PRODUCTS – LABELING.

POSITION IN FAVOR OF THIS BILL WITH AMENDMENT

For more than 45 years I have been a practicing Maryland physician[1] who specializes in Internal Medicine and Pediatrics with a special interest in treating complex medical problems, including environmental medicine.

Please refer to the cited articles that reference genetically modified products (GMP or GMO)[2] [3] These are uploaded in support of my testimony.

My proposed AMENDMENT:
Wherever the word "PERSON" is used, add the word "ORGANIZATION" or phrase "BUSINESS ENTITY"

Families and patients seek my expertise in identifying complex medical conditions, which often require extensive history gathering. They may have unusual or unexpected outcomes. Prior testing and treatments are hallmarks in the discovery process. After discovery, treatment frequently includes nutraceuticals and pharmaceuticals.

Understanding a person's interactions with previous treatments can be critical to creating a new regimen.

Part of my investigation usually includes a dietary history and sources of pharmaceuticals and nutraceuticals. I may require information on how these products are created.

[1] CV Alan R. Vinitsky, M.D.

[2] Wikipedia Genetically modified organism (on-line access 2/27/24), 21 pages of content and 390 references.

[3] Karalis DT, Karalis T, Karalis S, et al. 2020. Genetically Modified Products, Perspectives and Challenges. *Cureus* 12(3):e7306. DOI 10.7759/cureus.7306. 8 pages – 6 pages of content and 46 references.

Healthcare providers expect that FDA-approved pharmaceuticals will meet a certain standard of consistency. But foods and nutraceuticals do not have the same level of supervision. Some products are accompanied by a disclaimer.

Frequently, persons who react adversely to treatments have altered metabolic responses. They process substances too quickly or too slowly, which results in too little or too much of what they were using. Their metabolism is further affected by their environment. What they ingest, inhale, or apply to their skin further influences how their body reacts. Their DNA and proteins might be altered by their environmental exposures. These are called "adducts."

Some persons make selections based on how products are labeled. Others could care less. As a treating physician, I am concerned that sensitive persons respond differently, due to additives (such as colors, excipients, and pesticides). As many as 20-30% of persons have some unusual characteristics that alter their function.

GMPs are additional features that have the potential to contribute to reactions. Some scientists think that GMPs have no impact on consumers. One example – consumption of GMP plants that are resistant to GLYPHOSATE may have been treated with that herbicide. There are neurological consequences of consuming GLYPHOSATE in some persons.

Both citations reference **THE PRECAUTIONARY PRINCIPLE** or the concept that the consequences of GMP use are not fully understood. The outcomes for individuals and their offspring are not well appreciated currently. Therefore, GMPs should not be used.

The reasonable option is to allow consumers a choice by LABELING a product that contains GMPs.

Respectfully submitted,

Alan R. Vinitsky, M.D.

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The Free Encyclopedia

Genetically modified organism

A **genetically modified organism** (**GMO**) is any organism whose genetic material has been altered using genetic engineering techniques. The exact definition of a genetically modified organism and what constitutes genetic engineering varies, with the most common being an organism altered in a way that "does not occur naturally by mating and/or natural recombination".[1] A wide variety of organisms have been genetically modified (GM), including animals, plants, and microorganisms.

Genetic modification can include the introduction of new genes or enhancing, altering, or knocking out endogenous genes. In some genetic modifications, genes are transferred within the same species, across species (creating transgenic organisms), and even across kingdoms.

Creating a genetically modified organism is a multi-step process. Genetic engineers must isolate the gene they wish to insert into the host organism and combine it with other genetic elements, including a promoter and terminator region and often a selectable marker. A number of techniques are available for inserting the isolated gene into the host genome. Recent advancements using genome editing techniques, notably CRISPR, have made the production of GMOs much simpler. Herbert Boyer and Stanley Cohen made the first genetically modified organism in 1973, a bacterium resistant to the antibiotic kanamycin. The first genetically modified animal, a mouse, was created in 1974 by Rudolf Jaenisch, and the first plant was produced in 1983. In 1994, the Flavr Savr tomato was released, the first commercialized genetically modified food. The first genetically modified animal to be commercialized was the GloFish (2003) and the first genetically modified animal to be approved for food use was the AquAdvantage salmon in 2015.

Bacteria are the easiest organisms to engineer and have been used for research, food production, industrial protein purification (including drugs), agriculture, and art. There is potential to use them for environmental purposes or as medicine. Fungi have been engineered with much the same goals. Viruses play an important role as vectors for inserting genetic information into other organisms. This use is especially relevant to human gene therapy. There are proposals to remove the virulent genes from viruses to create vaccines. Plants have been engineered for scientific research, to create new colors in plants, deliver vaccines, and to create enhanced crops. Genetically modified crops are publicly the most controversial GMOs, in spite of having the most human health and environmental benefits.[2] The majority are engineered for herbicide tolerance or insect resistance. Golden rice has been engineered with three genes that increase its nutritional value. Other prospects for GM crops are as bioreactors for the production of biopharmaceuticals, biofuels, or medicines.

Animals are generally much harder to transform and the vast majority are still at the research stage. Mammals are the best model organisms for humans, making ones genetically engineered to resemble serious human diseases important to the discovery and development of treatments. Human proteins expressed in mammals are more likely to be similar to their natural counterparts

than those expressed in plants or microorganisms. Livestock is modified with the intention of improving economically important traits such as growth rate, quality of meat, milk composition, disease resistance, and survival. Genetically modified fish are used for scientific research, as pets, and as a food source. Genetic engineering has been proposed as a way to control mosquitos, a vector for many deadly diseases. Although human gene therapy is still relatively new, it has been used to treat genetic disorders such as severe combined immunodeficiency and Leber's congenital amaurosis.

Many objections have been raised over the development of GMOs, particularly their commercialization. Many of these involve GM crops and whether food produced from them is safe and what impact growing them will have on the environment. Other concerns are the objectivity and rigor of regulatory authorities, contamination of non-genetically modified food, control of the food supply, patenting of life, and the use of intellectual property rights. Although there is a scientific consensus that currently available food derived from GM crops poses no greater risk to human health than conventional food, GM food safety is a leading issue with critics. Gene flow, impact on non-target organisms, and escape are the major environmental concerns. Countries have adopted regulatory measures to deal with these concerns. There are differences in the regulation for the release of GMOs between countries, with some of the most marked differences occurring between the US and Europe. Key issues concerning regulators include whether GM food should be labeled and the status of gene-edited organisms.

Definition

The definition of a genetically modified organism (GMO) is not clear and varies widely between countries, international bodies, and other communities. At its broadest, the definition of a GMO can include anything that has had its genes altered, including by nature.[3][4] Taking a less broad view, it can encompass every organism that has had its genes altered by humans, which would include all crops and livestock. In 1993, the *Encyclopedia Britannica* defined genetic engineering as "any of a wide range of techniques ... among them artificial insemination, *in vitro* fertilization (*e.g.*, 'test-tube' babies), sperm banks, cloning, and gene manipulation."[5] The European Union (EU) included a similarly broad definition in early reviews, specifically mentioning GMOs being produced by "selective breeding and other means of artificial selection"[6] These definitions were promptly adjusted with a number of exceptions added as the result of pressure from scientific and farming communities, as well as developments in science. The EU definition later excluded traditional breeding, in vitro fertilization, induction of polyploidy, mutation breeding, and cell fusion techniques that do not use recombinant nucleic acids or a genetically modified organism in the process.[7][8][9]

Another approach was the definition provided by the Food and Agriculture Organization, the World Health Organization, and the European Commission, stating that the organisms must be altered in a way that does "not occur naturally by mating and/or natural recombination".[10][11][12] Progress in science, such as the discovery of horizontal gene transfer being a relatively common natural phenomenon, further added to the confusion on what "occurs naturally", which led to further adjustments and exceptions.[13] There are examples of crops that fit this definition, but are not normally considered GMOs.[14] For example, the grain crop triticale was fully developed in a laboratory in 1930 using various techniques to alter its genome.[15]

Genetically engineered organism (GEO) can be considered a more precise term compared to GMO when describing organisms' genomes that have been directly manipulated with biotechnology.[16]

[8] The Cartagena Protocol on Biosafety used the synonym *living modified organism* (*LMO*) in 2000 and defined it as "any living organism that possesses a novel combination of genetic material obtained through the use of modern biotechnology."[17] Modern biotechnology is further defined as "In vitro nucleic acid techniques, including recombinant deoxyribonucleic acid (DNA) and direct injection of nucleic acid into cells or organelles, or fusion of cells beyond the taxonomic family."[18]

Originally, the term GMO was not commonly used by scientists to describe genetically engineered organisms until after usage of GMO became common in popular media.[19] The United States Department of Agriculture (USDA) considers GMOs to be plants or animals with heritable changes introduced by genetic engineering or traditional methods, while GEO specifically refers to organisms with genes introduced, eliminated, or rearranged using molecular biology, particularly recombinant DNA techniques, such as transgenesis.[20]

The definitions focus on the process more than the product, which means there could be GMOS and non-GMOs with very similar genotypes and phenotypes.[21][22] This has led scientists to label it as a scientifically meaningless category,[23] saying that it is impossible to group all the different types of GMOs under one common definition.[24] It has also caused issues for organic institutions and groups looking to ban GMOs.[25][26] It also poses problems as new processes are developed. The current definitions came in before genome editing became popular and there is some confusion as to whether they are GMOs. The EU has adjudged that they are[27] changing their GMO definition to include "organisms obtained by mutagenesis", but has excluded them from regulation based on their "long safety record" and that they have been "conventionally been used in a number of applications".[9] In contrast the USDA has ruled that gene edited organisms are not considered GMOs.[28]

Even greater inconsistency and confusion is associated with various "Non-GMO" or "GMO-free" labeling schemes in food marketing, where even products such as water or salt, which do not contain any organic substances and genetic material (and thus cannot be genetically modified by definition), are being labeled to create an impression of being "more healthy".[29][30][31]

Production

Creating a genetically modified organism (GMO) is a multi-step process. Genetic engineers must isolate the gene they wish to insert into the host organism. This gene can be taken from a cell[32] or artificially synthesized.[33] If the chosen gene or the donor organism's genome has been well studied it may already be accessible from a genetic library. The gene is then combined with other genetic elements, including a promoter and terminator region and a selectable marker.[34]

A gene gun uses biolistics to insert DNA into plant tissue.

A number of techniques are available for inserting the isolated gene into the host genome. Bacteria can be induced to take up foreign DNA, usually by exposed heat shock or electroporation.[35] DNA is generally inserted into animal cells using microinjection, where it can be injected through the cell's nuclear envelope directly into the nucleus, or through the use of viral vectors.[36] In plants the DNA is often

inserted using *Agrobacterium*-mediated recombination,[37][38] biolistics[39] or electroporation.

As only a single cell is transformed with genetic material, the organism must be regenerated from that single cell. In plants this is accomplished through tissue culture.[40][41] In animals it is necessary to ensure that the inserted DNA is present in the embryonic stem cells.[37] Further testing using PCR, Southern hybridization, and DNA sequencing is conducted to confirm that an organism contains the new gene.[42]

Traditionally the new genetic material was inserted randomly within the host genome. Gene targeting techniques, which creates double-stranded breaks and takes advantage on the cells natural homologous recombination repair systems, have been developed to target insertion to exact locations. Genome editing uses artificially engineered nucleases that create breaks at specific points. There are four families of engineered nucleases: meganucleases,[43][44] zinc finger nucleases,[45][46] transcription activator-like effector nucleases (TALENs),[47][48] and the Cas9-guideRNA system (adapted from CRISPR).[49][50] TALEN and CRISPR are the two most commonly used and each has its own advantages.[51] TALENs have greater target specificity, while CRISPR is easier to design and more efficient.[51]

History

Herbert Boyer (pictured) and Stanley Cohen created the first genetically modified organism in 1973.

Humans have domesticated plants and animals since around 12,000 BCE, using selective breeding or artificial selection (as contrasted with natural selection).[52]:25 The process of selective breeding, in which organisms with desired traits (and thus with the desired genes) are used to breed the next generation and organisms lacking the trait are not bred, is a precursor to the modern concept of genetic modification.[53]:1[54]:1 Various advancements in genetics allowed humans to directly alter the DNA and therefore genes of organisms. In 1972, Paul Berg created the first recombinant DNA molecule when he combined DNA from a monkey virus with that of the lambda virus.[55][56]

Herbert Boyer and Stanley Cohen made the first genetically modified organism in 1973.[57] They took a gene from a bacterium that provided resistance to the antibiotic kanamycin, inserted it into a plasmid and then induced other bacteria to incorporate the plasmid. The bacteria that had successfully incorporated the plasmid was then able to survive in the presence of kanamycin.[58] Boyer and Cohen expressed other genes in bacteria. This included genes from the toad *Xenopus laevis* in 1974, creating the first GMO expressing a gene from an organism of a different kingdom.[59]

In 1974, Rudolf Jaenisch created a transgenic mouse by introducing foreign DNA into its embryo, making it the world's first transgenic animal.[60][61] However it took another eight years before transgenic mice were developed that passed the transgene to their offspring.[62][63] Genetically modified mice were created in 1984 that carried cloned oncogenes, predisposing them to developing cancer.[64] Mice with genes removed (termed a knockout mouse) were created in 1989. The first transgenic livestock were produced in 1985[65] and the first animal to synthesize

In 1974, Rudolf Jaenisch created the first genetically modified animal.

transgenic proteins in their milk were mice in 1987.[66] The mice were engineered to produce human tissue plasminogen activator, a protein involved in breaking down blood clots.[67]

In 1983, the first genetically engineered plant was developed by Michael W. Bevan, Richard B. Flavell and Mary-Dell Chilton. They infected tobacco with *Agrobacterium* transformed with an antibiotic resistance gene and through tissue culture techniques were able to grow a new plant containing the resistance gene.[68] The gene gun was invented in 1987, allowing transformation of plants not susceptible to *Agrobacterium* infection.[69] In 2000, Vitamin A-enriched golden rice was the first plant developed with increased nutrient value.[70]

In 1976, Genentech, the first genetic engineering company was founded by Herbert Boyer and Robert Swanson; a year later, the company produced a human protein (somatostatin) in *E. coli*. Genentech announced the production of genetically engineered human insulin in 1978.[71] The insulin produced by bacteria, branded Humulin, was approved for release by the Food and Drug Administration in 1982.[72] In 1988, the first human antibodies were produced in plants.[73] In 1987, a strain of *Pseudomonas syringae* became the first genetically modified organism to be released into the environment[74] when a strawberry and potato field in California were sprayed with it.[75]

The first genetically modified crop, an antibiotic-resistant tobacco plant, was produced in 1982.[76] China was the first country to commercialize transgenic plants, introducing a virus-resistant tobacco in 1992.[77] In 1994, Calgene attained approval to commercially release the Flavr Savr tomato, the first genetically modified food.[78] Also in 1994, the European Union approved tobacco engineered to be resistant to the herbicide bromoxynil, making it the first genetically engineered crop commercialized in Europe.[79] An insect resistant Potato was approved for release in the US in 1995,[80] and by 1996 approval had been granted to commercially grow 8 transgenic crops and one flower crop (carnation) in 6 countries plus the EU.[81]

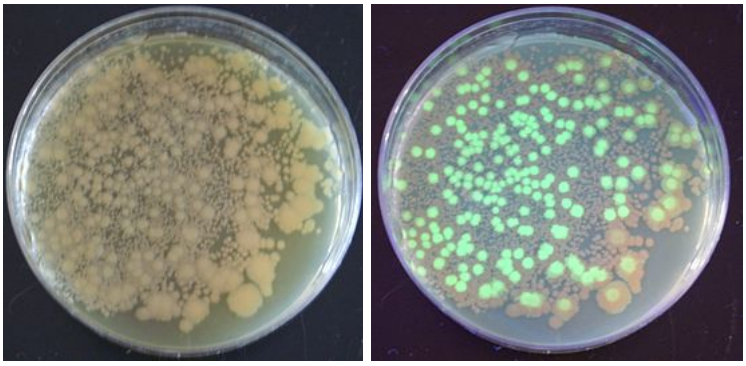
In 2010, scientists at the J. Craig Venter Institute announced that they had created the first synthetic bacterial genome. They named it Synthia and it was the world's first synthetic life form.[82][83]

The first genetically modified animal to be commercialized was the GloFish, a Zebra fish with a fluorescent gene added that allows it to glow in the dark under ultraviolet light.[84] It was released to the US market in 2003.[85] In 2015, AquAdvantage salmon became the first genetically modified animal to be approved for food use.[86] Approval is for fish raised in Panama and sold in the US.[86] The salmon were transformed with a growth hormone-regulating gene from a Pacific Chinook salmon and a promoter from an ocean pout enabling it to grow year-round instead of only during spring and summer.[87]

Bacteria

Bacteria were the first organisms to be genetically modified in the laboratory, due to the relative ease of modifying their chromosomes.[88] This ease made them important tools for the creation of other GMOs. Genes and other genetic information from a wide range of organisms can be added to

a plasmid and inserted into bacteria for storage and modification. Bacteria are cheap, easy to grow, clonal, multiply quickly and can be stored at −80 °C almost indefinitely. Once a gene is isolated it can be stored inside the bacteria, providing an unlimited supply for research.[89] A large number of custom plasmids make manipulating DNA extracted from bacteria relatively easy.[90]



Left: Bacteria transformed with pGLO under ambient light
Right: Bacteria transformed with pGLO visualized under ultraviolet light

Their ease of use has made them great tools for scientists looking to study gene function and evolution. The simplest model organisms come from bacteria, with most of our early understanding of molecular biology coming from studying *Escherichia coli*.[91] Scientists can easily manipulate and combine genes within the bacteria to create novel or disrupted proteins and observe the effect this has on various molecular systems. Researchers have combined the genes from bacteria and archaea, leading to insights on how these two diverged in the past.[92] In the field of synthetic biology, they have been used to test various synthetic approaches, from synthesizing genomes to creating novel nucleotides.[93][94][95]

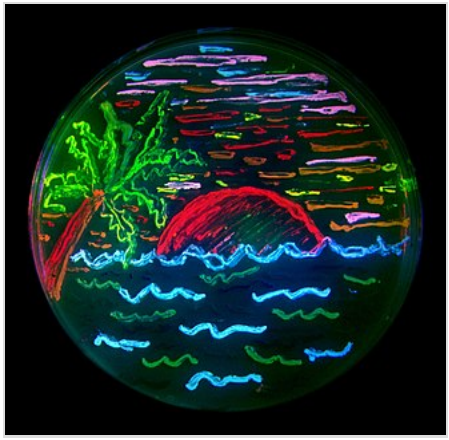
Bacteria have been used in the production of food for a long time, and specific strains have been developed and selected for that work on an industrial scale. They can be used to produce enzymes, amino acids, flavorings, and other compounds used in food production. With the advent of genetic engineering, new genetic changes can easily be introduced into these bacteria. Most food-producing bacteria are lactic acid bacteria, and this is where the majority of research into genetically engineering food-producing bacteria has gone. The bacteria can be modified to operate more efficiently, reduce toxic byproduct production, increase output, create improved compounds, and remove unnecessary pathways.[96] Food products from genetically modified bacteria include alpha-amylase, which converts starch to simple sugars, chymosin, which clots milk protein for cheese making, and pectinesterase, which improves fruit juice clarity.[97] The majority are produced in the US and even though regulations are in place to allow production in Europe, as of 2015 no food products derived from bacteria are currently available there.[98]

Genetically modified bacteria are used to produce large amounts of proteins for industrial use. The bacteria are generally grown to a large volume before the gene encoding the protein is activated. The bacteria are then harvested and the desired protein purified from them.[99] The high cost of extraction and purification has meant that only high value products have been produced at an industrial scale.[100] The majority of these products are human proteins for use in medicine.[101] Many of these proteins are impossible or difficult to obtain via natural methods and they are less likely to be contaminated with pathogens, making them safer.[99] The first medicinal use of GM bacteria was to produce the protein insulin to treat diabetes.[102] Other medicines produced include clotting factors to treat hemophilia,[103] human growth hormone to treat various forms of dwarfism,[104][105] interferon to treat some cancers, erythropoietin for anemic patients, and tissue plasminogen activator which dissolves blood clots.[99] Outside of medicine they have been used to produce biofuels.[106] There is interest in developing an extracellular expression system within the bacteria to reduce costs and make the production of more products economical.[100]

With a greater understanding of the role that the microbiome plays in human health, there is a potential to treat diseases by genetically altering the bacteria to, themselves, be therapeutic agents. Ideas include altering gut bacteria so they destroy harmful bacteria, or using bacteria to replace or increase deficient enzymes or proteins. One research focus is to modify *Lactobacillus*, bacteria that naturally provide some protection against HIV, with genes that will further enhance this protection. If the bacteria do not form colonies inside the patient, the person must repeatedly ingest the modified bacteria in order to get the required doses. Enabling the bacteria to form a colony could provide a more long-term solution, but could also raise safety concerns as interactions between bacteria and the human body are less well understood than with traditional drugs. There are concerns that horizontal gene transfer to other bacteria could have unknown effects. As of 2018 there are clinical trials underway testing the efficacy and safety of these treatments.[107]

For over a century, bacteria have been used in agriculture. Crops have been inoculated with Rhizobia (and more recently *Azospirillum*) to increase their production or to allow them to be grown outside their original habitat. Application of *Bacillus thuringiensis* (Bt) and other bacteria can help protect crops from insect infestation and plant diseases. With advances in genetic engineering, these bacteria have been manipulated for increased efficiency and expanded host range. Markers have also been added to aid in tracing the spread of the bacteria. The bacteria that naturally colonize certain crops have also been modified, in some cases to express the Bt genes responsible for pest resistance. *Pseudomonas* strains of bacteria cause frost damage by nucleating water into ice crystals around themselves. This led to the development of ice-minus bacteria, which have the ice-forming genes removed. When applied to crops they can compete with the non-modified bacteria and confer some frost resistance.[108]

Other uses for genetically modified bacteria include bioremediation, where the bacteria are used to convert pollutants into a less toxic form. Genetic engineering can increase the levels of the enzymes used to degrade a toxin or to make the bacteria more stable under environmental conditions.[109] Bioart has also been created using genetically modified bacteria. In the 1980s artist Jon Davis and geneticist Dana Boyd converted the Germanic symbol for femininity (ᛉ) into binary code and then into a DNA sequence, which was then expressed in *Escherichia coli*.[110] This was taken a step further in 2012, when a whole book was encoded onto DNA.[111] Paintings have also been produced using bacteria transformed with fluorescent proteins.[110]



This artwork is made with bacteria modified to express 8 different colors of fluorescent proteins.

Viruses

Viruses are often modified so they can be used as vectors for inserting genetic information into other organisms. This process is called transduction and if successful the recipient of the introduced DNA becomes a GMO. Different viruses have different efficiencies and capabilities. Researchers can use this to control for various factors; including the target location, insert size, and duration of gene expression. Any dangerous sequences inherent in the virus must be removed, while those that allow the gene to be delivered effectively are retained.[112]

While viral vectors can be used to insert DNA into almost any organism it is especially relevant for

its potential in treating human disease. Although primarily still at trial stages,[113] there has been some successes using gene therapy to replace defective genes. This is most evident in curing patients with severe combined immunodeficiency rising from adenosine deaminase deficiency (ADA-SCID),[114] although the development of leukemia in some ADA-SCID patients[115] along with the death of Jesse Gelsinger in a 1999 trial set back the development of this approach for many years.[116] In 2009, another breakthrough was achieved when an eight-year-old boy with Leber's congenital amaurosis regained normal eyesight[116] and in 2016 GlaxoSmithKline gained approval to commercialize a gene therapy treatment for ADA-SCID.[114] As of 2018, there are a substantial number of clinical trials underway, including treatments for hemophilia, glioblastoma, chronic granulomatous disease, cystic fibrosis and various cancers.[115]

The most common virus used for gene delivery comes from adenoviruses as they can carry up to 7.5 kb of foreign DNA and infect a relatively broad range of host cells, although they have been known to elicit immune responses in the host and only provide short term expression. Other common vectors are adeno-associated viruses, which have lower toxicity and longer-term expression, but can only carry about 4kb of DNA.[115] Herpes simplex viruses make promising vectors, having a carrying capacity of over 30kb and providing long term expression, although they are less efficient at gene delivery than other vectors.[117] The best vectors for long term integration of the gene into the host genome are retroviruses, but their propensity for random integration is problematic. Lentiviruses are a part of the same family as retroviruses with the advantage of infecting both dividing and non-dividing cells, whereas retroviruses only target dividing cells. Other viruses that have been used as vectors include alphaviruses, flaviviruses, measles viruses, rhabdoviruses, Newcastle disease virus, poxviruses, and picornaviruses.[115]

Most vaccines consist of viruses that have been attenuated, disabled, weakened or killed in some way so that their virulent properties are no longer effective. Genetic engineering could theoretically be used to create viruses with the virulent genes removed. This does not affect the viruses infectivity, invokes a natural immune response and there is no chance that they will regain their virulence function, which can occur with some other vaccines. As such they are generally considered safer and more efficient than conventional vaccines, although concerns remain over non-target infection, potential side effects and horizontal gene transfer to other viruses.[118] Another potential approach is to use vectors to create novel vaccines for diseases that have no vaccines available or the vaccines that do not work effectively, such as AIDS, malaria, and tuberculosis.[119] The most effective vaccine against Tuberculosis, the Bacillus Calmette–Guérin (BCG) vaccine, only provides partial protection. A modified vaccine expressing *a M tuberculosis* antigen is able to enhance BCG protection.[120] It has been shown to be safe to use at phase II trials, although not as effective as initially hoped.[121] Other vector-based vaccines have already been approved and many more are being developed.[119]

Another potential use of genetically modified viruses is to alter them so they can directly treat diseases. This can be through expression of protective proteins or by directly targeting infected cells. In 2004, researchers reported that a genetically modified virus that exploits the selfish behavior of cancer cells might offer an alternative way of killing tumours.[122][123] Since then, several researchers have developed genetically modified oncolytic viruses that show promise as treatments for various types of cancer.[124][125][126][127][128] In 2017, researchers genetically modified a virus to express spinach defensin proteins. The virus was injected into orange trees to combat citrus greening disease that had reduced orange production by 70% since 2005.[129]

Natural viral diseases, such as myxomatosis and rabbit hemorrhagic disease, have been used to

help control pest populations. Over time the surviving pests become resistant, leading researchers to look at alternative methods. Genetically modified viruses that make the target animals infertile through immunocontraception have been created in the laboratory[130] as well as others that target the developmental stage of the animal.[131] There are concerns with using this approach regarding virus containment[130] and cross species infection.[132] Sometimes the same virus can be modified for contrasting purposes. Genetic modification of the myxoma virus has been proposed to conserve European wild rabbits in the Iberian peninsula and to help regulate them in Australia. To protect the Iberian species from viral diseases, the myxoma virus was genetically modified to immunize the rabbits, while in Australia the same myxoma virus was genetically modified to lower fertility in the Australian rabbit population.[133]

Outside of biology scientists have used a genetically modified virus to construct a lithium-ion battery and other nanostructured materials. It is possible to engineer bacteriophages to express modified proteins on their surface and join them up in specific patterns (a technique called phage display). These structures have potential uses for energy storage and generation, biosensing and tissue regeneration with some new materials currently produced including quantum dots, liquid crystals, nanorings and nanofibres.[134] The battery was made by engineering M13 bacteriaophages so they would coat themselves in iron phosphate and then assemble themselves along a carbon nanotube. This created a highly conductive medium for use in a cathode, allowing energy to be transferred quickly. They could be constructed at lower temperatures with non-toxic chemicals, making them more environmentally friendly.[135]

Fungi

Fungi can be used for many of the same processes as bacteria. For industrial applications, yeasts combine the bacterial advantages of being a single-celled organism that is easy to manipulate and grow with the advanced protein modifications found in eukaryotes. They can be used to produce large complex molecules for use in food, pharmaceuticals, hormones, and steroids.[136] Yeast is important for wine production and as of 2016 two genetically modified yeasts involved in the fermentation of wine have been commercialized in the United States and Canada. One has increased malolactic fermentation efficiency, while the other prevents the production of dangerous ethyl carbamate compounds during fermentation.[96] There have also been advances in the production of biofuel from genetically modified fungi.[137]

Fungi, being the most common pathogens of insects, make attractive biopesticides. Unlike bacteria and viruses they have the advantage of infecting the insects by contact alone, although they are out competed in efficiency by chemical pesticides. Genetic engineering can improve virulence, usually by adding more virulent proteins,[138] increasing infection rate or enhancing spore persistence.[139] Many of the disease carrying vectors are susceptible to entomopathogenic fungi. An attractive target for biological control are mosquitos, vectors for a range of deadly diseases, including malaria, yellow fever and dengue fever. Mosquitos can evolve quickly so it becomes a balancing act of killing them before the *Plasmodium* they carry becomes the infectious disease, but not so fast that they become resistant to the fungi. By genetically engineering fungi like *Metarhizium anisopliae* and *Beauveria bassiana* to delay the development of mosquito infectiousness the selection pressure to evolve resistance is reduced.[140] Another strategy is to add proteins to the fungi that block transmission of malaria[140] or remove the *Plasmodium* altogether.[141]

Agaricus bisporus the common white button mushroom, has been gene edited to resist browning, giving it a longer shelf life. The process used CRISPR to knock out a gene that encodes polyphenol

oxidase. As it didn't introduce any foreign DNA into the organism it was not deemed to be regulated under existing GMO frameworks and as such is the first CRISPR-edited organism to be approved for release.[142] This has intensified debates as to whether gene-edited organisms should be considered genetically modified organisms[143] and how they should be regulated.[144]

Plants

Tissue culture used to regenerate *Arabidopsis thaliana*

Plants have been engineered for scientific research, to display new flower colors, deliver vaccines, and to create enhanced crops. Many plants are pluripotent, meaning that a single cell from a mature plant can be harvested and under the right conditions can develop into a new plant. This ability can be taken advantage of by genetic engineers; by selecting for cells that have been successfully transformed in an adult plant a new plant can then be grown that contains the transgene in every cell through a process known as tissue culture.[145]

Much of the advances in the field of genetic engineering has come from experimentation with tobacco. Major advances in tissue culture and plant cellular mechanisms for a wide range of plants has originated from systems developed in tobacco.[146] It was the first plant to be altered using genetic engineering and is considered a model organism for not only genetic engineering, but a range of other fields.[147] As such the transgenic tools and procedures are well established making tobacco one of the easiest plants to transform.[148] Another major model organism relevant to genetic engineering is *Arabidopsis thaliana*. Its small genome and short life cycle makes it easy to manipulate and it contains many homologs to important crop species.[149] It was the first plant sequenced, has a host of online resources available and can be transformed by simply dipping a flower in a transformed *Agrobacterium* solution.[150]

In research, plants are engineered to help discover the functions of certain genes. The simplest way to do this is to remove the gene and see what phenotype develops compared to the wild type form. Any differences are possibly the result of the missing gene. Unlike mutagenisis, genetic engineering allows targeted removal without disrupting other genes in the organism.[145] Some genes are only expressed in certain tissues, so reporter genes, like GUS, can be attached to the gene of interest allowing visualization of the location.[151] Other ways to test a gene is to alter it slightly and then return it to the plant and see if it still has the same effect on phenotype. Other strategies include attaching the gene to a strong promoter and see what happens when it is overexpressed, forcing a gene to be expressed in a different location or at different developmental stages.[145]

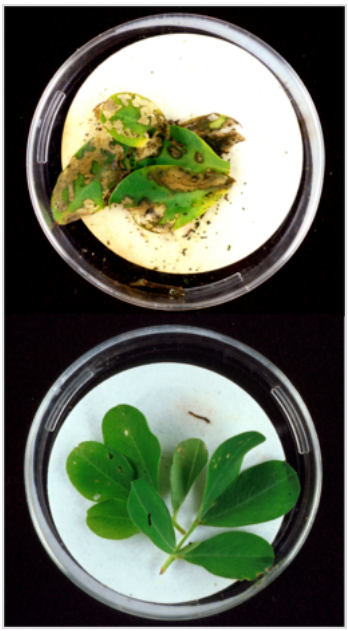
Some genetically modified plants are purely ornamental. They are modified for flower color, fragrance, flower shape and plant architecture.[152] The first genetically modified ornamentals commercialized altered color.[153] Carnations were released in 1997, with the most popular genetically modified organism, a blue rose (actually lavender or mauve) created in 2004.[154] The roses are sold in Japan, the United States, and Canada.[155][156] Other genetically modified ornamentals include *Chrysanthemum* and *Petunia*.[152] As well as increasing aesthetic value there are plans to develop ornamentals that use less water or are resistant to the cold, which would allow them to be grown outside their natural environments.[157]

It has been proposed to genetically modify some plant species threatened by extinction to be resistant to invasive plants and diseases, such as the emerald ash borer in North American and the fungal disease, *Ceratocystis platani*, in European plane trees.[158] The papaya ringspot virus devastated papaya trees in Hawaii in the twentieth century until transgenic papaya plants were given pathogen-derived resistance.[159] However, genetic modification for conservation in plants remains mainly speculative. A unique concern is that a transgenic species may no longer bear enough resemblance to the original species to truly claim that the original species is being conserved. Instead, the transgenic species may be genetically different enough to be considered a new species, thus diminishing the conservation worth of genetic modification.[158]

Suntory "blue" rose

Crops

Genetically modified crops are genetically modified plants that are used in agriculture. The first crops developed were used for animal or human food and provide resistance to certain pests, diseases, environmental conditions, spoilage or chemical treatments (e.g. resistance to a herbicide). The second generation of crops aimed to improve the quality, often by altering the nutrient profile. Third generation genetically modified crops could be used for non-food purposes, including the production of pharmaceutical agents, biofuels, and other industrially useful goods, as well as for bioremediation.[160]



Wild type peanut (**top**) and transgenic peanut with *Bacillus thuringiensis* gene added (**bottom**) exposed to cornstalk borer larva

Kenyans examining insect-resistant transgenic *Bacillus thuringiensis* (Bt) corn

There are three main aims to agricultural advancement; increased production, improved conditions for agricultural workers and sustainability. GM crops contribute by improving harvests through reducing insect pressure, increasing nutrient value and tolerating different abiotic stresses. Despite this potential, as of 2018, the commercialized crops are limited mostly to cash crops like cotton, soybean, maize and canola and the vast majority of the introduced traits provide either herbicide tolerance or insect resistance.[160] Soybeans accounted for half of all genetically modified crops planted in 2014.[161] Adoption by farmers has been rapid, between 1996 and 2013, the total surface area of land cultivated with GM crops increased by a factor of 100.[162] Geographically though the spread has been uneven, with strong growth in the Americas and parts of Asia and little in Europe and Africa.[160] Its socioeconomic spread has been more even, with approximately 54% of worldwide GM crops grown in developing countries in 2013.[162] Although doubts have been raised,[163] most studies have found growing GM crops to be beneficial to farmers through decreased pesticide use as well as increased crop yield and farm profit.[164][165]

[166]

The majority of GM crops have been modified to be resistant to selected herbicides, usually a glyphosate or glufosinate based one. Genetically modified crops engineered to resist herbicides are now more available than conventionally bred resistant varieties;[167] in the USA 93% of soybeans and most of the GM maize grown is glyphosate tolerant.[168] Most currently available genes used to engineer insect resistance come from the *Bacillus thuringiensis* bacterium and code for delta endotoxins. A few use the genes that encode for vegetative insecticidal proteins.[169] The only gene commercially used to provide insect protection that does not originate from *B. thuringiensis* is the Cowpea trypsin inhibitor (CpTI). CpTI was first approved for use cotton in 1999 and is currently undergoing trials in rice.[170][171] Less than one percent of GM crops contained other traits, which include providing virus resistance, delaying senescence and altering the plants composition.[161]

Golden rice compared to white rice

Golden rice is the most well known GM crop that is aimed at increasing nutrient value. It has been engineered with three genes that biosynthesise beta-carotene, a precursor of vitamin A, in the edible parts of rice.[70] It is intended to produce a fortified food to be grown and consumed in areas with a shortage of dietary vitamin A,[172] a deficiency which each year is estimated to kill 670,000 children under the age of 5[173] and cause an additional 500,000 cases of irreversible childhood blindness.[174] The original golden rice produced 1.6µg/g of the carotenoids, with further development increasing this 23 times.[175] It gained its first approvals for use as food in 2018.[176]

Plants and plant cells have been genetically engineered for production of biopharmaceuticals in bioreactors, a process known as pharming. Work has been done with duckweed *Lemna minor*,[177] the algae *Chlamydomonas reinhardtii*[178] and the moss *Physcomitrella patens*.[179][180] Biopharmaceuticals produced include cytokines, hormones, antibodies, enzymes and vaccines, most of which are accumulated in the plant seeds. Many drugs also contain natural plant ingredients and the pathways that lead to their production have been genetically altered or transferred to other plant species to produce greater volume.[181] Other options for bioreactors are biopolymers[182] and biofuels.[183] Unlike bacteria, plants can modify the proteins post-translationally, allowing them to make more complex molecules. They also pose less risk of being contaminated.[184] Therapeutics have been cultured in transgenic carrot and tobacco cells,[185] including a drug treatment for Gaucher's disease.[186]

Vaccine production and storage has great potential in transgenic plants. Vaccines are expensive to produce, transport, and administer, so having a system that could produce them locally would allow greater access to poorer and developing areas.[181] As well as purifying vaccines expressed in plants it is also possible to produce edible vaccines in plants. Edible vaccines stimulate the immune system when ingested to protect against certain diseases. Being stored in plants reduces the long-term cost as they can be disseminated without the need for cold storage, don't need to be purified, and have long term stability. Also being housed within plant cells provides some protection from the gut acids upon digestion. However the cost of developing, regulating, and containing transgenic plants is high, leading to most current plant-based vaccine development being applied to veterinary medicine, where the controls are not as strict.[187]

Genetically modified crops have been proposed as one of the ways to reduce farming-related CO_2

emissions due to higher yield, reduced use of pesticides, reduced use of tractor fuel and no tillage. According to a 2021 study, in EU alone widespread adoption of GE crops would reduce greenhouse gas emissions by 33 million tons of CO_2 equivalent or 7.5% of total farming-related emissions.[188]

Animals

The vast majority of genetically modified animals are at the research stage with the number close to entering the market remaining small.[189] As of 2018 only three genetically modified animals have been approved, all in the USA. A goat and a chicken have been engineered to produce medicines and a salmon has increased its own growth.[190] Despite the differences and difficulties in modifying them, the end aims are much the same as for plants. GM animals are created for research purposes, production of industrial or therapeutic products, agricultural uses, or improving their health. There is also a market for creating genetically modified pets.[191]

Mammals

The process of genetically engineering mammals is slow, tedious, and expensive. However, new technologies are making genetic modifications easier and more precise.[192] The first transgenic mammals were produced by injecting viral DNA into embryos and then implanting the embryos in females.[60] The embryo would develop and it would be hoped that some of the genetic material would be incorporated into the reproductive cells. Then researchers would have to wait until the animal reached breeding age and then offspring would be screened for the presence of the gene in every cell. The development of the CRISPR-Cas9 gene editing system as a cheap and fast way of directly modifying germ cells, effectively halving the amount of time needed to develop genetically modified mammals.[193]

Some chimeras, like the blotched mouse shown, are created through genetic modification techniques like gene targeting.

A porcine model of hemophilia A

Mammals are the best models for human disease, making genetic engineered ones vital to the discovery and development of cures and treatments for many serious diseases. Knocking out genes responsible for human genetic disorders allows researchers to study the mechanism of the disease and to test possible cures. Genetically modified mice have been the most common mammals used in biomedical research, as they are cheap and easy to manipulate. Pigs are also a good target as they have a similar body size and anatomical features, physiology, pathophysiological response and diet.[194] Nonhuman primates are the most similar model organisms to humans, but there is less public acceptance towards using them as research animals.[195] In 2009, scientists announced that they had successfully transferred a gene into a primate species (marmosets) for the first time.[196][197] Their first research target for these marmosets was

Parkinson's disease, but they were also considering amyotrophic lateral sclerosis and Huntington's disease.[198]

Human proteins expressed in mammals are more likely to be similar to their natural counterparts than those expressed in plants or microorganisms. Stable expression has been accomplished in sheep, pigs, rats and other animals. In 2009, the first human biological drug produced from such an animal, a goat, was approved. The drug, ATryn, is an anticoagulant which reduces the probability of blood clots during surgery or childbirth and is extracted from the goat's milk.[199] Human alpha-1-antitrypsin is another protein that has been produced from goats and is used in treating humans with this deficiency.[200] Another medicinal area is in creating pigs with greater capacity for human organ transplants (xenotransplantation). Pigs have been genetically modified so that their organs can no longer carry retroviruses[201] or have modifications to reduce the chance of rejection.[202][203] Pig lungs from genetically modified pigs are being considered for transplantation into humans.[204][205] There is even potential to create chimeric pigs that can carry human organs.[194][206]

Livestock are modified with the intention of improving economically important traits such as growth-rate, quality of meat, milk composition, disease resistance and survival. Animals have been engineered to grow faster, be healthier[207] and resist diseases.[208] Modifications have also improved the wool production of sheep and udder health of cows.[189] Goats have been genetically engineered to produce milk with strong spiderweb-like silk proteins in their milk.[209] A GM pig called Enviropig was created with the capability of digesting plant phosphorus more efficiently than conventional pigs.[210][211] They could reduce water pollution since they excrete 30 to 70% less phosphorus in manure.[210][212] Dairy cows have been genetically engineered to produce milk that would be the same as human breast milk.[213] This could potentially benefit mothers who cannot produce breast milk but want their children to have breast milk rather than formula.[214][215] Researchers have also developed a genetically engineered cow that produces allergy-free milk.[216]

Scientists have genetically engineered several organisms, including some mammals, to include green fluorescent protein (GFP), for research purposes.[217] GFP and other similar reporting genes allow easy visualization and localization of the products of the genetic modification.[218] Fluorescent pigs have been bred to study human organ transplants, regenerating ocular photoreceptor cells, and other topics.[219] In 2011, green-fluorescent cats were created to help find therapies for HIV/AIDS and other diseases[220] as feline immunodeficiency virus is related to HIV.[221]

Mice expressing the green fluorescent protein

There have been suggestions that genetic engineering could be used to bring animals back from extinction. It involves changing the genome of a close living relative to resemble the extinct one and is currently being attempted with the passenger pigeon.[222] Genes associated with the woolly mammoth have been added to the genome of an African Elephant, although the lead researcher says he has no intention of creating live elephants and transferring all the genes and reversing years of genetic evolution is a long way from being feasible.[223][224] It is more likely that scientists could use this technology to conserve endangered animals by bringing back lost diversity or transferring evolved genetic advantages from adapted organisms to those that are struggling.

[225]

Humans

Gene therapy[226] uses genetically modified viruses to deliver genes which can cure disease in humans. Although gene therapy is still relatively new, it has had some successes. It has been used to treat genetic disorders such as severe combined immunodeficiency,[227] and Leber's congenital amaurosis.[228] Treatments are also being developed for a range of other currently incurable diseases, such as cystic fibrosis,[229] sickle cell anemia,[230] Parkinson's disease,[231][232] cancer,[233][234][235] diabetes,[236] heart disease[237] and muscular dystrophy.[238] These treatments only effect somatic cells, meaning any changes would not be inheritable. Germline gene therapy results in any change being inheritable, which has raised concerns within the scientific community.[239][240]

In 2015, CRISPR was used to edit the DNA of non-viable human embryos.[241][242] In November 2018, He Jiankui announced that he had edited the genomes of two human embryos, in an attempt to disable the *CCR5* gene, which codes for a receptor that HIV uses to enter cells. He said that twin girls, Lulu and Nana, had been born a few weeks earlier and that they carried functional copies of CCR5 along with disabled CCR5 (mosaicism) and were still vulnerable to HIV. The work was widely condemned as unethical, dangerous, and premature.[243]

Fish

When exposed to 13 °C water the zebrafish modified to express a carp creatine kinase (**right**) maintained swimming behavior, while wild type zebrafish (**left**) could not.[244]

Genetically modified fish are used for scientific research, as pets and as a food source. Aquaculture is a growing industry, currently providing over half the consumed fish worldwide.[245] Through genetic engineering it is possible to increase growth rates, reduce food intake, remove allergenic properties, increase cold tolerance and provide disease resistance. Fish can also be used to detect aquatic pollution or function as bioreactors.[246]

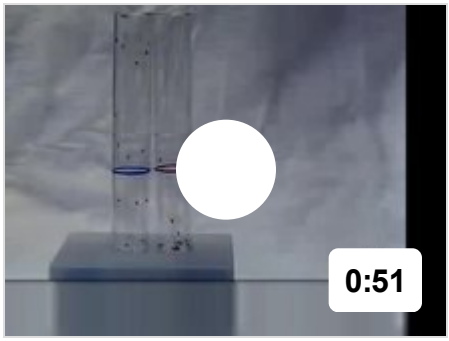
Several groups have been developing zebrafish to detect pollution by attaching fluorescent proteins to genes activated by the presence of pollutants. The fish will then glow and can be used as environmental sensors.[247][248] The GloFish is a brand of genetically modified fluorescent zebrafish with bright red, green, and orange fluorescent color. It was originally developed by one of the groups to detect pollution, but is now part of the ornamental fish trade, becoming the first genetically modified animal to become publicly available as a pet when in 2003 it was introduced for sale in the USA.[249]

GM fish are widely used in basic research in genetics and development. Two species of fish, zebrafish and medaka, are most commonly modified because they have optically clear chorions (membranes in the egg), rapidly develop, and the one-cell embryo is easy to see and microinject with transgenic DNA.[250] Zebrafish are model organisms for developmental processes, regeneration, genetics, behavior, disease mechanisms and toxicity testing.[251] Their transparency allows researchers to observe developmental stages, intestinal functions and tumour growth.[252] [253] The generation of transgenic protocols (whole organism, cell or tissue specific, tagged with reporter genes) has increased the level of information gained by studying these fish.[254]

GM fish have been developed with promoters driving an over-production of growth hormone for use in the aquaculture industry to increase the speed of development and potentially reduce fishing pressure on wild stocks. This has resulted in dramatic growth enhancement in several species, including salmon,[255] trout[256] and tilapia.[257] AquaBounty Technologies, a biotechnology company, have produced a salmon (called AquAdvantage salmon) that can mature in half the time as wild salmon.[258] It obtained regulatory approval in 2015, the first non-plant GMO food to be commercialized.[259] As of August 2017, GMO salmon is being sold in Canada.[260] Sales in the US started in May 2021.[261]

Insects

In biological research, transgenic fruit flies (*Drosophila melanogaster*) are model organisms used to study the effects of genetic changes on development.[263] Fruit flies are often preferred over other animals due to their short life cycle and low maintenance requirements. They also have a relatively simple genome compared to many vertebrates, with typically only one copy of each gene, making phenotypic analysis easy.[264] *Drosophila* have been used to study genetics and inheritance, embryonic development, learning, behavior, and aging.[265] The discovery of transposons, in particular the p-element, in *Drosophila* provided an early method to add transgenes to their genome, although this has been taken over by more modern gene-editing techniques.[266]



Overexpression of methyl-CpG–binding protein 2 in *Drosophila* impairs climbing ability (**right**) compared to the control group (**left**).[262]

Due to their significance to human health, scientists are looking at ways to control mosquitoes through genetic engineering. Malaria-resistant mosquitoes have been developed in the laboratory by inserting a gene that reduces the development of the malaria parasite[267] and then use homing endonucleases to rapidly spread that gene throughout the male population (known as a gene drive).[268][269] This approach has been taken further by using the gene drive to spread a lethal gene.[270][271] In trials the populations of *Aedes aegypti* mosquitoes, the single most important carrier of dengue fever and Zika virus, were reduced by between 80% and by 90%.[272][273][271] Another approach is to use a sterile insect technique, whereby males genetically engineered to be sterile out compete viable males, to reduce population numbers.[274]

Other insect pests that make attractive targets are moths. Diamondback moths cause US$4 to $5 billion of damage each year worldwide.[275] The approach is similar to the sterile technique tested on mosquitoes, where males are transformed with a gene that prevents any females born from

reaching maturity.[276] They underwent field trials in 2017.[275] Genetically modified moths have previously been released in field trials.[277] In this case a strain of pink bollworm that were sterilized with radiation were genetically engineered to express a red fluorescent protein making it easier for researchers to monitor them.[278]

Silkworm, the larvae stage of *Bombyx mori*, is an economically important insect in sericulture. Scientists are developing strategies to enhance silk quality and quantity. There is also potential to use the silk producing machinery to make other valuable proteins.[279] Proteins currently developed to be expressed by silkworms include; human serum albumin, human collagen α-chain, mouse monoclonal antibody and N-glycanase.[280] Silkworms have been created that produce spider silk, a stronger but extremely difficult to harvest silk,[281] and even novel silks.[282]

Other

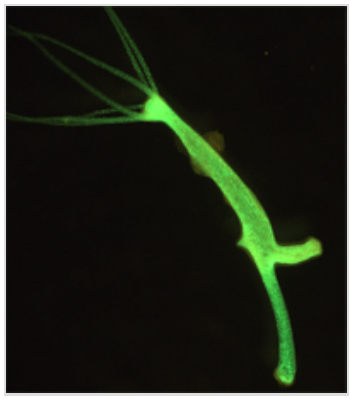
Frog expressing green fluorescent protein

Systems have been developed to create transgenic organisms in a wide variety of other animals. Chickens have been genetically modified for a variety of purposes. This includes studying embryo development,[283] preventing the transmission of bird flu[284] and providing evolutionary insights using reverse engineering to recreate dinosaur-like phenotypes.[285] A GM chicken that produces the drug Kanuma, an enzyme that treats a rare condition, in its egg passed US regulatory approval in 2015.[286] Genetically modified frogs, in particular *Xenopus laevis* and *Xenopus tropicalis*, are used in developmental biology research. GM frogs can also be used as pollution sensors, especially for endocrine disrupting chemicals.[287] There are proposals to use genetic engineering to control cane toads in Australia.[288][289]

The nematode *Caenorhabditis elegans* is one of the major model organisms for researching molecular biology.[290] RNA interference (RNAi) was discovered in *C. elegans*[291] and could be induced by simply feeding them bacteria modified to express double stranded RNA.[292] It is also relatively easy to produce stable transgenic nematodes and this along with RNAi are the major tools used in studying their genes.[293] The most common use of transgenic nematodes has been studying gene expression and localization by attaching reporter genes. Transgenes can also be combined with RNAi techniques to rescue phenotypes, study gene function, image cell development in real time or control expression for different tissues or developmental stages.[293] Transgenic nematodes have been used to study viruses,[294] toxicology,[295] diseases,[296][297] and to detect environmental pollutants.[298]

The gene responsible for albinism in sea cucumbers has been found and used to engineer white sea cucumbers, a rare delicacy. The technology also opens the way to investigate the genes responsible for some of the cucumbers more unusual traits, including hibernating in summer, eviscerating their intestines, and dissolving their bodies upon death.[299] Flatworms have the ability to regenerate themselves from a single cell.[300] Until 2017 there was no effective way to transform them, which hampered research. By using microinjection and radiation scientists have now created the first genetically modified flatworms.[301] The bristle worm, a marine annelid, has been modified. It is of interest due to its reproductive cycle being synchronized with lunar phases, regeneration capacity and slow evolution rate.[302] Cnidaria such as *Hydra* and the sea anemone

Nematostella vectensis are attractive model organisms to study the evolution of immunity and certain developmental processes.[303] Other animals that have been genetically modified include snails,[304] geckos, turtles,[305] crayfish, oysters, shrimp, clams, abalone[306] and sponges.[307]



Transgenic Hydra expressing green fluorescent protein

Regulation

Genetically modified organisms are regulated by government agencies. This applies to research as well as the release of genetically modified organisms, including crops and food. The development of a regulatory framework concerning genetic engineering began in 1975, at Asilomar, California. The Asilomar meeting recommended a set of guidelines regarding the cautious use of recombinant technology and any products resulting from that technology.[308] The Cartagena Protocol on Biosafety was adopted on 29 January 2000 and entered into force on 11 September 2003.[309] It is an international treaty that governs the transfer, handling, and use of genetically modified organisms.[310] One hundred and fifty-seven countries are members of the Protocol and many use it as a reference point for their own regulations.[311]

Universities and research institutes generally have a special committee that is responsible for approving any experiments that involve genetic engineering. Many experiments also need permission from a national regulatory group or legislation. All staff must be trained in the use of GMOs and all laboratories must gain approval from their regulatory agency to work with GMOs.[312] The legislation covering GMOs are often derived from regulations and guidelines in place for the non-GMO version of the organism, although they are more severe.[313] There is a near-universal system for assessing the relative risks associated with GMOs and other agents to laboratory staff and the community. They are assigned to one of four risk categories based on their virulence, the severity of the disease, the mode of transmission, and the availability of preventive measures or treatments. There are four biosafety levels that a laboratory can fall into, ranging from level 1 (which is suitable for working with agents not associated with disease) to level 4 (working with life-threatening agents). Different countries use different nomenclature to describe the levels and can have different requirements for what can be done at each level.[313]

There are differences in the regulation for the release of GMOs between countries, with some of the most marked differences occurring between the US and Europe.[314] Regulation varies in a given country depending on the intended use of the products of the genetic engineering. For example, a crop not intended for food use is generally not reviewed by authorities responsible for food safety.[315] Some nations have banned the release of GMOs or restricted their use, and others permit them with widely differing degrees of regulation.[316][317][318][319] In 2016, thirty eight countries officially ban or prohibit the cultivation of GMOs and nine (Algeria, Bhutan, Kenya, Kyrgyzstan, Madagascar, Peru, Russia, Venezuela and Zimbabwe) ban their importation.[320] Most countries that do not allow GMO cultivation do permit research using GMOs.[321] Despite regulation, illegal releases have sometimes occurred, due to weakness of enforcement.[8]

The European Union (EU) differentiates between approval for cultivation within the EU and approval for import and processing.[322] While only a few GMOs have been approved for cultivation in the EU a number of GMOs have been approved for import and processing.[323] The

cultivation of GMOs has triggered a debate about the market for GMOs in Europe.[324] Depending on the coexistence regulations, incentives for cultivation of GM crops differ.[325] The US policy does not focus on the process as much as other countries, looks at verifiable scientific risks and uses the concept of substantial equivalence.[326] Whether gene edited organisms should be regulated the same as genetically modified organism is debated. USA regulations sees them as separate and does not regulate them under the same conditions, while in Europe a GMO is any organism created using genetic engineering techniques.[28]

A label marking this peanut butter as being non-GMO

One of the key issues concerning regulators is whether GM products should be labeled. The European Commission says that mandatory labeling and traceability are needed to allow for informed choice, avoid potential false advertising[327] and facilitate the withdrawal of products if adverse effects on health or the environment are discovered.[328] The American Medical Association[329] and the American Association for the Advancement of Science[330] say that absent scientific evidence of harm even voluntary labeling is misleading and will falsely alarm consumers. Labeling of GMO products in the marketplace is required in 64 countries.[331] Labeling can be mandatory up to a threshold GM content level (which varies between countries) or voluntary. In Canada and the US labeling of GM food is voluntary,[332] while in Europe all food (including processed food) or feed which contains greater than 0.9% of approved GMOs must be labeled.[333] In 2014, sales of products that had been labeled as non-GMO grew 30 percent to $1.1 billion.[334]

Detail of a French cheese box declaring "GMO-free" production (i.e., below 0.9%)

Controversy

There is controversy over GMOs, especially with regard to their release outside laboratory environments. The dispute involves consumers, producers, biotechnology companies, governmental regulators, non-governmental organizations, and scientists. Many of these concerns involve GM crops and whether food produced from them is safe and what impact growing them will have on the environment. These controversies have led to litigation, international trade disputes, and protests, and to restrictive regulation of commercial products in some countries.[335] Most concerns are around the health and environmental effects of GMOs. These include whether they may provoke an allergic reaction, whether the transgenes could transfer to human cells, and whether genes not approved for human consumption could outcross into the food supply.[336]

There is a scientific consensus[337][338][339][340] that currently available food derived from GM crops poses no greater risk to human health than conventional food,[341][342][343][344][345] but that each GM food needs to be tested on a case-by-case basis before introduction.[346][347][348] Nonetheless, members of the public are much less likely than scientists to perceive GM foods as safe.[349][350][351][352] The legal and regulatory status of GM foods varies by country, with some nations banning or restricting them, and others permitting them with widely differing degrees of regulation.[353][354][355][356]

A protester advocating for the labeling of GMOs

As late as the 1990s gene flow into wild populations was thought to be unlikely and rare, and if it were to occur, easily eradicated. It was thought that this would add no additional environmental costs or risks – no effects were expected other than those already caused by pesticide applications.[357] However, in the decades since, several such examples have been observed. Gene flow between GM crops and compatible plants, along with increased use of broad-spectrum herbicides,[358] can increase the risk of herbicide resistant weed populations.[359] Debate over the extent and consequences of gene flow intensified in 2001 when a paper was published showing transgenes had been found in landrace maize in Mexico, the crop's center of diversity.[360][361] Gene flow from GM crops to other organisms has been found to generally be lower than what would occur naturally.[362] In order to address some of these concerns some GMOs have been developed with traits to help control their spread. To prevent the genetically modified salmon inadvertently breeding with wild salmon, all the fish raised for food are females, triploid, 99% are reproductively sterile, and raised in areas where escaped salmon could not survive.[363][364] Bacteria have also been modified to depend on nutrients that cannot be found in nature,[365] and genetic use restriction technology has been developed, though not yet marketed, that causes the second generation of GM plants to be sterile.[366]

Other environmental and agronomic concerns include a decrease in biodiversity, an increase in secondary pests (non-targeted pests) and evolution of resistant insect pests.[367][368][369] In the areas of China and the US with Bt crops the overall biodiversity of insects has increased and the impact of secondary pests has been minimal.[370] Resistance was found to be slow to evolve when best practice strategies were followed.[370] The impact of Bt crops on beneficial non-target organisms became a public issue after a 1999 paper suggested they could be toxic to monarch butterflies. Follow up studies have since shown that the toxicity levels encountered in the field were not high enough to harm the larvae.[371]

Accusations that scientists are "playing God" and other religious issues have been ascribed to the technology from the beginning.[372] With the ability to genetically engineer humans now possible there are ethical concerns over how far this technology should go, or if it should be used at all.[373] Much debate revolves around where the line between treatment and enhancement is and whether the modifications should be inheritable.[374] Other concerns include contamination of the non-genetically modified food supply,[375][376] the rigor of the regulatory process,[377][378] consolidation of control of the food supply in companies that make and sell GMOs,[379] exaggeration of the benefits of genetic modification,[380] or concerns over the use of herbicides with glyphosate.[381] Other issues raised include the patenting of life[382] and the use of intellectual property rights.[383]

There are large differences in consumer acceptance of GMOs, with Europeans more likely to view GM food negatively than North Americans.[384] GMOs arrived on the scene as the public confidence in food safety, attributed to recent food scares such as Bovine spongiform encephalopathy and other scandals involving government regulation of products in Europe, was low.[385] This along with campaigns run by various non-governmental organizations (NGO) have been very successful in blocking or limiting the use of GM crops.[386] NGOs like the Organic

Consumers Association, the Union of Concerned Scientists,[387][388][389] Greenpeace and other groups have said that risks have not been adequately identified and managed[390] and that there are unanswered questions regarding the potential long-term impact on human health from food derived from GMOs. They propose mandatory labeling[391][392] or a moratorium on such products.[379][377][393]

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319. Lynch D, Vogel D (5 April 2001). "The Regulation of GMOs in Europe and the United States: A Case-Study of Contemporary European Regulatory Politics" (https://web.archive.org/web/20160929200540/http://www.cfr.org/agricultural-policy/regulation-gmos-europe-united-states-case-study-contemporary-european-regulatory-politics/p8688). Council on Foreign Relations. Archived from the original (http://www.cfr.org/agricultural-policy/regulation-gmos-europe-united-states-case-study-contemporary-european-regulatory-politics/p8688) on 29 September 2016. Retrieved 24 February 2016.
320. "Where are GMOs grown and banned?" (https://gmo.geneticliteracyproject.org/FAQ/where-are-gmos-grown-and-banned/). *GMO FAQ*. 7 February 2016. Retrieved 11 February 2019.
321. "Restrictions on Genetically Modified Organisms – Law Library of Congress" (https://www.loc.gov/law/help/restrictions-on-gmos/). *Library of Congress*. 22 January 2017.
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323. Wesseler J, Purnhagen K. "Present and Future EU GMO policy". In Oskam A, Meesters G, Silvis H (eds.). *EU Policy for Agriculture, Food and Rural Areas* (2nd ed.). Wageningen: Wageningen Academic Publishers. pp. 23–332.
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325. Beckmann V, Soregaroli C, Wesseler J (July 2011). "Chapter 8: Coexistence of Genetically Modified (GM) and Non-Modified (non-GM) crops: Are the Two Main Property Rights Regimes Equivalent with Respect to the Coexistence Value?". In Carter G, Moschini G, Sheldon I (eds.). *Genetically modified food and global welfare*. Frontiers of Economics and Globalization. Vol. 10. Bingley, UK: Emerald Group Publishing. pp. 201–224.
326. Emily Marden, Risk and Regulation: U.S. Regulatory Policy on Genetically Modified Food and Agriculture, 44 B.C.L. Rev. 733 (2003)[1] (http://lawdigitalcommons.bc.edu/cgi/viewcontent.cgi?article=2236&context=bclr)
327. "Regulation (EC) No 1829/2003 of the European Parliament and of the Council of 22 September 2003 On Genetically Modified Food And Feed" (https://web.archive.org/web/20140120113714/http://ec.europa.eu/food/food/animalnutrition/labelling/Reg_1829_2003_en.pdf) (PDF). *Official Journal of the European Union L 268/3 (21)*. The European Parliament and the Council of the European Union. 2003. Archived from the original (http://ec.europa.eu/food/food/animalnutrition/labelling/Reg_1829_2003_en.pdf) (PDF) on 20 January 2014. "The labeling should include objective information to the effect that a food or feed consists of, contains or is produced from GMOs. Clear labeling, irrespective of the detectability of DNA or protein resulting from the genetic modification in the final product, meets the demands expressed in numerous surveys by a large majority of consumers, facilitates informed choice, and precludes potential misleading of consumers as regards methods of manufacture or production."

328. "Regulation (EC) No 1830/2003 of the European Parliament and of the Council of 22 September 2003 concerning the traceability and labeling of genetically modified organisms and the traceability of food and feed products produced from genetically modified organisms and amending Directive 2001/18/EC" (http://eur-lex.europa.eu/legal-content/EN/ALL/?uri=CELEX:32003R1830). *Official Journal L 268*. The European Parliament and the Council of the European Union. 2003. pp. 24–28. "(3) Traceability requirements for GMOs should facilitate both the withdrawal of products where unforeseen adverse effects on human health, animal health or the environment, including ecosystems, are established, and the targeting of monitoring to examine potential effects on, in particular, the environment. Traceability should also facilitate the implementation of risk management measures in accordance with the precautionary principle. (4) Traceability requirements for food and feed produced from GMOs should be established to facilitate accurate labeling of such products."
329. "Report 2 of the Council on Science and Public Health: Labeling of Bioengineered Foods" (https://web.archive.org/web/20120907023039/http://www.ama-assn.org/resources/doc/csaph/a12-csaph2-bioengineeredfoods.pdf) (PDF). American Medical Association. 2012. Archived from the original (http://www.ama-assn.org/resources/doc/csaph/a12-csaph2-bioengineeredfoods.pdf) (PDF) on 7 September 2012.
330. American Association for the Advancement of Science (AAAS), Board of Directors (2012). Statement by the AAAS Board of Directors On Labeling of Genetically Modified Foods (http://www.aaas.org/sites/default/files/AAAS_GM_statement.pdf), and associated Press release: Legally Mandating GM Food Labels Could Mislead and Falsely Alarm Consumers (http://www.aaas.org/news/releases/2012/1025gm_statement.shtml) Archived (https://web.archive.org/web/20131104063411/http://www.aaas.org/news/releases/2012/1025gm_statement.shtml) 4 November 2013 at the Wayback Machine
331. Hallenbeck T (27 April 2014). "How GMO labeling came to pass in Vermont" (http://www.burlingtonfreepress.com/story/news/politics/2014/04/27/gmo-labeling-came-pass-vermont/8166519/). *Burlington Free Press*. Retrieved 28 May 2014.
332. "The Regulation of Genetically Modified Foods" (https://web.archive.org/web/20170610170104/http://www.hc-sc.gc.ca/sr-sr/pubs/biotech/reg_gen_mod-eng.php). Archived from the original (http://www.hc-sc.gc.ca/sr-sr/pubs/biotech/reg_gen_mod-eng.php) on 10 June 2017. Retrieved 25 December 2018.
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334. Smithsonian (2015). "Some Brands Are Labeling Products 'GMO-free' Even if They Don't Have Genes" (http://www.smithsonianmag.com/smart-news/some-brands-are-labeling-products-gmo-free-even-if-they-dont-have-genes-180956421/).
335. Sheldon IM (1 March 2002). "Regulation of biotechnology: will we ever 'freely' trade GMOs?". *European Review of Agricultural Economics*. **29** (1): 155–76. CiteSeerX 10.1.1.596.7670 (https://citeseerx.ist.psu.edu/viewdoc/summary?doi=10.1.1.596.7670). doi:10.1093/erae/29.1.155 (https://doi.org/10.1093%2Ferae%2F29.1.155).
336. "Q&A: genetically modified food" (https://www.who.int/foodsafety/areas_work/food-technology/faq-genetically-modified-food/en/). *World Health Organization*. Retrieved 7 May 2017.

337. Nicolia, Alessandro; Manzo, Alberto; Veronesi, Fabio; Rosellini, Daniele (2013). "An overview of the last 10 years of genetically engineered crop safety research" (https://www.pps.net/cms/lib/OR01913224/Centricity/Domain/3337/peer%20reviewed%20meta%20study%20on%20GMOs%20copy.pdf) (PDF). *Critical Reviews in Biotechnology*. **34** (1): 77–88. doi: 10.3109/07388551.2013.823595 (https://doi.org/10.3109%2F07388551.2013.823595). PMID 24041244 (https://pubmed.ncbi.nlm.nih.gov/24041244). S2CID 9836802 (https://api.semanticscholar.org/CorpusID:9836802). "We have reviewed the scientific literature on GE crop safety for the last 10 years that catches the scientific consensus matured since GE plants became widely cultivated worldwide, and we can conclude that the scientific research conducted so far has not detected any significant hazard directly connected with the use of GM crops.

The literature about Biodiversity and the GE food/feed consumption has sometimes resulted in an animated debate regarding the suitability of the experimental designs, the choice of the statistical methods, or the public accessibility of data. Such debate, even if positive and part of the natural process of review by the scientific community, has frequently been distorted by the media and often used politically and inappropriately in anti-GE crops campaigns."

338. "State of Food and Agriculture 2003–2004. Agricultural Biotechnology: Meeting the Needs of the Poor. Health and environmental impacts of transgenic crops" (http://www.fao.org/docrep/006/Y5160E/y5160e10.htm#P3_1651The). Food and Agriculture Organization of the United Nations. Retrieved 30 August 2019. "Currently available transgenic crops and foods derived from them have been judged safe to eat and the methods used to test their safety have been deemed appropriate. These conclusions represent the consensus of the scientific evidence surveyed by the ICSU (2003) and they are consistent with the views of the World Health Organization (WHO, 2002). These foods have been assessed for increased risks to human health by several national regulatory authorities (inter alia, Argentina, Brazil, Canada, China, the United Kingdom, and the United States) using their national food safety procedures (ICSU). To date, no verifiable untoward toxic or nutritionally deleterious effects resulting from the consumption of foods derived from genetically modified crops have been discovered anywhere in the world (GM Science Review Panel). Many millions of people have consumed foods derived from GM plants – mainly maize, soybean, and oilseed rape – without any observed adverse effects (ICSU)."

339. Ronald, Pamela (1 May 2011). "Plant Genetics, Sustainable Agriculture and Global Food Security" (https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3120150). *Genetics*. **188** (1): 11–20. doi:10.1534/genetics.111.128553 (https://doi.org/10.1534%2Fgenetics.111.128553). PMC 3120150 (https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3120150). PMID 21546547 (https://pubmed.ncbi.nlm.nih.gov/21546547). "There is broad scientific consensus that genetically engineered crops currently on the market are safe to eat. After 14 years of cultivation and a cumulative total of 2 billion acres planted, no adverse health or environmental effects have resulted from the commercialization of genetically engineered crops (Board on Agriculture and Natural Resources, Committee on Environmental Impacts Associated with Commercialization of Transgenic Plants, National Research Council and Division on Earth and Life Studies 2002). Both the U.S. National Research Council and the Joint Research Centre (the European Union's scientific and technical research laboratory and an integral part of the European Commission) have concluded that there is a comprehensive body of knowledge that adequately addresses the food safety issue of genetically engineered crops (Committee on Identifying and Assessing Unintended Effects of Genetically Engineered Foods on Human Health and National Research Council 2004; European Commission Joint Research Centre 2008). These and other recent reports conclude that the processes of genetic engineering and conventional breeding are no different in terms of unintended consequences to human health and the environment (European Commission Directorate-General for Research and Innovation 2010)."

340. But see also:
Domingo, José L.; Bordonaba, Jordi Giné (2011). "A literature review on the safety assessment of genetically modified plants" (http://gaiapresse.ca/images/nouvelles/28563.pdf) (PDF). *Environment International*. **37** (4): 734–742. doi:10.1016/j.envint.2011.01.003 (https://doi.org/10.1016%2Fj.envint.2011.01.003). PMID 21296423 (https://pubmed.ncbi.nlm.nih.gov/21296423). Archived (https://web.archive.org/web/20120921003818/http://gaiapresse.ca/images/nouvelles/28563.pdf) (PDF) from the original on 21 September 2012. "In spite of this, the number of studies specifically focused on safety assessment of GM plants is still limited. However, it is important to remark that for the first time, a certain equilibrium in the number of research groups suggesting, on the basis of their studies, that a number of varieties of GM products (mainly maize and soybeans) are as safe and nutritious as the respective conventional non-GM plant, and those raising still serious concerns, was observed. Moreover, it is worth mentioning that most of the studies demonstrating that GM foods are as nutritional and safe as those obtained by conventional breeding have been performed by biotechnology companies or associates, which are also responsible for commercializing these GM plants. Anyhow, this represents a notable advance in comparison with the lack of studies published in recent years in scientific journals by those companies."

Krimsky, Sheldon (2015). "An Illusory Consensus behind GMO Health Assessment" (https://pdfs.semanticscholar.org/1128/7f26b85d049b3270acc1058011a2e7bdf9a6.pdf) (PDF). *Science, Technology, & Human Values*. **40** (6): 883–914. doi:10.1177/0162243915598381 (https://doi.org/10.1177%2F0162243915598381). S2CID 40855100 (https://api.semanticscholar.org/CorpusID:40855100). Archived (https://web.archive.org/web/20190831011737/https://pdfs.semanticscholar.org/1128/7f26b85d049b3270acc1058011a2e7bdf9a6.pdf) (PDF) from the original on 31 August 2019. "I began this article with the testimonials from respected scientists that there is literally no scientific controversy over the health effects of GMOs. My investigation into the scientific literature tells another story."

And contrast:

Panchin, Alexander Y.; Tuzhikov, Alexander I. (14 January 2016). "Published GMO studies find no evidence of harm when corrected for multiple comparisons". *Critical Reviews in Biotechnology*. **37** (2): 213–217. doi:10.3109/07388551.2015.1130684 (https://doi.org/10.3109%2F07388551.2015.1130684). PMID 26767435 (https://pubmed.ncbi.nlm.nih.gov/26767435). S2CID 11786594 (https://api.semanticscholar.org/CorpusID:11786594). "Here, we show that a number of articles some of which have strongly and negatively influenced the public opinion on GM crops and even provoked political actions, such as GMO embargo, share common flaws in the statistical evaluation of the data. Having accounted for these flaws, we conclude that the data presented in these articles do not provide any substantial evidence of GMO harm.

The presented articles suggesting the possible harm of GMOs received high public attention. However, despite their claims, they actually weaken the evidence for the harm and lack of substantial equivalency of studied GMOs. We emphasize that with over 1783 published articles on GMOs over the last 10 years it is expected that some of them should have reported undesired differences between GMOs and conventional crops even if no such differences exist in reality."

Yang, Y.T.; Chen, B. (2016). "Governing GMOs in the USA: science, law and public health". *Journal of the Science of Food and Agriculture*. **96** (4): 1851–1855. Bibcode:2016JSFA...96.1851Y (https://ui.adsabs.harvard.edu/abs/2016JSFA...96.1851Y). doi: 10.1002/jsfa.7523 (https://doi.org/10.1002%2Fjsfa.7523). PMID 26536836 (https://pubmed.ncbi.nlm.nih.gov/26536836). "It is therefore not surprising that efforts to require labeling and to ban GMOs have been a growing political issue in the USA *(citing Domingo and Bordonaba, 2011)*. Overall, a broad scientific consensus holds that currently marketed GM food poses no greater risk than conventional food ... Major national and international science and medical associations have stated that no adverse human health effects related to GMO food have been reported or substantiated in peer-reviewed literature to date.

Despite various concerns, today, the American Association for the Advancement of Science, the World Health Organization, and many independent international science organizations agree that GMOs are just as safe as other foods. Compared with conventional breeding techniques, genetic engineering is far more precise and, in most cases, less likely to create an unexpected outcome."

341. "Statement by the AAAS Board of Directors on Labeling of Genetically Modified Foods" (http://www.aaas.org/sites/default/files/AAAS_GM_statement.pdf) (PDF). American Association for the Advancement of Science. 20 October 2012. Retrieved 30 August 2019. "The EU, for example, has invested more than €300 million in research on the biosafety of GMOs. Its recent report states: 'The main conclusion to be drawn from the efforts of more than 130 research projects, covering a period of more than 25 years of research and involving more than 500 independent research groups, is that biotechnology, and in particular GMOs, are not per se riskier than e.g. conventional plant breeding technologies.' The World Health Organization, the American Medical Association, the U.S. National Academy of Sciences, the British Royal Society, and every other respected organization that has examined the evidence has come to the same conclusion: consuming foods containing ingredients derived from GM crops is no riskier than consuming the same foods containing ingredients from crop plants modified by conventional plant improvement techniques."

    Pinholster, Ginger (25 October 2012). "AAAS Board of Directors: Legally Mandating GM Food Labels Could 'Mislead and Falsely Alarm Consumers' " (https://www.aaas.org/sites/default/files/AAAS_GM_statement.pdf) (PDF). American Association for the Advancement of Science. Archived (https://web.archive.org/web/20140302223150/http://www.aaas.org/sites/default/files/AAAS_GM_statement.pdf) (PDF) from the original on 2 March 2014. Retrieved 30 August 2019.
342. Directorate-General for Research and Innovation (European Commission) (2010). *A decade of EU-funded GMO research (2001–2010)* (http://ec.europa.eu/research/biosociety/pdf/a_decade_of_eu-funded_gmo_research.pdf) (PDF). Publications Office of the European Union. doi: 10.2777/97784 (https://doi.org/10.2777%2F97784). ISBN 978-92-79-16344-9. Archived (https://web.archive.org/web/20101224152216/http://ec.europa.eu/research/biosociety/pdf/a_decade_of_eu-funded_gmo_research.pdf) (PDF) from the original on 24 December 2010. Retrieved 30 August 2019.

343. "AMA Report on Genetically Modified Crops and Foods (online summary)" (https://www.isaaa.org/kc/Publications/htm/articles/Position/ama.htm). American Medical Association. January 2001. Retrieved 30 August 2019. "A report issued by the scientific council of the American Medical Association (AMA) says that no long-term health effects have been detected from the use of transgenic crops and genetically modified foods and that these foods are substantially equivalent to their conventional counterparts. ... Crops and foods produced using recombinant DNA techniques have been available for fewer than 10 years and no long-term effects have been detected to date. These foods are substantially equivalent to their conventional counterparts."

"Report 2 of the Council On Science and Public Health (A-12): Labeling of Bioengineered Foods" (https://web.archive.org/web/20120907023039/http://www.ama-assn.org/resources/doc/csaph/a12-csaph2-bioengineeredfoods.pdf) (PDF). American Medical Association. 2012. Archived from the original (http://www.ama-assn.org/resources/doc/csaph/a12-csaph2-bioengineeredfoods.pdf) (PDF) on 7 September 2012. Retrieved 30 August 2019. "Bioengineered foods have been consumed for close to 20 years, and during that time, no overt consequences on human health have been reported and/or substantiated in the peer-reviewed literature."

344. "Restrictions on Genetically Modified Organisms: United States. Public and Scholarly Opinion" (http://www.loc.gov/law/help/restrictions-on-gmos/usa.php#Opinion). Library of Congress. 30 June 2015. Retrieved 30 August 2019. "Several scientific organizations in the US have issued studies or statements regarding the safety of GMOs indicating that there is no evidence that GMOs present unique safety risks compared to conventionally bred products. These include the National Research Council, the American Association for the Advancement of Science, and the American Medical Association. Groups in the US opposed to GMOs include some environmental organizations, organic farming organizations, and consumer organizations. A substantial number of legal academics have criticized the US's approach to regulating GMOs."

345. National Academies of Sciences, Engineering, and Medicine; Division on Earth and Life Studies; Board on Agriculture and Natural Resources; Committee on Genetically Engineered Crops: Past Experience and Future Prospects (2016). *Genetically Engineered Crops: Experiences and Prospects* (http://www.nap.edu/read/23395/chapter/7#149). The National Academies of Sciences, Engineering, and Medicine. p. 149. doi:10.17226/23395 (https://doi.org/10.17226%2F23395). ISBN 978-0-309-43738-7. PMID 28230933 (https://pubmed.ncbi.nlm.nih.gov/28230933). Retrieved 30 August 2019. "*Overall finding on purported adverse effects on human health of foods derived from GE crops:* On the basis of a detailed examination of comparisons of currently commercialized GE with non-GE foods in compositional analysis, acute and chronic animal toxicity tests, long-term data on the health of livestock fed GE foods, and human epidemiological data, the committee found no differences that implicate a higher risk to human health from GE foods than from their non-GE counterparts."

346. "Frequently asked questions on genetically modified foods" (https://www.who.int/foodsafety/areas_work/food-technology/faq-genetically-modified-food/en/). World Health Organization. Retrieved 30 August 2019. "Different GM organisms include different genes inserted in different ways. This means that individual GM foods and their safety should be assessed on a case-by-case basis and that it is not possible to make general statements on the safety of all GM foods.

    GM foods currently available on the international market have passed safety assessments and are not likely to present risks for human health. In addition, no effects on human health have been shown as a result of the consumption of such foods by the general population in the countries where they have been approved. Continuous application of safety assessments based on the Codex Alimentarius principles and, where appropriate, adequate post-market monitoring, should form the basis for ensuring the safety of GM foods."
347. Haslberger, Alexander G. (2003). "Codex guidelines for GM foods include the analysis of unintended effects". *Nature Biotechnology*. **21** (7): 739–741. doi:10.1038/nbt0703-739 (https://doi.org/10.1038%2Fnbt0703-739). PMID 12833088 (https://pubmed.ncbi.nlm.nih.gov/12833088). S2CID 2533628 (https://api.semanticscholar.org/CorpusID:2533628). "These principles dictate a case-by-case premarket assessment that includes an evaluation of both direct and unintended effects."
348. Some medical organizations, including the British Medical Association, advocate further caution based upon the precautionary principle:

    "Genetically modified foods and health: a second interim statement" (http://www.argenbio.org/adc/uploads/pdf/bma.pdf) (PDF). British Medical Association. March 2004. Retrieved 30 August 2019. "In our view, the potential for GM foods to cause harmful health effects is very small and many of the concerns expressed apply with equal vigour to conventionally derived foods. However, safety concerns cannot, as yet, be dismissed completely on the basis of information currently available.

    When seeking to optimize the balance between benefits and risks, it is prudent to err on the side of caution and, above all, learn from accumulating knowledge and experience. Any new technology such as genetic modification must be examined for possible benefits and risks to human health and the environment. As with all novel foods, safety assessments in relation to GM foods must be made on a case-by-case basis.

    Members of the GM jury project were briefed on various aspects of genetic modification by a diverse group of acknowledged experts in the relevant subjects. The GM jury reached the conclusion that the sale of GM foods currently available should be halted and the moratorium on commercial growth of GM crops should be continued. These conclusions were based on the precautionary principle and lack of evidence of any benefit. The Jury expressed concern over the impact of GM crops on farming, the environment, food safety and other potential health effects.

    The Royal Society review (2002) concluded that the risks to human health associated with the use of specific viral DNA sequences in GM plants are negligible, and while calling for caution in the introduction of potential allergens into food crops, stressed the absence of evidence that commercially available GM foods cause clinical allergic manifestations. The BMA shares the view that there is no robust evidence to prove that GM foods are unsafe but we endorse the call for further research and surveillance to provide convincing evidence of safety and benefit."

349. Funk, Cary; Rainie, Lee (29 January 2015). "Public and Scientists' Views on Science and Society" (http://www.pewinternet.org/2015/01/29/public-and-scientists-views-on-science-and-society/). Pew Research Center. Retrieved 30 August 2019. "The largest differences between the public and the AAAS scientists are found in beliefs about the safety of eating genetically modified (GM) foods. Nearly nine-in-ten (88%) scientists say it is generally safe to eat GM foods compared with 37% of the general public, a difference of 51 percentage points."
350. Marris, Claire (2001). "Public views on GMOs: deconstructing the myths" (https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1083956). *EMBO Reports*. **2** (7): 545–548. doi:10.1093/embo-reports/kve142 (https://doi.org/10.1093%2Fembo-reports%2Fkve142). PMC 1083956 (https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1083956). PMID 11463731 (https://pubmed.ncbi.nlm.nih.gov/11463731).
351. Final Report of the PABE research project (December 2001). "Public Perceptions of Agricultural Biotechnologies in Europe" (https://web.archive.org/web/20170525042822/http://csec.lancs.ac.uk/archive/pabe/docs/pabe_finalreport.doc). Commission of European Communities. Archived from the original (http://csec.lancs.ac.uk/archive/pabe/docs/pabe_finalreport.doc) on 25 May 2017. Retrieved 30 August 2019.
352. Scott, Sydney E.; Inbar, Yoel; Rozin, Paul (2016). "Evidence for Absolute Moral Opposition to Genetically Modified Food in the United States" (http://yoelinbar.net/papers/gmo_absolute.pdf) (PDF). *Perspectives on Psychological Science*. **11** (3): 315–324. doi:10.1177/1745691615621275 (https://doi.org/10.1177%2F1745691615621275). PMID 27217243 (https://pubmed.ncbi.nlm.nih.gov/27217243). S2CID 261060 (https://api.semanticscholar.org/CorpusID:261060). Archived (https://web.archive.org/web/20160325125049/http://yoelinbar.net/papers/gmo_absolute.pdf) (PDF) from the original on 25 March 2016.
353. "Restrictions on Genetically Modified Organisms" (http://www.loc.gov/law/help/restrictions-on-gmos/). Library of Congress. 9 June 2015. Retrieved 30 August 2019.
354. Bashshur, Ramona (February 2013). "FDA and Regulation of GMOs" (https://web.archive.org/web/20180621044554/https://www.americanbar.org/content/newsletter/publications/aba_health_esource_home/aba_health_law_esource_1302_bashshur.html). American Bar Association. Archived from the original (http://www.americanbar.org/content/newsletter/publications/aba_health_esource_home/aba_health_law_esource_1302_bashshur.html) on 21 June 2018. Retrieved 30 August 2019.
355. Sifferlin, Alexandra (3 October 2015). "Over Half of E.U. Countries Are Opting Out of GMOs" (http://time.com/4060476/eu-gmo-crops-european-union-opt-out/). *Time*. Retrieved 30 August 2019.
356. Lynch, Diahanna; Vogel, David (5 April 2001). "The Regulation of GMOs in Europe and the United States: A Case-Study of Contemporary European Regulatory Politics" (https://web.archive.org/web/20160929200540/http://www.cfr.org/agricultural-policy/regulation-gmos-europe-united-states-case-study-contemporary-european-regulatory-politics/p8688). Council on Foreign Relations. Archived from the original (http://www.cfr.org/agricultural-policy/regulation-gmos-europe-united-states-case-study-contemporary-european-regulatory-politics/p8688) on 29 September 2016. Retrieved 30 August 2019.
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External links

- ISAAA database (http://www.isaaa.org/gmapprovaldatabase/cropslist/default.asp)
- GMO-Compass: Information on genetically modified organisms (https://web.archive.org/web/20080719170701/http://www.gmo-compass.org/.)

Testimony FWA HB SB911 labeling -2024.pdf
Uploaded by: Emily Tarsel
Position: FWA

Emily Tarsell, LCPC

2314 Benson Mill Road
Sparks, Maryland 21152

March 7, 2024

FAVORABLE With Amendment SB 911 (HB1421**) - Labeling synthetic food**

Good Afternoon Chair and Committee Members,

I am Emily Tarsell, a licensed therapist and President of Health Choice Maryland. We ask for a favorable vote, particularly for mandatory labeling of synthetic food.

Precision fermentation, or synthetic biology, is a clever food-technology whereby organisms like bacteria are gene edited to produce artificial fats and proteins for making artificial foods that some call Frankinfoods. These include synthetic milk, synthetic dairy products and synthetic meats. Independent testing of some of these products found that they lacked many important micronutrients and vitamins found in the natural product. They also found a host of compounds that could be harmful to humans including foreign DNA.[1]

The FDA would not require these foods to be tested or labeled. Other countries like Italy have banned the sale of synthetically produced meat. Such countries require that fake foods be tested for safety before they're put on the market, but not the U.S. [2] Labeling here is non-existent or misleading and designed to deceive the unwary consumer.

This is a new technology with unknown consequences in terms of health, safety, social and environmental impact. It is an investor model driven by the duty is to make profit for its shareholders, not driven by the public good. The food industry is known for deceptive and discriminatory food labeling practices.

Other states have set precedent for food safety. The antibiotics in food law that began in California and the GMO food labeling law that began in Vermont were both later adopted as national policy because of their public health implications. [4,5] Scholars implore more states to take such initiatives to enact food safety regulations of their own. They say that states need to fill in the gaps in the current patchwork of US food regulations and serve as laboratories for developing new rules and standards.

Maryland should set the standard for the nation to ensure the proper labeling of synthetic foods because we the consumers have a right to know. **Please vote Favorable with Amendment for SB911** Thank you.

Emily Tarsell, LCPC

[[] **https://www.forbes.com/sites/errolschweizer/2022/03/02/what-should-consumers-be-asking-about-precision-fermentation/?sh=c64073727b02**
[2] https://childrenshealthdefense.org/defender/bored-cow-synthetic-milk-protein-unknown-compounds/?utm_source=luminate&utm_medium=email&utm_campaign=defender&utm_id=20231218
[3] https://childrenshealthdefense.org/defender/lab-grown-fake-chicken-heavy-metals-rodent-dna-cola/?utm_source=luminate&utm_medium=email&utm_campaign=defender&utm_id=20240110
[4]https://thehill.com/blogs/congress-blog/healthcare/259273-california-antibiotics-law-is-national-policy/
[5] https://www.downeybrand.com/publications/gmo-labeling-coming-soon-to-california-and-the-rest-of-the-country/

Support 2024 Senate Bill 0911.pdf
Uploaded by: Eszter Szabo
Position: FWA

Support with Amendment for 2024 Senate Bill 0911

Eszter Szabo
Bethesda, MD 20817
March 6, 2024

SB 911 aims at prohibiting for sale in Maryland a gene structure - or function -modifying product without certain labeling and sets penalties for violating this law. This is a good and forward-looking bill since today many consumers are worried about certain genetically modified food, vaccines, cosmetics, etc.

Consumers have the right to know what they ingest into their bodies via nutrition, as a medical treatment or via using a cosmetics product on their bodies since these products have the capacity to change/modify the structure of function of one or more genes in a consumer. Before they use these products, consumers have the right to know that gene structure modification can be the result after consuming or using these products. And with such labeling requirement, if they choose so, they can avoid their use.

As it happened with the organic labeling of food that assures consumers that the produce wasn't grown via using genetically modified organisms or artificial pesticides, the labeling for gene structure modification would help consumers choose products that better align with their consumption philosophy or help avoid those products that could potentially be harmful to them.

Here are some articles that talk about genetically modified food and the issues with them:

https://www.forbes.com/sites/errolschweizer/2022/03/02/what-should-consumers-be-asking-about-precision-fermentation/?sh=c64073727b02

https://childrenshealthdefense.org/defender/bored-cow-synthetic-milk-protein-unknown-compounds/

https://childrenshealthdefense.org/defender/lab-grown-fake-chicken-heavy-metals-rodent-dna-cola/

Please support this bill with an amendment that **would add a requirement for labeling especially of foods produced by artificially engineered elements that may modify genes in a consumer.**

Thank you and sincerely,

Favorable with amendment SB911.pdf
Uploaded by: Peter DOrazio
Position: FWA

Please vote Favorable with Amendment for SB911

All genetically modified / lab made foods must be labeled as such so people can avoid toxic chemicals and altered genes in their meals. Any food made with precision fermentation / synthetic biology food technology, ie.Lab-Grown Fake 'Chicken' — With a Side of Heavy Metals and Rodent DNA should be outright illegal.

See how many people are suffering of chronic diseases compared to before GMO foods / lab foods were available. Up until a few years ago farmers In Romania lived to over 90 years of age. My farmer grandmother died at age 94 as all her food was organically grown. My mother died at age 66, at a young age, as she moved into the city and eat conventionally, lab grown and gmo food.
It's urgent! We must stop messing with Mother Nature! Meanwhile we can start with labeling those gmo , lab foods, crickets or any other forms of foods that's somehow modified so we can vote with our dollars .
I care for my family's health and our environment so please vote favorable with amendment for SB911

Thank you,

Daniela D’Orazio

SB911_BIO_Harrington_Unfavorable.pdf
Uploaded by: Gene Harrington
Position: UNF

Biotechnology Innovation Organization
1201 New York Ave., NW
Suite 1300
Washington, DC, 20005
202-962-9200

March 1, 2024

The Honorable Pamela Beidle, Chair
Committee on Finance
Maryland Senate
Annapolis, MD

Dear Chair Beidle and Members of the Committee on Finance,

I write on behalf of the Biotechnology Innovation Organization (BIO) – the world's largest biotechnology focused trade group – and as a lifelong Marylander to oppose **Senate Bill 911 – Food, Drugs, and Cosmetics – Gene Structure- and Function-Modifying Products – Labeling – and urge an unfavorable report.**

While SB 911 is an extremely confusing and oddly written bill, it is BIO's understanding that the legislation is aimed at requiring a Maryland-specific label for genetically engineered (GE) food. Such a bill has not been considered in the Maryland General Assembly since 2014 and there are good reasons for that. A state-by-state approach to the labeling of products containing GE ingredients is untenable. That is why in the summer of 2016 Congress passed and President Obama signed into law legislation requiring the U.S. Secretary of Agriculture to establish a mandatory uniform national disclosure standard for human food that is or may be genetically engineered or bioengineered.

The Bioengineered Food Disclosure Law also preempts state and local GE labeling requirements. As such, no U.S. state or local government has adopted and implemented – or even seriously considered - its own GE seed or food disclosure requirement since the 2016 law was enacted.

Under the standard, food manufacturers, importers, and certain retailers are required to ensure bioengineered foods are appropriately disclosed. Regulated entities have several disclosure options: text, symbol, or electronic or digital link, and or text message. Additional options such as phone number or web address are available to small food manufacturers or for small or very small packages. The standard went into full effect on January 1, 2022 and applies to food sold in Maryland and the rest of the country.

Since 1986 the U.S. Food and Drug Administration (FDA), U.S. Environmental Protection Agency, and U.S. Department of Agriculture have regulated agricultural biotechnology research and commercialized products under extensive federal laws known collectively as the "Coordinated Framework." The comprehensive federal regulatory review process has determined that foods produced using bioengineering are safe and not materially different in any way from those made

using other methods. This finding is consistent with scientific research conducted and reviewed by FDA and USDA and private entities. Indeed, foods and food crops produced using biotechnology are among the most reviewed, studied, scrutinized, and regulated products in the world. Leading scientific and medical organizations, including the American Medical Association (AMA), American Association for the Advancement of Science, and World Health Organization, maintain that foods made from crops improved through biotechnology are as safe and nutritious as conventionally grown crops. According to 2012 AMA report: "Bioengineered foods have been consumed for close to 20 years, and during that time, no overt consequences on human health have been reported and/or substantiated in the peer reviewed literature."

The federal law ensures that the national disclosure standard and USDA's implementing regulations treat the safety of a bioengineered food the same as its non-bioengineered counterpart. The mandatory disclosure requirement is designed solely to address marketing matters, not based on any concerns with respect to safety of bioengineered foods or ingredients. Distinguishing GE foods with a false state specific label would mislead consumers by implying differences where none exist. To that end, it must be noted that GE food does not, contrary to the legislation's assertion, "modify the structure or function of one or more genes in a consumer."

Finally, a mandatory Maryland specific label would almost certainly limit consumer choice, increase food prices, and disrupt supply chains, as some food manufacturers would simply choose not add such an egregiously false and defamatory statement to their product labels and those that did would pass along the increased cost to consumers.

In the years prior to 2016, before the passage of the federal law, various states considered legislation requiring the labeling of GE food products, which would have created a patchwork of different state laws. In June of that year, Vermont began implementation of its GE food labeling law, which has since been preempted by the federal law. The Corn Refiners Association undertook an economic impact analysis of the Vermont law and demonstrated that the cost of implementation would lead to an average increase in annual food cost of $1,050 per American family. The analysis also found that lower income families would have been especially burdened, as the increased costs could account for nearly 2.5 percent of the median income for the poorest fifth of the population.

For these and many other reasons, BIO urges an unfavorable report on SB 911.

I appreciate your time and attention and encourage you to contact me at (202) 365-6436 and gharrington@bio.org if you have any questions.

Sincerely,

Gene Harrington
Senior Director, State Government Affairs, Agriculture & Environment

BIO is the world's largest trade association representing biotechnology companies, academic institutions, state biotechnology centers and related organizations across the United States and more than 30 other nations. BIO members are involved in research and development of innovative healthcare, agricultural, industrial, and environmental biotechnology products.

SB 911 - FIN - MDH- LOO.docx.pdf
Uploaded by: Jason Caplan
Position: UNF

Maryland
DEPARTMENT OF HEALTH

Wes Moore, Governor · Aruna Miller, Lt. Governor · Laura Herrera Scott, M.D., M.P.H., Secretary

March 7, 2024

The Honorable Pamela Beidle
Chair, Senate Finance Committee
3 East, Miller Senate Office Building
Annapolis, MD 21401-1991

RE: Senate Bill 911 – Food, Drugs, and Cosmetics – Gene Structure– and Function–Modifying Products – Labeling – Letter of Opposition

Dear Chair Beidle and Committee Members:

The Maryland Department of Health (Department) respectfully submits this letter of opposition for Senate Bill (SB) 911 – Food, Drugs, and Cosmetics – Gene Structure – and Function – Modifying Products – Labeling. SB 911 would prohibit the offering for sale in Maryland any gene structure- or function-modifying (hereon called simply "gene-modifying") product unless the gene-modifying product is labeled with the words "gene structure- or function-modifying product" and all potential risks, side effects, adverse effects, and other reasonably possible effects the product may have on the user, or anyone who comes into contact with the user. Violation of the requirement would be a misdemeanor accompanied by fines.

The Department is concerned that the scope of SB 911 and the definition of gene-modifying is extremely broad. It includes a significant array of consumer products, foods, and medical therapeutics, including vaccines, cancer chemotherapy agents, antibiotics, and monoclonal antibody products essential to health care in the State. Many of these products have already been extensively tested and vetted by the U.S. Food and Drug Administration (FDA), and their labels and necessary warnings are already standardized by the FDA.

SB 911 would also potentially affect foods that naturally contain chemicals that can alter genetic material or function. It is not clear if such products would also be covered by this bill, or to what extent.

This bill will have a fiscal impact on the Department. There is currently no budget, staff, or laboratory capacity in the Department to conduct testing on product referrals. In response, it is likely that the Department will instead require producers to conduct testing at private laboratories. In the instance of inter-state commerce, it is possible that the FDA could do the testing. Because of the unclear implication of the phrase "gene structure- or function-modifying" in the bill, the Department would require a 1.0 FTE Public Health Laboratory Principal Scientist Developmental to advise the Bureau Chief and the Department on gene structure- and

function-modifying science, testing possibilities, interpretation of test results, recommended actions, etc. at the State and national level. The State Fiscal Year 2025 salary and fringe cost is $94,181 with associated operating costs of $11,333. The total State Fiscal Year 2025 cost is $105,514.

If you would like to discuss this further, please do not hesitate to contact Sarah Case-Herron, Director of Governmental Affairs at sarah.case-herron@maryland.gov.

Sincerely,

Laura Herrera Scott, M.D., M.P.H.
Secretary

Opposition of SB911 Food, Drugs, and Cosmetics - G

Uploaded by: Tyler Hough

Position: UNF

Maryland Farm Bureau
3358 Davidsonville Road | Davidsonville, MD 21035
410-922-3426 | www.mdfarmbureau.com

To: Senate Finance Committee

From: Maryland Farm Bureau, Inc.

RE: **Opposition of SB911 Food, Drugs, and Cosmetics - Gene Structure- and Function-Modifying Products – Labeling**

On behalf of our nearly 9,500 Farm Bureau families in Maryland, I submit this written testimony in opposition to SB911. This bill prohibits and restricts the marketing and labeling of Genetically Modified Organism (GMO) commodities grown in the state. We strongly oppose state-mandated labeling of these products and believe only the federal government policy should be utilized on this issue.

SB911 is proposed as legislation to require a Maryland-specific label for genetically engineered food. The US federal government has already passed legislation to create a standard set for human food that is or may be genetically engineered or bioengineered. This Bioengineered Food Disclosure Law is monitored by the U.S. Secretary of Agriculture and this law has been in place since 2016. The effort to monitor GMOs has been conducted by the U.S. Food and Drug Administration (FDA), U.S. Environmental Protection Agency, and U.S. Department of Agriculture. Federal regulation has ensured that bioengineered foods are safe and indifferent to other foods produced in any other way. Other organizations have supported this conclusion such as the American Medical Association (AMA), American Association for the Advancement of Science, and World Health Organization.

This bill stands on the aspect of marketing rather than safety. Labels should not mislead consumers. Labeling should be left and entrusted in the federal framework as there is no reason for Maryland to differentiate their labeling from these standards. This new labeling requirement could limit our farmers' consumer base and disrupt their processes as they attempt to promote their product, possibly leading to an increase in food costs. Maryland Farm Bureau cannot

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support this bill as it is unnecessary and disregards the federal framework already in place for Genetically Modified Organisms.

Maryland Farm Bureau Policy: We oppose legislation that would restrict the use of GMO commodities grown in the state. We support GMO policy decisions only at the federal government level and not at the state government level. We oppose state-mandated labeling of products made with GMO crops.

Maryland Farm Bureau Respectfully Opposes SB911.

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Please contact Tyler Hough at 443-878-4045 with any questions