Section 4
Poultry Physiology: Adaptation to the Environment
Notes

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What is health? Health can be defined as a general condition or state. Pretty vague- Can also be described as an absence of disease. To be healthy there are many physiological processes that must be maintained. For example heart rate. In chicken's heart rate is … and in turkeys heart rate is … What would either depress or excited heart rate potentially indicate… disease. Respiration rate must also be maintained for health. In chickens respiration rate is … and turkeys… again what could depress or excited respiration rate indicate? Another physiological process that must be maintained that is not commonly considered is body temperature. Elevated body temperature (fever) can be an excellent sign of disease/infection.

Therefore it is important to understand how animals maintain body temperature, how the animal's environment impacts body temperature, and how these factors effect rearing conditions and production

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Poultry are homoeothermic or warm-blooded animals, what does this mean? That they must maintain a nearly constant body temperature. The maintenance of that body temperature is called homeostasis. Homeostasis is where heat that is put out by the animal is equal to heat input to the animal (typically from the environment).

An example of this is heat production through body processes such as metabolism. Animals can use this heat to stay warm is environmental temperature is cold and will need to dissipate heat produced if environmental temperature is too warm.

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If an animal, specifically a chicken, needs to dissipate heat to maintain homoeostasis there are two general classifications of heat loss considered:

Sensible heat loss and insensible heat loss. Sensible heat loss increases the temperature of the surrounding air. Insensible heat loss does not increase the temperature of the surrounding air.

There are three forms of sensible heat loss: conduction, convection and radiation

You experience conduction if you were to touch a hot stove, or sit on a hot car seat.

Conduction occurs when an animal lies on a cool surface. In a poultry house, heat loss for the birds by conduction is minimal because the temperature of the contact surfaces (floor, equipment, etc.) is not very different from bird temperature.

Convection occurs when wind comes in contact with the skin and carries the heat away. Heat carried in the blood is also a form of convection.

You experience radiation when you stand in the sun or sit by a camp fire.

Radiation occurs when heat flows from the birds to the surrounding air. Radiation only occurs when a temperature difference exists between skin and the surrounding air. Therefore, the amount of heat loss by radiation decreases as air temperature increases closer to the body temperature.

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In poultry insensible heat loss occurs in the respiratory tract. Heat is used to vaporize water and then the water is exhaled. Because water vapor lost and not heat temperature of surrounding air is not increased.

In higher temperatures (greater than 85^{o} F) insensible heat loss is the primary form of heat loss. This is why high temperature and humidity are a particular issue in poultry production. High humidity reduces the effectiveness of insensible heat loss

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Think of the body as a core and shell

-The core includes internal organs; heat is produced in the core through normal metabolic and catabolic reactions

-The shell can help buffer against changes in environmental temperatures, primary function is to protect core from large gains or losses of heat.

-Because the body temperature of the bird is typically higher than the environmental temperature heat will flow from the core through the shell into the environment.

-Heat flowing from the core is a form of conduction.

Behavioral changes – decreased feed intake, decreased activity, wing spreading movement away from other birds, dust bathing

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Thermal Neutral Zone – Animal is comfortable in environment; where rate and efficiency of performance are maximized and health is optimal; decision on thermal neutral zone of animal must not be made on the comfort of humans

Cool Zone – Animal begins to conserve heat; Passive thermoregulation used these methods include

Vasoconstriction of blood vessels to decrease blood flow to shell, Piloerection, Behavioral changes

- Behavioral changes include huddling, crowding and moving to warmer areas of the house or spreading out and moving to cooler areas of the house, increasing or decreasing feed intake

- Piloerection - feather fluffing in poultry (Goosebumps)

Cold Zone – Animal is very cold in this zone. Active thermoregulatory methods must be used these include: Increased feed intake, shivering, and hormone release

- Hormone release - Thyroxin is hormone released which increases metabolic rate

Intolerably Cold Zone – Animal is unable to stay warm using both passive and active thermoregulation. All feed consumed is used to produce heat to maintain body temperature. Eventual death will occur.

Warm Zone – Passive thermoregulatory methods are being used which include vasodilation and behavior changes.

Behavioral changes - spreading away from other birds and migrating from warm areas of the house to cooler areas.

Hot Zone – Animal is very hot and is experiencing heat stress. Begins to use active thermoregulatory methods which include: Increased heart rate (increased blood flow to shell; increased conductive cooling), panting, and sweating (not in birds).

Remember active thermoregulatory method require energy and produce heat, so although they are dissipating heat they are also producing heat

Intolerably Hot Zone – Animal can no longer sustain body temperature, eventual death will occur.

Also, panting will result in insensible heat loss via the respiratory tract. However, this can also result in dehydration from loss of water vapor in Hot and Intolerably Hot Zone.

Heat Production:

Not only is there environmental temperature to consider heat production of the birds in the house should also be taken into account. When birds are first placed in a house they produce less total heat but more heat per unit body weight. Although more heat is produced per unit body weight chicks still require supplemental heat during the first weeks of production.

Big birds on the other hand produce more total heat but less heat per unit body weight. Especially in the summer months it will be critical to remove this excess heat produced by the birds as well as humidity from the grow-out house.

Also, as birds age the thermal neutral zone expands to fit in a broader range of temperatures. So, older animals are more able to cope with warmer and colder temperatures than younger animals.

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In commercial poultry birds are raised in a contained environment to protect them from large changes in the environment (Temperature, humidity, etc.)

By controlling the environment, farmers are able to produce the most productive healthy flock possible. However, the environment of a poultry house cannot be completely controlled, and the ambient temperature and humidity will have some effect on how the flock adapts to its environment.

At temperatures around 70oF – 85oF poultry are dissipating much of their excess heat by sensible methods

At temperature greater than 85oF poultry are dissipating excess heat through insensible methods.

Humidity affects in sensible heat loss because it affects the amount of water that can be absorbed by the air. As humidity increases amount of water able to absorb decreases.

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Ambient temperature will also affect feed and water intake

As the environmental temperature increases moisture loss through insensible heat loss also increases. Water intake increases as insensible heat loss increases; makes sense to prevent dehydration

Feed intake decreases as environmental temperature increases. Heat is produced as feedstuffs are metabolized. This heat produced is called the heat increment. Heat increment is detrimental to birds particularly in Hot and Intolerably Hot Zone.

If you want your birds to grow bigger they must consume more feed… How would you adjust environmental temperature to increase feed consumption?

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Animals that are well nourished will be healthier than animals that are not receiving proper nutrition. Under-nourished animals will often have suppressed immune systems as well as other disease complications that can result from malnutrition

Sanitation – often the amount of a pathogen (infectious dose) that an animal is exposed to will significantly affect the severity of the disease. Therefore, reducing the pathogen load in the animal's environment can often improve health. Proper cleaning removes over 95% of disease organisms, even without disinfectants

Perhaps most importantly for poultry is biosecurity. Biosecurity is the first line of defense on farm for protecting animals from disease. Biosecurity is used to minimize the risk of disease transmission from outside sources as well as reducing the transmission of disease between different groups on the same farm

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These are common biosecurity practices for a commercial poultry farmer to adhere to however, small flock farmers would benefit from using these practices also.

Say as much or as little as you want about these practices

The most critical being 3 days clean from other birds, controlling visitor traffic, mortality disposal (both timely and appropriate) and avoiding contact with wild game

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What is disease? Remember the definition of health; therefore disease is a state other than complete health. Often when we are sick we tell the doctor about symptoms that we have (sore throat, headache etc.). As caretakers of animals we recognize disease by identifying clinical signs. They are considered clinical signs because animals cannot tell us about the symptoms that they are experiencing. In animals disease can be recognized in a variety of ways. Some clinical signs that animals will exhibit that could be a sign of disease include: fever, weight loss, and reduced performance. Visible lesions may also be a

clinical sign that a caretaker could identify. These lesions could include changes in size, color, or shape of body organ and could be the result of a tumor or an abscess.

As a farmer being able to recognize clinical signs of disease is critical. If detected early, sick animals can be separated from the flock being key to a successful treatment program.

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Animals can have predisposing cause that would make them more susceptible to disease (exhibiting clinical sign)

For example, stress - heat stress, poor conformation – swollen hocks, malnutrition

Direct cause of disease is a pathogen

Some common pathogens are bacteria, virus, parasite, fungi, and toxins

OF these bacteria and virus are considered to be an infectious disease

An infectious disease is defined as a disease that can be communicated from one animal to another

COMPARE to un-infectious disease and causes of uninfectious disease

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To begin to understand disease first it is helpful to have an understanding of some general definitions pertaining to pathogens and disease.

Firstly, when referring to pathogens, pathogenicity is often discussed. This is the ability of the organism to cause disease.

Virulence is the degree of pathogenicity and often these terms can be used interchangeably.

For example, a lactic acid bacteria, which is commonly found in the intestinal microflora has low pathogenicity. Compare this to an E. Coli 0157 H7, this bacteria has high pathogenicity.

Organisms that are low virulence will likely only cause disease in a host that is immune compromised. Where highly virulent organisms will likely cause disease even in a healthy host.

Other terms that are also used when discussing disease, pathogenicity and virulence are clinical vs. sub clinical disease. With a clinical disease symptoms are often evident. The animal is clearly showing signs of disease. In contrast, with a sub-clinical disease the symptoms of the disease are not always evident; however animals with subclinical disease will often be carriers of the disease

To compare and contrast acute disease vs. chronic disease, with acute disease often the clinical signs come on suddenly and the disease will resolve in 2-3 weeks. Either the animal will die or recover in 2-3 weeks. With a chronic disease however, symptoms progress slowly over a period of several weeks, often decreased performance is noted instead of traditional clinical signs.

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Now that we have a basic understanding of disease terminology and mechanism let's discuss some disease causing agents

Firstly,

Bacteria are single celled ubiquitous organisms, what is ubiquitous? It means that they are everywhere literally; there are millions upon millions on our bodies alone. Most bacteria are not harmful and actually have a symbiotic relationship with our body. Maintaining a healthy bacterial microflora on and inside our bodies is essential for health. In some cases, bacteria may be pathogenic. In these cases the host must receive an appropriate infectious dose to become ill. Animals are probably exposed to pathogenic bacteria daily; however, it is only when these bacteria are in great enough quantities to cause illness that animals are affected by them. How many bacteria is an infectious dose? It is often dependent on the pathogenicity of the organism (remember pathogenicity – ability to cause disease). If an organism is very virulent smaller infectious does are required to cause disease. However, if it is not a very virulent strain maybe millions of the pathogenic bacteria must be present to cause disease. Examples of poultry diseases caused by bacteria include salmonella and cholera.

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Unlike bacteria viruses are not living organisms, what they are is genetic material in a protein coat or case. Viruses can only reproduce inside of a host organism; they use the host cell to reproduce copies of their genetic material through a complex life cycle. The first step in viral replication is adherence. This means that the virus must first attach itself to the host cell using receptors on the surface of the host cell. After the virus is adhered to the surface of the host cell it must penetrate the host cell and inject its genetic material into the cytoplasm of the host cell. Once the genetic material has gained entry into the cell it uses the cells machinery to replicate itself. After a certain number of replications are made then the new genetic material will assimilate themselves into new viruses. After assimilation the viruses will typically trigger host cell lysis (rupture) and thousands of new copies of the virus will be released into the host's body.

In a poultry flock the only ways to prevent viral disease in flocks is through biosecurity and immunization. Examples of viral pathogens in poultry include Marek's disease, and fowl pox.

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Bacteria and virus are the most common cause of disease; however, some other organisms can be commonly seen in poultry. Poultry can get parasitic infections as with other animals, a parasite is an organism that lives on or in a host organism and gets its food from the host. Poultry can get round worm infections like many other species and another parasitic infection of poultry is the fowl mite.

Protozoa can also be parasitic organisms or they can be free living. A common protozoa infection of poultry is coccidiosis.

Fungi, common multi-cellular eukaryotic organisms can also cause disease in poultry. However, this is typically the result of ingesting old/contaminated feed ingredients

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Infectious diseases have a general lifecycle.

1…

2…

3…

4…

At what point can intervention be made to prevent disease?

Most obvious is keeping host from being exposed to pathogen. Remember infectious dose? If host is only exposed to a few pathogenic organisms will probably not cause disease. However, pathogens become a problem when the load is large. Consider bacteria and humans, we consume millions of bacteria a day on the food that we eat. Some are harmful some are not. The only time we become ill from a pathogen is when the dose that we receive is large enough to cause signs of disease.

Viruses are a little different because they are able to replicate within the host. However, preventative steps such as biosecurity can keep them from being introduced into the environment

2., 3., 4. Intervention in these steps would include antibiotics (WITH BACTERIAL PATHOGENS ONLY!) and vaccination. Some poultry diseases are slow spreading and vaccinating in the face of an outbreak would be realistic to stop further infection (ex. Fowl pox)

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(ANSC and Industry 227)

Now that we have had a discussion about common disease terminology and disease causing agents let us briefly discuss immunity and disease prevention

Immunity is defined as a state of resistance in the animal to a disease producing agent. There are two general categories of immunity, active and passive.

Passive immunity is maternal immunity, meaning it is passed from mother to offspring. In the chicken maternal antibodies are found in the yolk and therefore absorbed into the chicks body during the last days of incubation.

Active immunity on the other hand occurs from natural exposure and recovery of a disease. When exposed to a disease the body produces antibodies. Antibodies are proteins produced by the body that label cells of infectous agents for destruction by macrophages and heterophils.

Vaccinations rely on active immunity to be effective. Vaccinations are often killed strains of infectious agents. Therefore the body can be exposed and form antibodies against infectious agents without having to contract the disease and display clinical signs. That way if ever the animal is exposed pre-formed antibodies are able to mount an immune response rapidly.

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The hatchery is the most practical place to deliver vaccine to commercial poultry. The development of in-ovo vaccine has revolutionized commercial poultry vaccination. Often spray vaccines will be administered at the hatchery during chick processing

Most vaccines used in commercial poultry industry are live-virus vaccines. Active/acquired immunity.

Vaccinating flocks on farm is avoided as much as possible because of labor involved, however in some cases it would be necessary to vaccinate a flock on farm especially if the flock has great value like a broiler breeder flock.

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If a flock needs to be vaccinated on farm there are several methods that could be used. Including through the drinking water, intraocular (in the eye), intranasal (in the nose), in the wing web, and sub Q (under the skin).

Small flock producers seldom vaccinate however, if vaccination is required for a small flock vaccine can be delivered through the wing web or sub-q. Small flock owners should consider vaccinating flocks if the risk for disease transmission to the farm is high. For example, owner takes birds to poultry shows, buys birds from other farms, sale barns, etc., have had disease problems in the past.