Epigenetics: Blessing or Curse

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Epigenetics is the study of changes in organisms caused by modification of gene expression rather than alteration of the genetic code itself. Genes occur in pairs and code for specific traits or combinations of traits in the body. Most genes can have significant variation in the degree to which they express themselves. This is very important to remember as we discuss the impact of epigenetics on animal performance. What factors can alter degree of gene expression? Primarily environmental factors such as diet or nutrition, climate, disease, toxins, deficiencies, and other environmental influences.

Epigenetics can influence any living organism that contains DNA. This includes animals, plants, insects, and microbes. It provides a mechanism of inheritance that is not solely dependent on DNA sequence. These effects may explain certain instances of non-Mendelian inheritance patterns. Even more importantly, epigenetic changes can interfere with normal developmental processes and lead to disease development.

When livestock are exposed to infectious agents, toxins, or nutritional deficiencies, then there can be profound effects on either the exposed animals or their direct offspring. When detrimental environmental factors affect the embryonic germline during pregnancy the result can be transgenerational effects traced all the way to the F3 generation. These effects often occur due to direct environmental insult at critical periods in the development of an organism.

Pesticides and other chemicals in the environment can have significant transgenerational epigenetic effects on body systems such as the circulatory system, nervous system, endocrine system, and digestive system. This has been known to lead to cancers in animals. When these insults occur during critical periods in development, then negative consequences can result in humans, animal, insects, and plants. Epigenetics can even affect hybrid vigor.

In my series on adaptive grazing, we explored the Principle of Compounding. Just like with adaptive grazing, epigenetic effects have compounding and cascading effects.

So, what can cause epigenetic effects? Chemicals, animal supplements, and even reproductive technologies. Chemicals can create epigenetic effects either almost immediately, if at toxic levels in a single application, or over multiple application periods. Research results have shown that synthetic fertilizers, herbicides, pesticides, and fungicides can produce multigenerational epigenetic effects in plants, animals, humans, insects, and microorganisms.

Supplements that we supply to our livestock can also produce epigenetic effects. Supplementing simply because a salesperson tells you to can have impacts far beyond what you may imagine. If the supplementation alters the proper mineral:vitamin ratio it can create deficiencies or toxicities. These, in turn, produce negative epigenetic effects.
Research has also shown that reproductive technologies can alter the degree of gene expression. For example, cryopreservation (freezing) of sperm and embryos can damage DNA in sperm cells and decrease their motility, and can increase the risk of abnormalities in embryos. These abnormalities can be transgenerational and are often exacerbated in inbred (i.e., linebred) strains of livestock.

Epigenetic effects impact animal health, fertility, milk component production, calf performance and lifetime health, longevity, soundness, and endocrine system functioning. They can even decrease an animal’s ability to exhibit resistance to internal and external parasites.

Sounds dire doesn’t it? The truth is, it can be downright frightening and these negative epigenetic effects do explain a lot of the issues we currently face in our plant and animal agriculture. One example of a dire consequence is the case of significantly increased incidence of ALS, Alzheimer’s and Parkinson’s disease in the Chamorro people of Guam. They suffer a degree of ALS in their population at a rate almost 100 x’s the average population of the world. Investigation into this phenomenon showed that the Chamorro like to eat giant fruit bats. These fruit bats are fond of the seed of the Cycad bush. It so happens that the Cycad seeds contain high amounts of an amino acid called BMAA, which is a potent neurotoxin. This neurotoxin is produced by cyanobacteria in the plant roots.

The amino acid, BMAA, causes a slow breakdown of proteins in the central nervous system, which causes “tangled up” proteins. Tangled proteins result in neurological disorders in our brains and central nervous system. BMAA primarily does this by displacing a key amino acid in nerve proteins called L-serine. The BMAA turns a “switch” on that causes a cascading disruption in nerve proteins. This is called tangling. L-serine can turn this “switch” off and reverse the situation. In contrast to the Chamorro people, Okinawan’s are known to have the highest percentage of centenarians in the world. It just so happens that Okinawans consume the highest amounts of L-serine in their diet compared to any other peoples in the world.

The phrase, “We are the cause of our own demise” really holds true here. These same cyanobacteria are popping up in many places in the U.S. In our lakes, streams, bays, and gulfs. The blue-green algal blooms that are increasingly occurring in our bodies of water are caused by cyanobacteria. Increased incidences of neurological disorders that include Alzheimer’s, Parkinson’s, and ALS have been found in human populations that live near bodies of water with significant blue-green algal blooms. States where populations have been impacted include New Hampshire, Ohio, Minnesota, Iowa, Louisiana, and Biscayne Bay, TX.

No doubt that the negative effects of epigenetics can create havoc among all living organisms and can help explain a number of the disorders that we experience. However, there is good news. There are also positive epigenetic effects. These positive epigenetic effects can also lead to positive transgenerational impacts in plants, animals, insects, microorganisms, and humans.
So, how do we influence positive, rather than negative, epigenetic effects? It is actually fairly simple --- by the way we manage our farms and ranches and our own diets. If you go back and read my series on the three principles of adaptive grazing, following those principles will lead to positive epigenetic effects. Very practical steps we can take to reduce negative epigenetic effects and produce positive effects instead include:

- **Increase** plant species diversity and complexity in our pastures.
  - This one thing increases the array of plant secondary and tertiary chemical compounds that increase the array of medicinal properties that our livestock can consume, have anthelmintic properties, attract a broader array of soil microbial species, and result in a better water and mineral cycle.
- **Adaptive grazing management.**
  - This results in favorable gene expression and better overall animal performance and health.
- **Significant reduction in tillage.**
- **Reduce** use of or eliminate use of chemicals in our operations.
  - This includes all synthetics, such as herbicides, pesticides, fungicides, and synthetic fertilizers. Even chemical dewormers can cause some negative epigenetics effects.
  - Beware also of blatant overuse of “organic” fertilizers as well. Over-application of manures and similar organic fertilizers can also create potential negative epigenetic effects. Use them judiciously.
- **Make sure** livestock are not nutritionally stressed over longer periods of time.
- **Use** adaptive management to reduce incidence of disease in your livestock and plants.
- **Use** adaptive management to increase soil microbial, insect, pollinator, bird, and wildlife populations. Whenever we have thriving populations of these species on our farms and ranches, we see very positive epigenetic factors occurring.
- **Manage for** polycultures rather than monocultures.

**Bottom line** --- if we want to create positive epigenetic effects and significantly reduce any negative epigenetic effects, then we need to employ adaptive management practices that build better soil, water, plant heath and animal health. Doing so, will automatically reduce negative epigenetic effects in humans and significantly improve our health.

**Next up** --- What size do our cattle need to be to be optimally profitable, how do we know when an animal is truly finished and ready for harvest, and what are the key considerations for linebreeding.