Thermoregulation in laying hens explained

Laying hens are warm blooded (homeothermic) animals, which means they can maintain their body temperature within a certain range. On average, the body temperature of healthy chickens falls within the range of 40-42°C.

The thermal neutral zone for adult laying hens ranges from 18-24°C (ambient temperatures), which means that within this temperature range the birds do not need to modify their metabolism to stay warm or to get rid of the heat.

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For newborn animals it takes some time before their heat regulating mechanisms can function normally. This is the main reason why young birds need higher ambient temperatures during the first weeks of their life. Directly linked to that is their lack of body reserves (especially fat), and the ratio of the surface area vs. their bodyweight is unfavourable, resulting in heat losses.

When house temperatures are not within the thermal neutral zone, birds have several characteristics that enable them to keep their body temperature constant without the need to produce extra heat.

Keep in mind that a young chick has relatively the largest contact surface with the surrounding air, therefore they can cool off much quicker compared to an adult female.

These characteristics include:

- Feathers. These have an insulating effect and help to prevent the hens from excessive heat loss.
- Tissue insulation. Subcutaneous fat will allow the hens to drop their skin temperature whilst not negatively affecting their body temperature.
- Blood flow. Chickens can regulate the widening and contraction of their blood vessels and adapt the blood flow through the skin (including combs and wattles). To lose more heat, the blood flow will be enlarged.
- Birds will huddle together to minimise the loss of heat.
- Ability to increase their body surface to lose more heat.

Five ways to keep cool

Birds regulate their body temperature via their hypothalamus, which is a part of the brain that is comparable to a thermostat. Heat emission and heat retention is largely influenced by the contraction and widening of the blood vessels and the speed of respiration.

Chickens do not have sweat glands; therefore, they are not able to lose their heat via transpiration. They are able to lose their heat themselves via five different pathways:

- Radiation.
- Convection.
- Conduction.
- Evaporation.
- Vasodilation.

Radiation, convection, and conduction are all related to sensible heat loss. Sensible heat is the energy required to change the temperature of a substance with no change of phases.

The loss of body heat comes from the contact with the cooler surrounding air, that absorbs the heat of the birds.

Chickens are normally able to maintain their normal body temperature of 40-42°C via sensible heat loss when the environmental temperature falls within their thermal neutral zone of 18-24°C.

When the barn temperature rises above 25°C the efficiency of sensible heat loss is going down, and at 35°C it has hardly any effect unless the relative humidity is low.

Management plays a vital role in maintaining your birds' body temperature within their comfort zone.

Laying hens can lose heat to the surrounding air. This is called convection or radiation and permits the transfer of body heat to the air. Proper ventilation, which results in faster air movement inside the poultry house, will result in better heat loss due to convection.

As long as the ambient air temperature is colder than the birds' body temperature the aforementioned will work. Therefore cooling the incoming air will result in improved radiation. But keep in mind, the smaller the difference between the body temperature of the birds and the ambient temperature, the lower the possibility for proper heat loss.

This is also true for humidity – the amount of moisture that the birds can evaporate becomes smaller when the humidity goes up.

Next to panting, laying hens can increase their heat loss by extending their wings and putting up their feathers (they become fluffy). This will allow more air to circulate near the body (especially the skin), and it

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The relationship between heat stress and eggshell quality

As a result of heat stress, the bird's body temperature can rise above 42.5°C. As a result of panting (hyperventilation), birds will lose extreme amounts of CO_2. This extreme loss will cause a rise in the pH of the blood, i.e., the blood will become alkalotic and cause metabolic alkalosis. This will cause low concentrations of blood calcium. As the blood pH increases, blood transport proteins, such as calbindin, become more ionised into anions. This causes the free calcium present in the blood to bind more strongly with the calbindin, resulting in less availability of calcium and phosphorus for the eggshell formation and reduced secretion of calcium and carbonate by the shell gland.

TIP: adding vitamin C, vitamin E and H_2CO_3 to the diets can help to prevent the blood from becoming alkalotic.

LUNGS		BLOOD		SHELL GLAND
CO_2+H_2O	⟷	$H_2CO_3 \longleftrightarrow H^+ + HCO_3$	⟷	$CO_3 + H^+$
		Non-diffusible calcium bounds to protein		Ionised diffusible calcium

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increases the contact surface with the surrounding air to expel the heat.

As mentioned earlier, the birds can regulate their blood circulation to lose heat. They can increase blood circulation in their comb, wattles, and skin to lose more heat to the cooler surrounding air (called vasodilation). Always reconsider the aforementioned prior to asking for dubbed birds as it can negatively influence the bird's health and welfare under situations of heat stress.

The above mechanisms can only work when management is properly adapted to the needs of the birds. Changes in water and feed management, like adding vitamins or buffers can impact about 15% of the heat stress. A much larger impact (85%) can be made via managing the climate in the poultry house via ventilation. This will better help your flocks in dealing with too high and too cold temperatures via management of the flock.

Heat stress occurs when the birds' core body temperature increases to fatal temperatures because of poor heat loss. Birds are not that capable of coping with high body temperatures, therefore severe heat stress can cause increased mortality of the flock. Both temperature and relative humidity play a crucial role in the occurrence of heat stress. It is key to measure and monitor both carefully.

As birds cannot sweat, they use evaporation (latent heat) to stabilise their body temperature by increasing their respiration rate. The latent heat of evaporation is the heat required to change water into water vapour.

The water vapour is taking away the heat from the birds' body. This behaviour is better known as 'panting'. Panting can only be effective when the relative environmental humidity is not too high. The evaporation of 1g of water results in a heat loss of over 500 calories. Losing heat also comes with a cost, as the birds need to expend their energy in trying to maintain their body temperature below 42.5°C. As it is pretty hard to compensate for this higher energy requirement via their nutrition, you are likely to see a reduction in growth, body weight and production performance.

Keep in mind that chickens do not have sweat glands, therefore they are not able to lose their heat via transpiration.

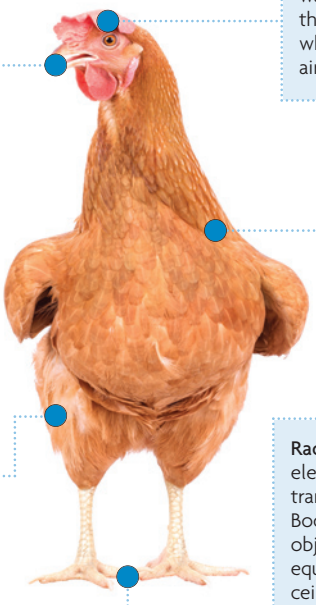
When a chicken wants to cool down, she will start panting. Via panting with her beak open (you can see the birds' throat rapidly moving backwards and forwards) the bird is able to get rid of the excess heat as the panting enables moisture to evaporate through the airways. Next to the panting, the birds will hold their wings out slightly from their bodies and they raise their feathers to maximise the skin contact with air to expel the heat.

As heat stress is already a stress on its own, it is important not to stress your birds any further.

We have listed some practical tips and tricks below, which are often easy to implement and at a low cost.

- When bird handling is required (vaccination, transfer, sorting, depopulation) it is advised to do this in the early mornings.
- When transporting the birds, place fewer birds in crates and place empty crates in the truck to enhance ventilation during transport. Try to minimise the drive and travel during late night time and early morning.
- Try to avoid disturbing the birds during the hottest part of the day, as this results in even more stress to the birds.
- Respect the stocking densities carefully, both in cage and floor housing systems. Too high stocking densities could reduce the effectiveness of ventilation and creates competition for water and feed.

In general, cage birds are more susceptible to heat stress as they are not able to find a cooler place. ■



Evaporation: Loss of heat by evaporation of water, i.e. the cooling effect of water turning from a liquid to a gas. Fast, shallow breathing with the mouth open helps to increase the loss of body heat. Removing or lowering the moisture content in the surrounding air of the chickens contributes to evaporative cooling.

Vasodilation: Blood swells the wattles and the combs, sending the core body heat to the surface which is lost to the surrounding air (so do not remove combs).

Convection: The loss of body heat through cold circulating air. Chickens enlarge the exposed surface area by lowering and extending their wings away from their bodies. Moving air helps to remove radiated heat as it is creating a cold air effect.

Radiation: Emission of heat via electromagnetic waves as they transfer energy through the air. Body heat is irradiated to colder objects in the barn, such as equipment, the walls or the ceiling of the poultry house.

Conduction: Direct transfer of heat via contact with an object of a different temperature, such as the slats, cage wire, roost floors, litter poultry house and the loss of body heat.