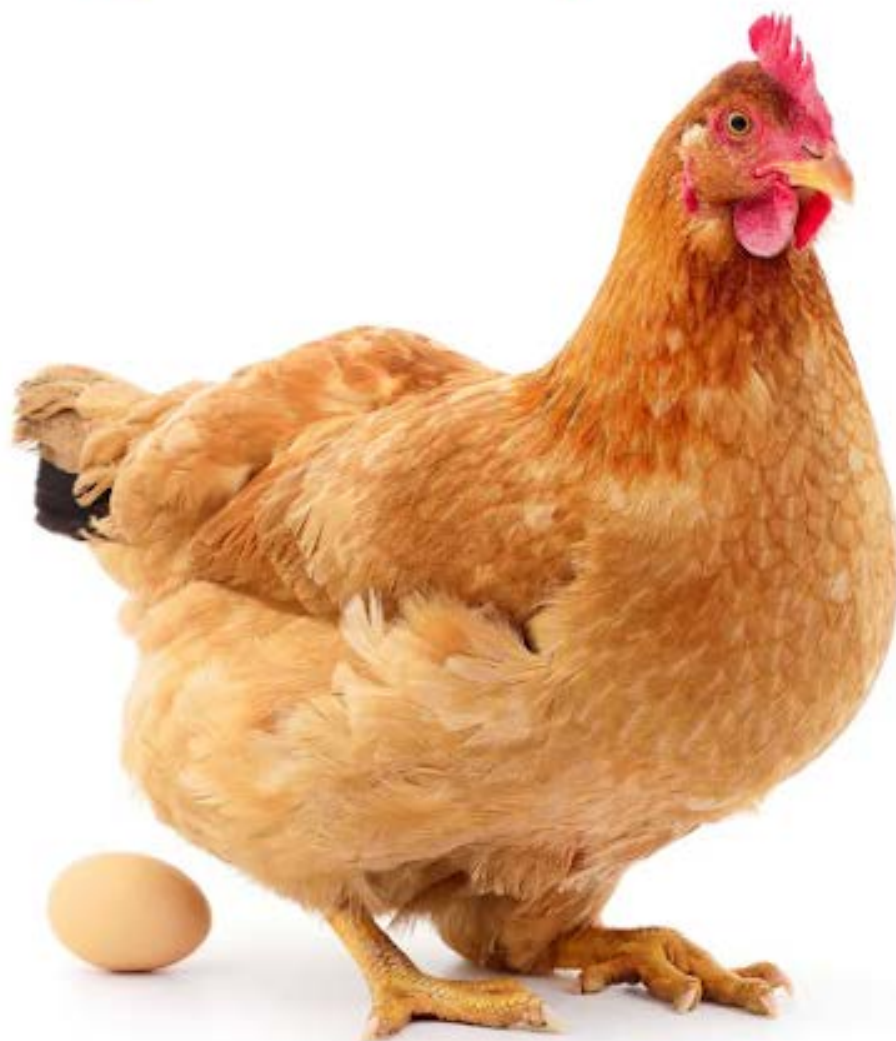


StartupFarming Agricultural

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Introduction to EGG PRODUCTION Layer Farming Basics



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Introduction to the South African Poultry Farming Industry



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1. THE POULTRY INDUSTRY IN SOUTH AFRICA

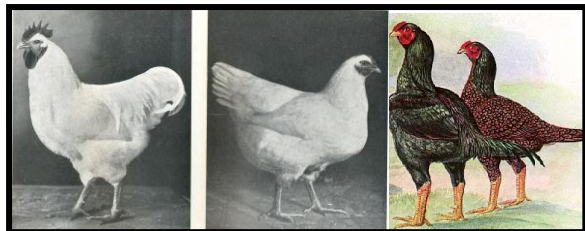
Introduction

After reading and studying these notes you will be able to see where your industry fits into the bigger picture of either poultry meat production or commercial egg production, you will be able to demonstrate an understanding of the origin of the present day breeds that are being used for meat and egg production as well as the supply chain for the production of meat and eggs. You will also have the opportunity to familiarize yourself with the most popular housing systems used for poultry production.

The poultry industry can be divided into two main divisions:

Poultry meat production

Pure meat-type breeds were used by overseas companies to develop lines with outstanding characteristics to put on weight fast and use feed efficiently



Male and female White Plymouth Rock and male and female Indian Game

Commercial egg production

Pure egg-type breeds were used by overseas companies to develop lines with outstanding characteristics to put on weight fast and use feed efficiently



White Leghorn male and female and New Hampshire male and female

The development of lines: Males of one of the pure breeds, White Plymouth Rock, were mated (cross-bred) with females of the Indian Game breed to obtain a male line for meat-type birds. A female line was developed by mating females of the White Plymouth Rock with males of the Indian Game breed to serve as the female meat-type bird. Nowadays these lines are called breeds and bear the names of their companies: Ross, Cobb, Arbor Acres, Hubbard etc.

The very same procedures were followed by companies to develop the commercial egg-laying birds. These birds bear names such as Lohmann Silver, Lohmann Brown, Hy-Line and Amber-Link.

The lines developed by the breeding companies by mating pure breeds are most valuable and are therefore maintained under very strict conditions of bio-security and remains the property of a particular company.

Selection of the best performers is constantly taking place and only limited numbers of males and females, known as great-grand parents (GGPs), of either a meat-line or a commercial egg-line, will be sold to reputable organisations to use them as parents of breeding flocks (known as parent flocks) to produce hatching eggs from which chickens can be hatched and reared as either broilers or pullets for commercial egg production.

Broilers is the term that is always used for meat-type poultry, they include males and females. Broilers are reared from day-old to 33 - 35 days of age before being processed at an abattoir and the meat sold to supermarkets.

Commercial layers produce eggs that are sold in the supermarkets. Hens that produce fertile eggs for the production of day-old broilers or pullets for the table egg market are referred to as breeders. Some companies use the term breeder laying farm where females are mated with males to produce fertile eggs for day-old chicken production).

The supply chain for poultry meat

Broiler production

An illustration in Figure 1 shows the involvement of different divisions of the broiler industry to ensure a constant supply of meat to the consumer.

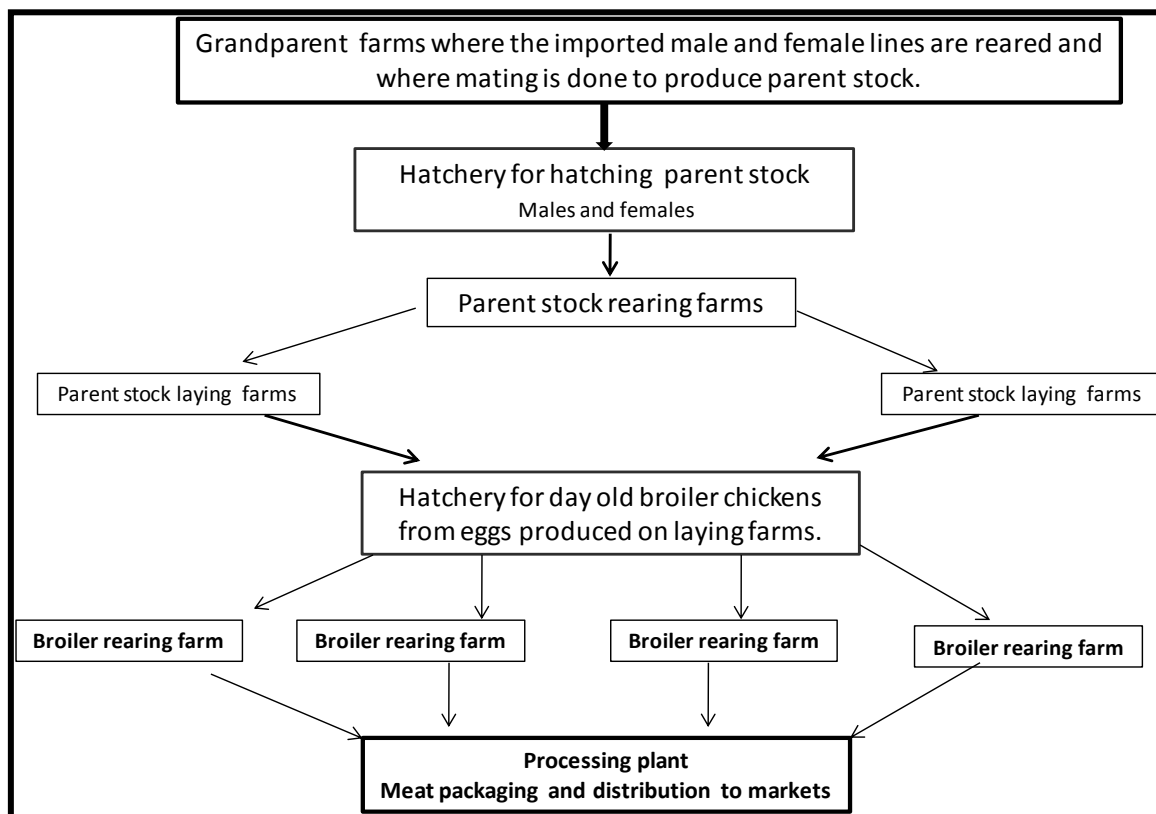


Figure 1 Supply chain for poultry meat

The supply chain for production of eggs for the fresh egg market (table eggs) is in essence the same as the scheme in Figure 1 for the production of poultry meat. Instead of a hatchery for day-old broiler chickens one would find a hatchery for the production of day-old pullets¹.

Why a company does not share parent stock and broiler chick hatcheries.	
1.	The hatchery for the production of day-old chickens for broiler production delivers to a large number of rearing farms. Travelling to such farms by feed trucks and lorries during depopulation pose a high risk to contaminate equipment at their hatchery.
2.	People and equipment can contaminate a parent stock hatchery which on turn will contaminate the breeding farms. This can result in a collapse in the supply chain of hatching eggs for the production of broilers for the market.

The poultry meat and table egg industries

Poultry industries worldwide are playing a huge role to supply mankind with high quality food as well as the means for people to make a living. Some of these aspects are summarized in **Table 1**.

Table 1: Role of poultry to feed mankind

Conversion of feed to food.	Maize, soybeans, offal from animal industries, minerals, vitamins and many other products not readily acceptable by humans, are mixed and fed as balanced diets for broilers and layers to produce meat and eggs. Thus converting low quality products into highly nutritious food for mankind. Poultry meat is one of the best sources of protein for mankind. The low fat content of the breast meat, so-called white meat, is regarded as healthy meat. Eggs are the most balanced source of nutrients for humans. The proteins in eggs are used as standard against which all other proteins are evaluated in their ability to support growth in young animals and humans. It is also a good source of all vitamins and micro-minerals for healthy development as well as fats and oils as source of energy.
Efficient converters of feed to food.	Poultry, compared to cattle, has low energy requirements to maintain their own bodies and are therefore very efficient converters of feed to meat and eggs. That is why the price of these products has remained relatively low in relation to the cost beef and mutton.
Consumption of poultry meat and eggs.	Since 2010 more poultry meat was produced and consumed, 36.1 kg per person per year, than the combined figure for beef, mutton and pork viz 23.5 kg. Consumption of eggs is 156 per person per year.
Marketing of meat and eggs	Marketing is done by the individual producers themselves and they would normally be under contract to supply a certain amount of meat or eggs over a certain period of time. The producer is thus under obligation to deliver their goods according to a specified program and this requires exceptional good planning to place orders for replacement stock, feed and packing material, transport etc. Health management of poultry flocks therefor needs to receive the highest priority to ensure a constant level of production of meat or eggs to satisfy demands from the consumer.

Systems for meat and egg production

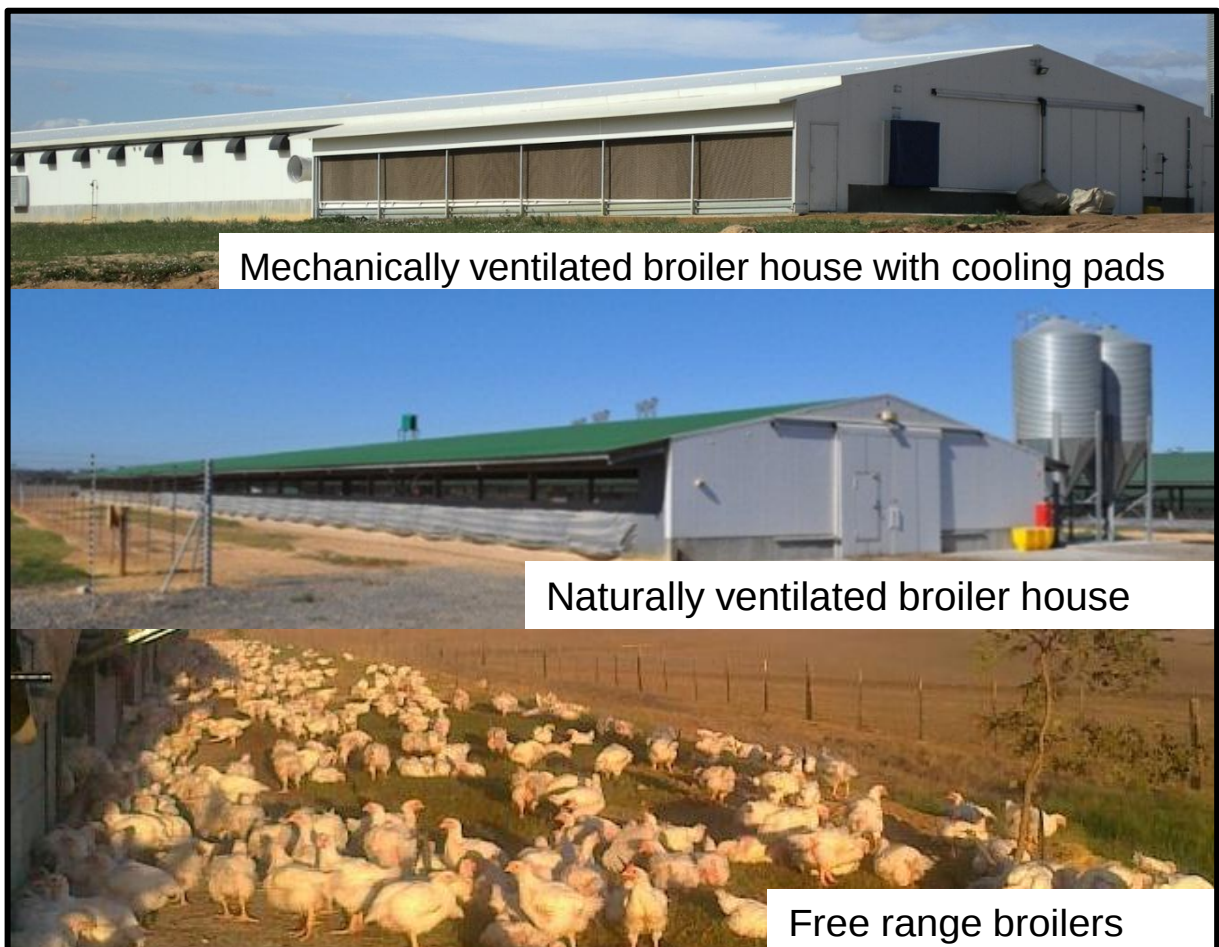
Housing of broilers

Structures vary a lot; from open-sided buildings to mechanically ventilated broiler sheds with insulated panels forming the side walls and roofs. The most important consideration for the latter type of construction is to save on fuel cost during the brooding period and to be able to cool buildings during hot summer conditions by means of extraction fans. Providing optimum environmental conditions enable chickens to put on weight rapidly and they would reach a marketing weight of 1.85 kg at 34 days of age. (Emergency generators in cases of power failures are an essential part of the operation.)

On the other hand open-sided buildings with curtains that can be closed during brooding of day-old chickens and raised during warm weather are much cheaper to erect. Ventilation of these buildings, the so-called naturally ventilated buildings however, are dependent on air movement by wind. During summer mortalities might occur if no wind is blowing.

Cost and efficiency of production play an important role when deciding on a particular type of housing. Normally broiler production is practiced under intensive conditions, in which the birds are confined to the inside of the building for the entire growing period. However, due to consumer demand, there are organizations that will allow the birds to move out of the building after the brooding period onto grassland, the so-called free-range system.

Pictures of the three types of buildings are shown below:



Housing of layers

Similar to the broiler industry housing of commercial layers will be housed in two types of buildings: mechanically ventilated in which climate control is possible by means of extraction fans and cooling pads or naturally ventilated depending on air displacement by current winds. Pullets at point-of-lay are placed in battery cages at 17 to 18 weeks of age and will remain in production for approximately one year before being replaced by a new flock of point-of-lay pullets.

The rearing of point-of-lay pullets² is done specialist organizations to ensure that the correct lighting patterns are being followed and that the body mass at point-of-lay is according to the breed standards.

Similar to the broiler industry the production of eggs under a free range system is also very commonly practiced.

Below: Inspection of hens in cages.



Modern battery cage system with automatic egg collection.



High rise building for layers in cages on the right, note openings for removal of manure from side-openings



Free range hens outside a laying house, inside view of layers and nest boxes

² A pullet is the word used for a female bird from day-old to point-of-lay when she becomes a hen or a layer.

The production cost of eggs under free range is higher because of the higher feed intake by hens due to the higher energy requirements for energy spent on walking.

Table 2 Summary of terminology

Eggs	This product of the poultry industry is regarded as the most balanced source of nutrients for humans
Broilers	The term used for meat-type poultry slaughtered for meat
Breeders	Those birds that lay fertile eggs for day-old broilers or day-old pullets
Hatcheries	The places where chickens are hatched and they play an important role to maintain biosecurity in the supply chain of poultry meat and eggs
Mechanically	The term used for those broiler houses that are ventilated by electric fans
Naturally	This term describes the type of ventilation that depends on wind for air movement
Pullets	The word used for female birds from hatch to the point of lay

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South African Poultry Association

The South African Poultry Association (SAPA) was established in 1904 in Kimberley, mainly as a body of poultry “fanciers” to co-ordinate and promote, show holding and later to stage egg laying tests, and to provide an instrument to voice the feelings of the industry.

Historically, poultry was very much part of the South African scene. Thousands of people kept poultry, and it was seen as backyard industry. Of the largest units kept between two and four thousand birds under extensive conditions. Therefore, poultry clubs consisted of people from all walks of life who considered poultry also as a hobby. A number of poultry clubs were in existence, arranging competitions and shows. The main functions of the South African Poultry Association would thus be composing and formulating show rules and regulating the appointment of judges.

Early Years

The early years were difficult and turbulent, and the main issues always emerged as area representation and decentralization of management. Despite clashes between exhibitors and “commercial producers” – a bad word at the time – the Association forged ahead. A South African Poultry Breeders Register was established in 1926, and in 1936 assurance was given that Government would definitely recognize SAPA as the representative organization of the industry. At SAPA’s request the Egg Control Board was established in 1951. The Poultry Bulletin was published by SAPA as its mouthpiece since 1937. Previously the Association selected various existing outside magazines to air its views.

SAPA Vision and Mission

- **SAPA Vision**

To create a viable and sustainable industry contributing to economic growth and development, employment and food security, based on successful producers adhering to environmental and ethical production norms and generating sustainable profits.

- **SAPA Mission**

To create an enabling environment to achieve sustainable producer profits in the domestic and global village market. As a representative association, the South African Poultry

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Association (SAPA) serves the interests of the poultry industry in a number of ways. SAPA acts as a medium and catalyst for any matter the industry wishes to collectively address. It acts as the face of the industry, addressing and maintaining a presence in society without which opposing groups could play havoc with the industry's interests - without opposition.

The role of the Developing Poultry Farmer Organisation in the poultry industry”

To facilitate the entry of emerging poultry farmers especially those from the PDI's into the main stream economy.

How

This will be by providing poultry farmers with the resources necessary for managing successful poultry farming enterprises.

Aim

To promote access to finance for members, lobbying for the establishment of resource centres in each region to ensure sustainable poultry and egg production in each area, train and develop emerging farmers in their communities on all egg and allied industries including production, grading, packaging, transport, storage & marketing, assist farmers in securing profitable production and supporting sustainability of businesses, organise seminars and courses to establish and enhance a learning culture amongst all poultry farmers, publish literature, journals pamphlets and circulars dealing with all matters pertaining to the developing poultry sector, conduct and assist in practical and scientific investigative work, facilitate, lobby and communicate with national and provincial government agencies and the donor communities highlighting the plight of all developing farmers in south Africa and to lobby government to implement legislation and regulations that are beneficial to developing farmers and allied industries and negotiate discount on production inputs on behalf of its members.

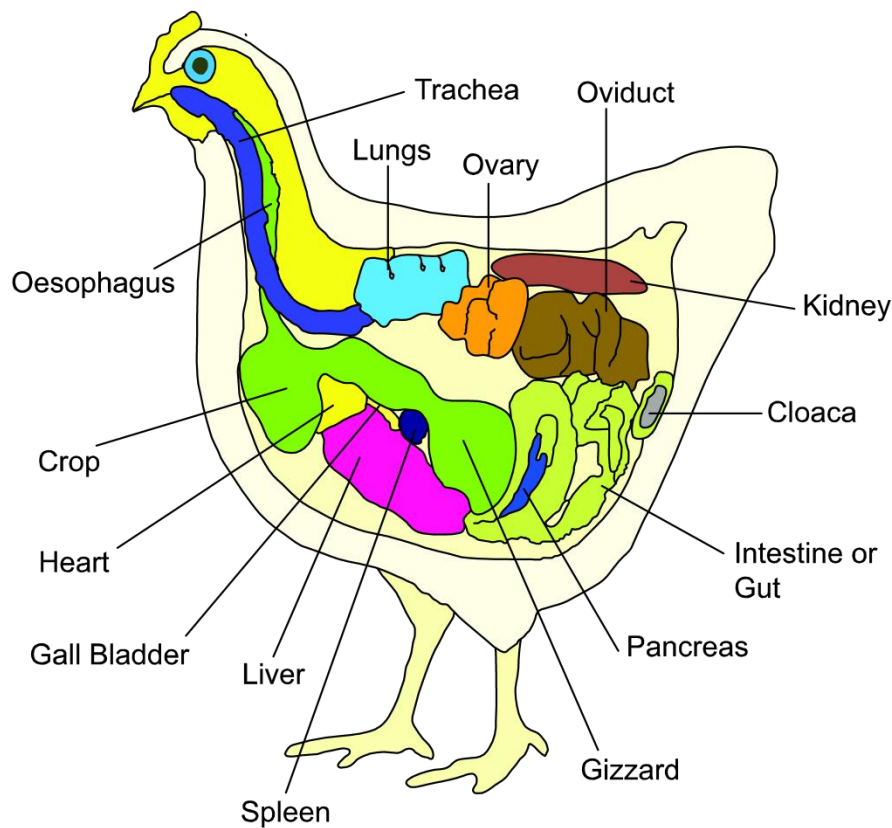
Note to the learner

Congratulations you have completed the first module introducing you to the South African Poultry Industry. Take some time to reflect on where you currently fit into the industry and what role you would like to play in this exciting industry.

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ANATOMY AND PHYSIOLOGY OF THE HEN



Startup Farming

1. Anatomy and Physiology of the Hen

Introduction

The word anatomy means structure of the body and the organs in the body of the hen. Physiology has more to do with the functioning of organs of the body, for example the digestion of and absorption of feed. This knowledge is essential not only to enjoy your work more but also to empower you to be in a better position to identify problems and to provide conditions for good production results.

The external body parts

The external organs include the skin, eyes, ears, nostrils, comb and wattles and will be discussed first before proceeding to internal organs such as the digestive tract, reproductive system etc.

Cells are the real working units of the body and all tissue consist of cells:

Cells of muscle tissue are able to contract (shorten itself) to cause movement of the legs, wings etc.

Liver cells make (produce) substances such as egg yolk (the yellow material of an egg).

Cells lining the mouth cavity secrete saliva (moisture) to enable the bird to swallow feed.

Skin cells consist of several layers of which the outer layer is tough and dry and protects the body.

The cells in bone are filled mainly with calcium to make bones strong to carry the weight of the bird.

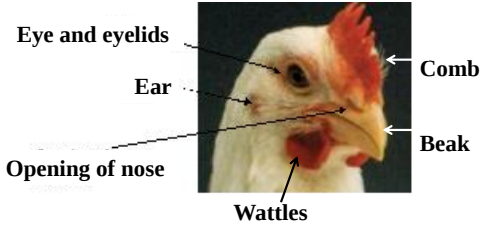
Important knowledge:

The **tissue** of all organs consists of **cells** that enable that organ to perform its function.

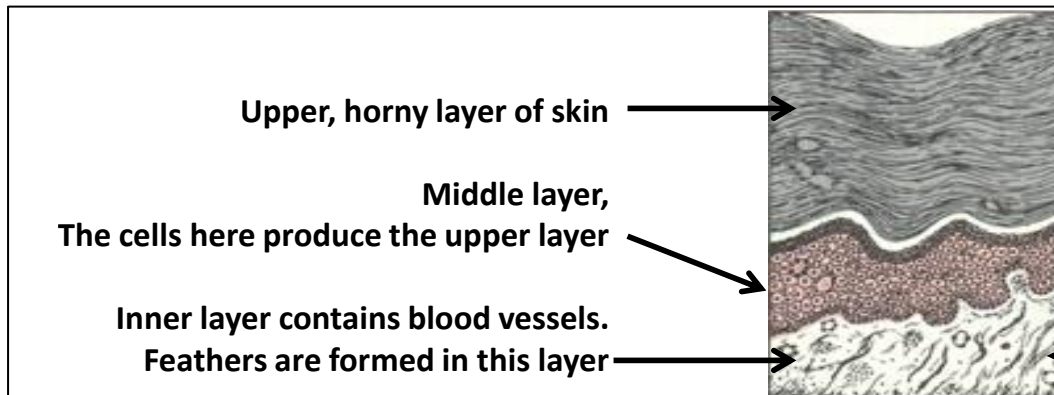
In young chickens **growth is the duplication of cells** of the various organs but in adult birds cells are constantly renewed.

Cells receive **nutrients** from feed by means of the **blood stream** for their duplication.

The **chemical reactions** taking place inside cells result in **heat** being produced. This is the origin of the warmth of a living animal.

	
The comb and wattles are well supplied with blood vessels. Cool air moving over these areas removes body heat. These organs assist with body temperature regulation in hot weather.	

The skin: Two functions, protection and regulation of body temperature



Protective function: The outer horny layer has no blood supply, scratches through this layer will not result in infection but into the deeper layers infections will occur.

Feathers growing from the skin have an insulating effect and protect the bird from losing heat to the environment during cold conditions.

The function of the skin is to protect the bird from losing moisture to the environment and also in the regulation of body temperature.

Poultry do not have sweat glands like humans or horses or cattle. During very hot weather they pant with beaks open to lose moisture from the mouth where cooling then takes place.

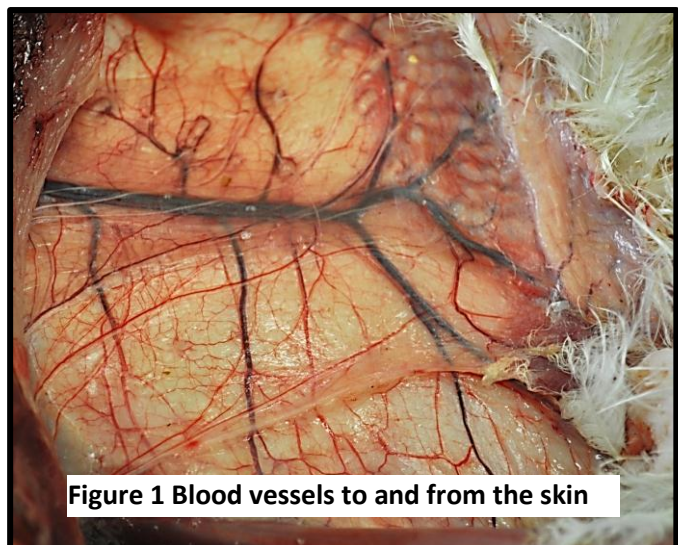
Regulation of body temperature: The skin is very well supplied by blood vessels, and that causes the skin to be warm.

Cool air moving over the hot skin would thus cause cooling of the skin and cooling of the blood that flows back to the inner organs.

It is often seen on hot days that the hens would raise their wings to allow air movement over the skin.

Important to realise cooling can only take place if the air temperature is cooler than body temperature of the bird.

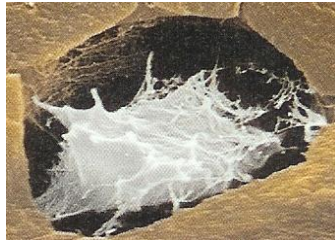
The normal body temperature of the hen is 42 °C and the ideal temperature in the laying house is 25 °C.



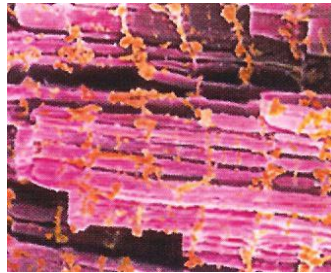
**Red blood
cells**



Bone cells



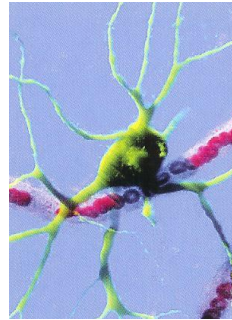
**Muscle
cells**



Fat cell



Nerve cell



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The skeleton of the bird.

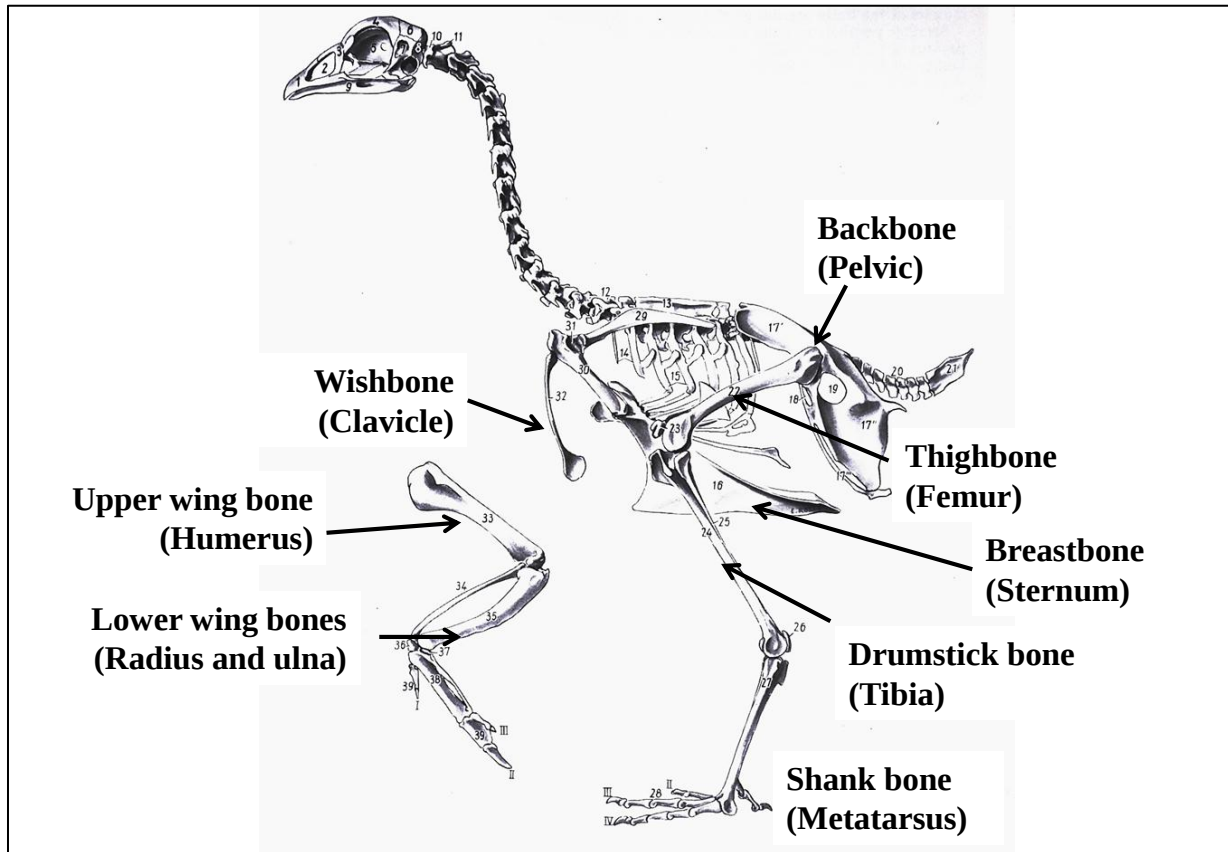


Figure 2 Skeleton of an adult chicken

Important knowledge:

The bones of the skeleton¹ consist of cells that contain the two minerals, calcium and phosphorus, and that's why bones are almost as hard as stone.

The skeleton is a framework of bones to which muscles are attached.

The skeleton provides rigidity (firmness) to the body.

The skeleton provides protection to internal organs, for example the digestive tract, heart, lungs, kidneys and the reproductive system, etc.

Contraction of muscles results in movement of those bones to which the muscles are attached. All kinds of movement are brought about by such contractions: walking, flapping of wings, movement of the neck and head to pick up feed or to drink.

Also for respiration where the body cavity is contracted to expel air or can be expanded to inhale air.

¹ The calcium of these cells can be withdrawn into the blood and utilized in the formation of egg shells. The bones of hens at the end of their laying year are thus very thin and will break if handled roughly. That is why hens should be removed carefully from the cages and caught and carried by both legs.

The internal organs of the hen

Look carefully at the position of the organs inside a hen, Figure 3.

In the section that follows we shall be studying the functions of the internal organs. This will not only be a very interesting exercise to know what happens to feed and water after it has been consumed, but you will also enjoy to know more about the internal processes that take place in organs such as the lungs, the reproductive system how eggs are formed and how body temperature is regulated.

You will also learn more about those organs that are involved in protecting the hen against diseases, the immune system.

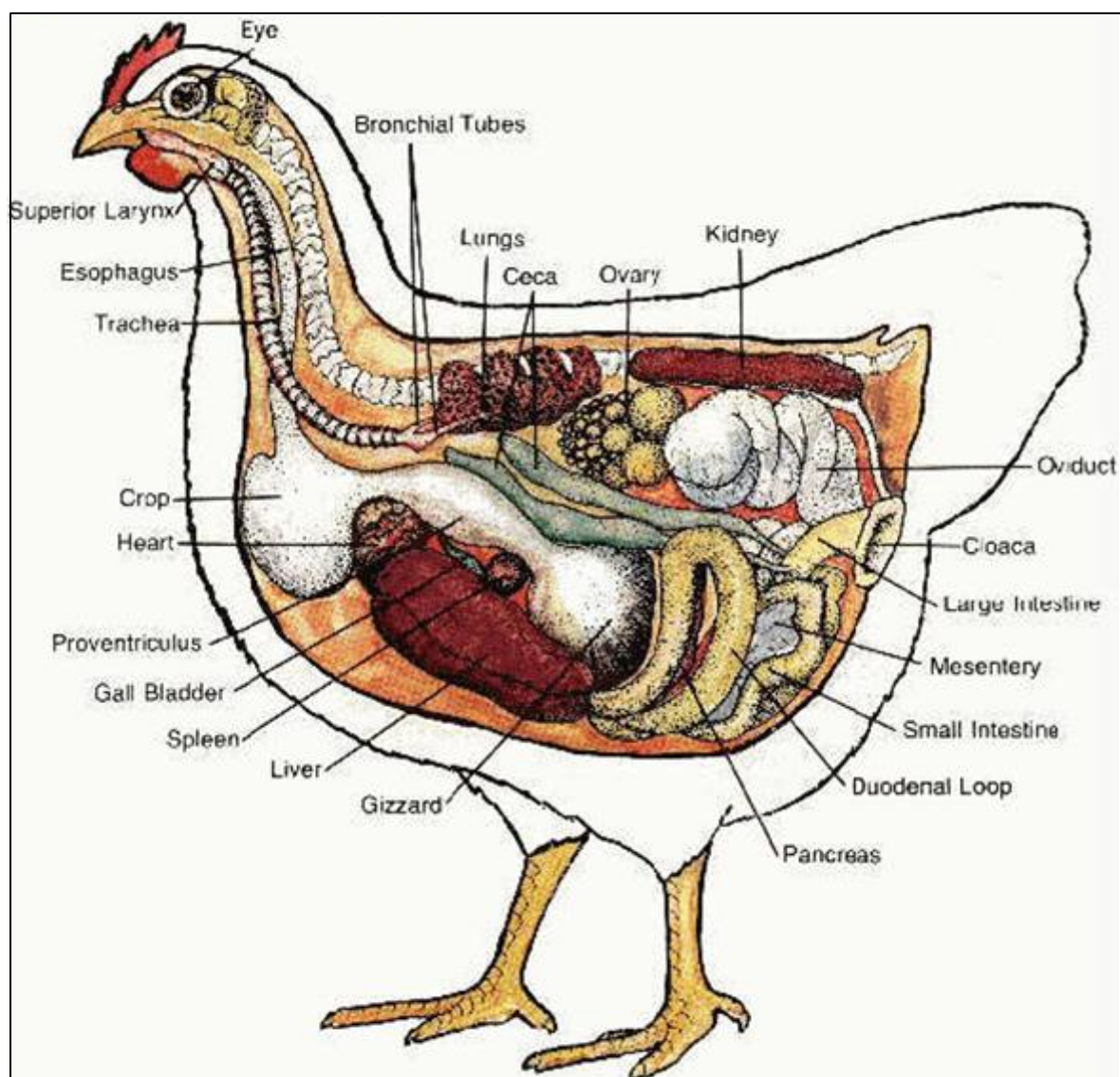


Figure 3 Cross-section through the body of a hen.

The digestive tract²: A critical link from feed to maintenance of the body and formation of eggs.

The function of the digestive tract is to digest feed and to make substances available that can be used by the hen to grow into maturity, to form eggs and to maintain her body. The following are substances present in the body, see Table 1.

Table 1 Composition of the young pullet's body

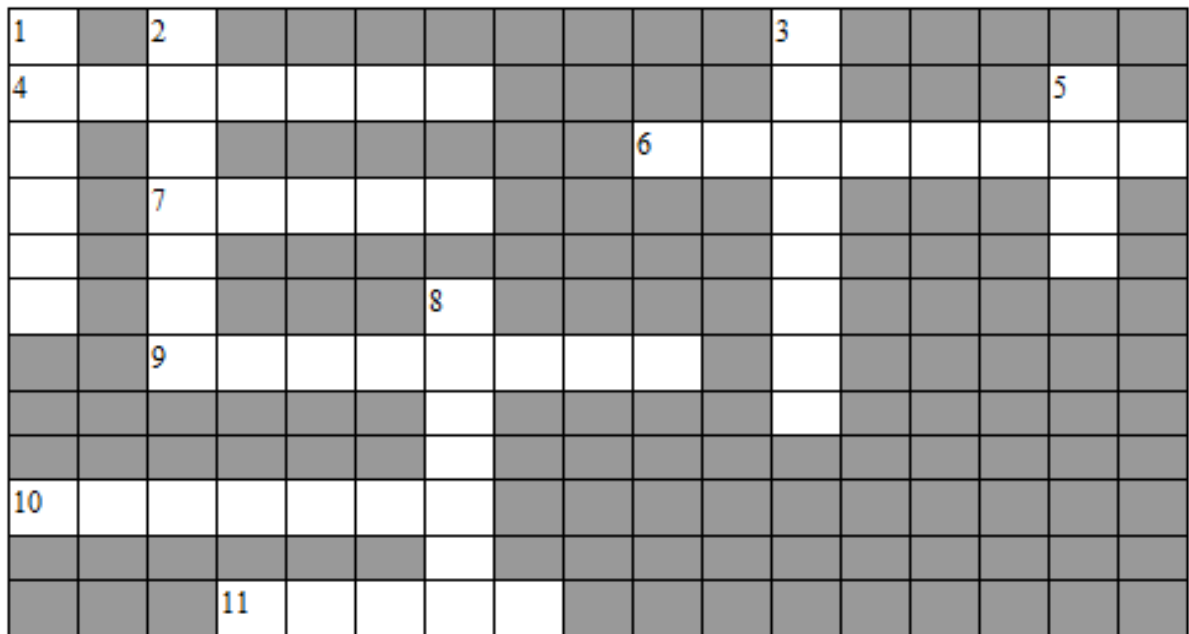
	Water.	In a 100g of body mass water amounts to	65g
	Fat.	In a 100g of body mass the fat amounts to	15g
	Minerals.	In 100 g of body mass minerals (mainly calcium and phosphorus) amounts to only	4g
	Proteins.	In a 100g of body mass proteins amounts to	16g
In summary	When looking at a hen, everything you see, whether from outside or in an opened bird, if something is not fat, minerals (as in bone tissue) or water (in blood or as wet tissue), then it is protein. Proteins are chemical substances that have different compositions and that is why various tissues such skin, muscles, feathers, liver, ear lobes are so different in function and appearance: their proteins differ in composition.		

Body substances: their origin and functions		
Substance	Origin	Function
WATER	Supplied by the water lines.	All the many reactions inside cells of an organ ³ can <u>only take place</u> in a watery medium.
FAT	From starch and fats in feed	Source of energy and used to produced yolk fats
MINERALS	Limestone and calcium phosphate	Formation of bones in the skeleton
PROTEINS	Digestion of feed proteins, for example soya proteins, into amino acids.	Amino acids are used by body cells to make body proteins for: muscles, feathers, skin, liver tissue, proteins in eggs etc etc.
Whenever an action takes place, such as walking or the formation of proteins for egg yolk, it means that energy was required to drive those reactions. That energy was obtained from glucose. Glucose is the universal source of energy for all living people and animals.		

² Another term is the gastro-intestinal tract.

³ An organ:such as the oviduct, **Figure 3** where egg white is formed or the heart that pumps blood.

Test your knowledge memory challenge number 1



Clue Across	Clue Down	
	1	Fluid secreted by cells in the mouth of the chicken
	2	One of the main minerals in bone cells
	3	The type of reactions responsible for the warmth generated in the body
	5	The feather-like structures with which the day-old chicken hatches
	8	One of the four components of the body that is not water, minerals or fat
4		Word describing the structure of the body
6		The framework protecting inner organs of the bird
7		The working units in tissue of organs
9		One of the four components of the body that is not protein, water or fat
10		This substance serves as the source of energy for a chicken
11		These acids are the building blocks of proteins

Startup Farming

The functions of the different parts of the digestive system

Mouth and crop

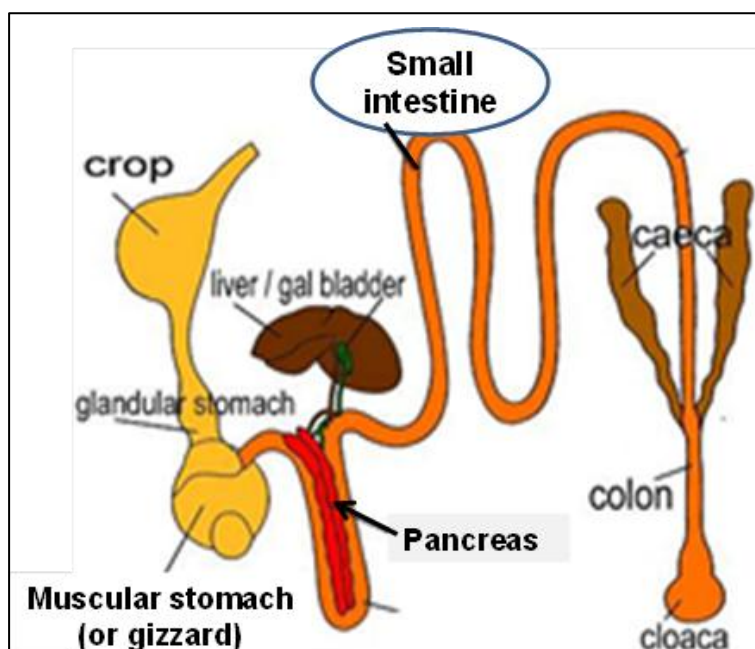
Important knowledge  Refreshing your mind	Digestion is the process by which nutrients in feed is made available for absorption into the body: Proteins in feed are digested to amino acids. Starch in feed is digested to glucose. Fat is digested to fatty acids. (Water and minerals are not digested but absorbed as such)
--	--

The feed is picked up and swallowed by means of the tongue.

Salivary glands⁴ in the mouth secrete mucus (*slym*) to enable passage of feed down the tract. **(Read the footnotes indicated by subscripts.)**

The hen has taste buds on the tongue and can distinguish between different flavours.

It prefers sweet but will reject a bitter taste. Although taste does not play a very important role in the control of feed intake by birds, they will reject feed that has become rancid⁵ or feed containing high levels of salt.



The crop serves as storage organ and no digestion takes place there. However, it is in the crop where feed is mixed with water to soften feed particles to enable the penetration of acid⁶ which improves the digestion process, availability of water is most important.

⁴A gland consists of cells capable of producing and secreting products such as mucus (saliva, spit) in the mouth.

⁵Rancid means the fat has developed a bad smell during storage

⁶Hydrochloric acid. (*soutsuur*) This is the acid also used in the water purification plant to adjust the pH of the drinking water.

Glandular stomach (or proventriculus)

This is the first section of the gastrointestinal tract, see **Error! Reference source not found.** or Figure 4, where digestion really begins. Digestion means *breaking up* into small absorbable substances. For example the digestion of feed proteins to amino acids. (Amino acids can be regarded as the building blocks of proteins.)

Muscular stomach (or gizzard)

The gizzard with its strong muscles and tough inner lining is very effective to grind tough particles into a pulp onto which enzymes can react very efficiently during the digestive process.

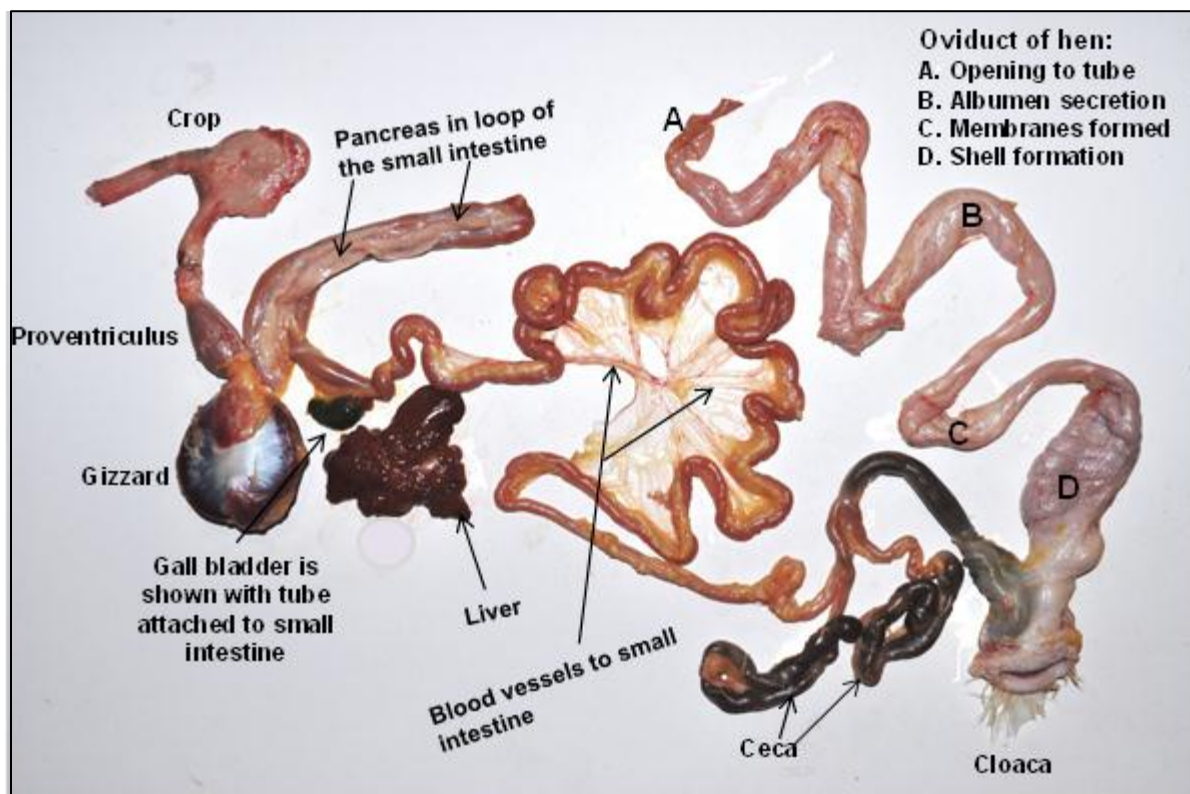


Figure 4 The digestive tract and oviduct of the hen

Small intestine and enzyme actions

In the small intestine most of the digestive reactions and the absorption of nutrients take place. The inner wall has finger-like structures that secrete (produce) a variety of enzymes that react with feed proteins, starch and fats to digest these components.

The reader might know that meat tenderizer (commonly found in many kitchens) contains enzymes that are capable of digesting (breaking-up) those tough white strands of connective tissue in meat to make it tender.

The pancreas.

Keep in mind that the pancreas, the organ that lies in the loop of the small intestine, also plays a most important role in the production and secretion enzymes. These enzymes flow via a tube into the small intestine where they also act on starch, proteins and fats in the feed to enable the bird to digest feed very efficiently.

The only substance that cannot be digested is the fibre layer surrounding a mealie or wheat kernel.

Gall bladder (*galblaas*)

This sac-like organ is attached to the liver and can easily be recognised by its bluish-green colour. Gall is produced by the liver and the function is to break up fats and oil into very small droplets that mix with water. The reaction between enzymes and the fat can then take place to break it down into fatty acids.

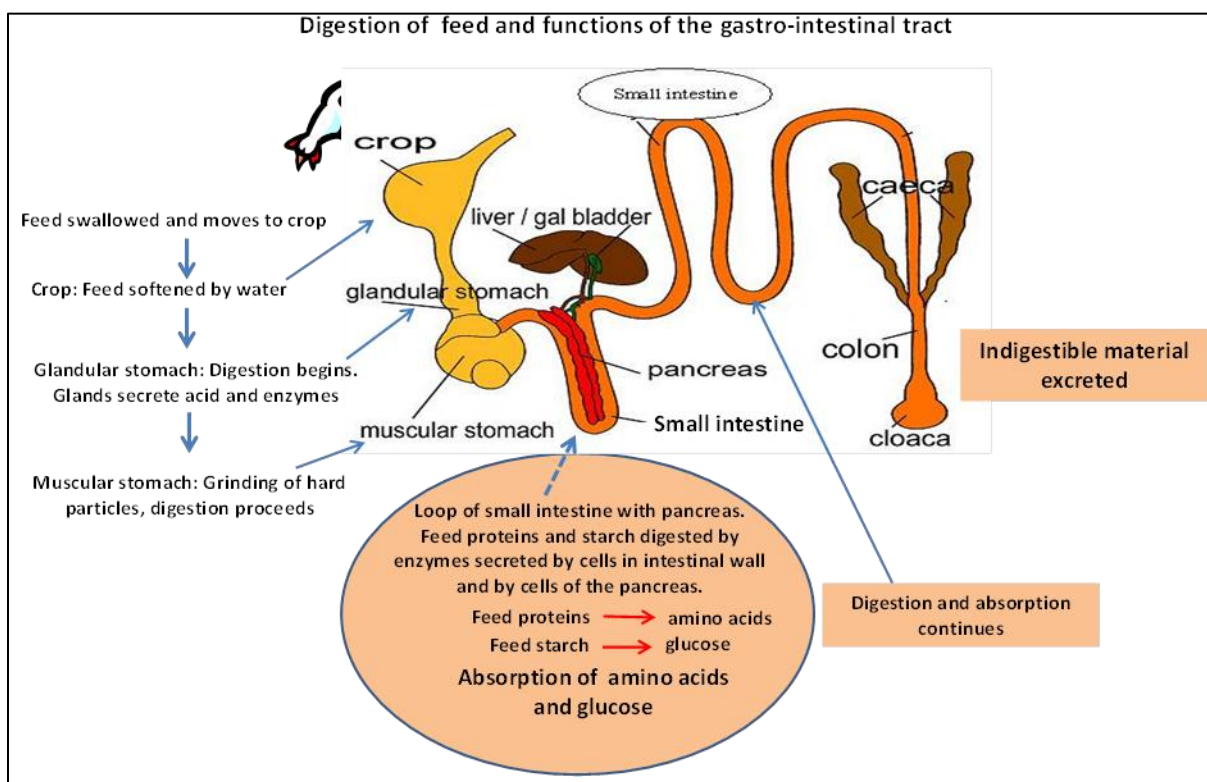
Caeca and colon

The lower portion of the intestinal tract consists of the two caecae, and the colon. No absorption of nutrients takes place here. Only water can be absorbed in the very lowest part of the colon, close to the cloaca, and this saves the amount of water that a bird has to drink to transport indigestible material through the gastro-intestinal tract.

The cloaca

The cloaca, also known as the vent, serves as a temporary storage organ of the indigestible feed residues and uric acid. In adult males the sperm ducts (tubes), or in females the tube (oviduct) in which the egg is formed, also have their openings in the cloaca.

A summary of the digestive process is given in the picture below.



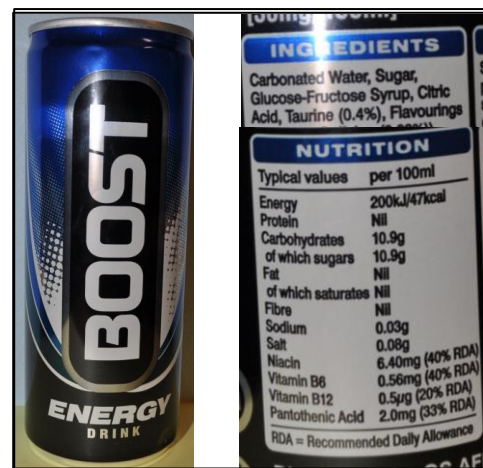
Household items: starch, glucose, protein and enzymes.

Maize meal and maize starch are very common items in most kitchens, maize starch⁷ or “Maizena” is a firming agent in gravy. In the intestinal tract of the hen starch has to be broken down by enzymes to glucose before it can be absorbed and used as energy source by the tissue cells.



Glucose

Is indeed also a very common item used in sports drinks or beverages to supply energy, such as in *Boost*. The ingredients list show the following composition: Carbonated water, sugar, glucose-fructose syrup, citric acid etc. Energy content is 200 kilojoules / 100 ml



Protein in the household.

Gelatin is a pure protein and dissolves in hot water. It is used for making jelly or puddings. It occurs with other proteins in tendons⁸, that tough, white tissue at the end of a muscle and is normally the attachment to the bone.

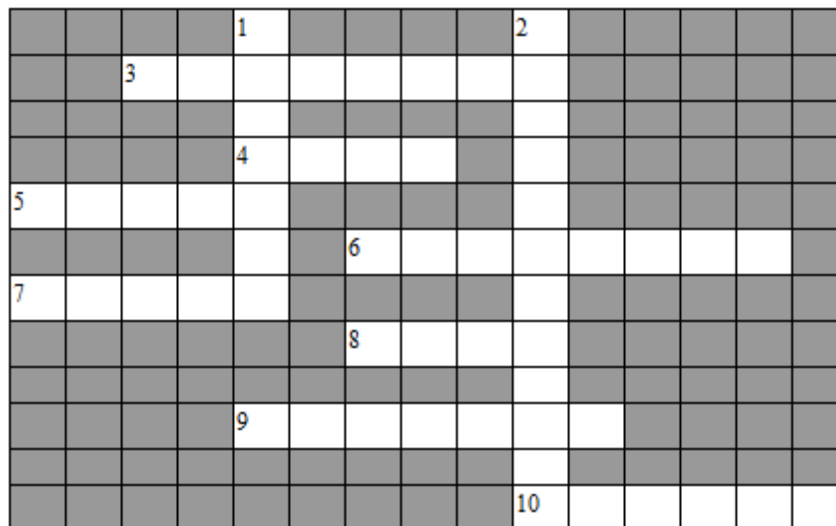
Enzymes can be bought in pure form. On a bottle of meat tenderiser you will note in the list of ingredients it contains salt, a number of other substances, and *proteolytic enzymes*⁹. The client is advised to allow 30 minutes after the meat tenderiser has been rubbed into the meat before cooking or roasting the meat. The toughness in meat is caused by tendons. They are those white threadlike structures in the muscle that are connected to the bone, in other words they are part of the muscle. The chemical reaction between the enzymes and those proteins of the tendon takes time to be broken down, thus the reason for time to allowed for the reaction to take place.

⁷ Starch is also the major component in products such as rice, potatoes, wheat and oats and there are indeed also many industrial uses for starch in foodstuffs and in glues.

⁸ Tendons are described as connective tissue and consist of collagens, the collective name for a number of proteins in connective tissue. One of these proteins is gelatin and is extracted by an industrial process of filtration.

⁹ Proteolytic enzymes: chemicals that are able to digest proteins, break them up into their smallest building blocks

Test your memory challenge number 2 on the functions of the different parts of the digestive system.



Clue Across	Clue Down	
	1	This is the source of energy used by cells and is the result of the digestion of starch
	2	The acid secreted by the wall of the glandular stomach that assists with the digestive process
3		Glands that secrete saliva
4		In that part of the digestive system feed is softened by water
5		Acids resulting from the digestion of proteins
6		The organ in the loop of the small intestine that produces enzymes for the digestion of proteins, fats and starch.
7		This material cannot be digested by enzymes and excreted in the faeces
8		Produced by the liver to break fats up into small droplets to for enzymes to react with the fat.
9		The organ that grinds feed to increase surface areas on which enzymes can act to digest proteins, starch and fats in feed.
10		The last part of the gastro-intestinal tract where water that was contained in faecal matter, is absorbed.

The urinary system of the hen: the kidneys.

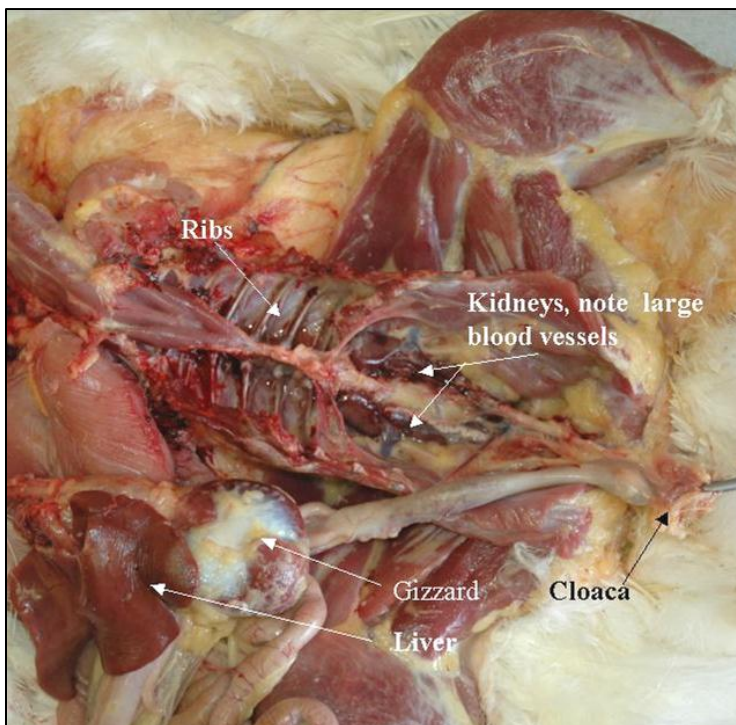
In poultry the white topping on the faeces is the hen's *urine*. It consists of uric acid, and is stored as a paste in the cloaca and excreted with the faeces.

Important knowledge.



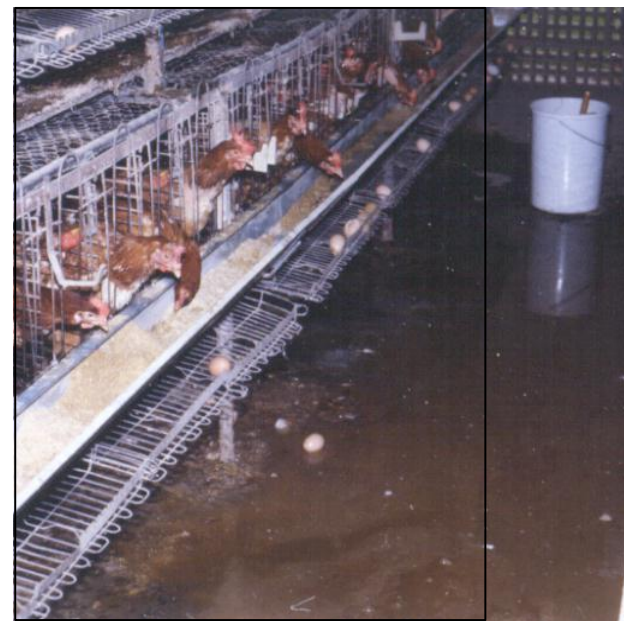
Uric acid is the waste product from chemical reactions inside body cells and is passed into the blood stream.

Function of the kidneys is to remove uric acid from the blood by means of filtration.



The kidneys, see picture on the left, have the ability to separate uric acid particles from the blood by means of a filtration process into the urinary tubes that run to the cloaca.

During serious dehydration¹⁰ (read the footnote) uric acid crystals will block the tubes in the kidneys as well as those running from the kidneys to the cloaca. **Access to drinking water for hens is of utmost**



importance.

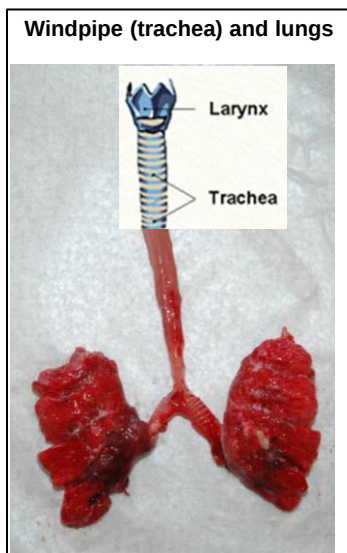
Feed containing exceptionally high levels of salt due to mixing errors, will result in birds consuming large quantities of water. Salt is soluble in water (unlike uric acid!) and the kidneys excrete the salt as a watery solution. (One should not be mistaken to see the situation as diarrhoea because of the watery appearance of the excreta.)

In poultry houses with wet bedding material, bacteria acts on uric acid and convert it to ammonia gas. Under dry conditions these reactions by the bacteria cannot take place.

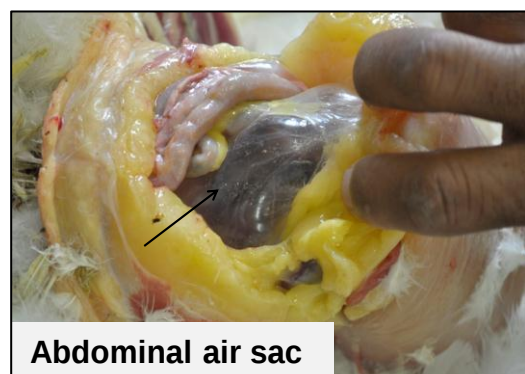
¹⁰Dehydration is when the bird has lost water from the body cells. This can happen during excessive panting in hot weather or accidental water restriction for prolonged periods of time.

Respiratory system: lungs and air sacs

Important knowledge. 	Chemical reactions in body cells use oxygen¹¹ to obtain energy from glucose¹² and carbon dioxide is produced during this combustion process. Oxygen is carried by the blood to body cells and exchanged for carbon dioxide. In the lungs the carbon dioxide is given off to the inhaled air in exchange for oxygen.
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The extraction of oxygen from inhaled air is very efficient in poultry. The lungs are connected to a number of air sacs in the body cavity, which enables the bird to extract oxygen twice from inhaled air. Firstly during inhalation and then again when air leaves the body, in other words during exhalation. A picture of the abdominal air sac is shown in the above picture.



During combustion of glucose to obtain energy, heat is generated and these reactions are the source of heat that enables the body to maintain a temperature of 42 °C.

The fact that heat production is an on-going process (as long as the bird is alive), heat has to be given off constantly to air surrounding the bird; this is to prevent the temperature of the bird from increasing. It stands to reason that if the temperature of the surrounding air is high, say 30 °C, the flow of heat from the body to the surrounding air will not be very effective and the body temperature of the bird will start to increase and the birds will start panting to lose body heat.

¹¹Oxygen is only required as long as the animal is alive, when death sets in no more O₂ is needed!

¹²Glucose can be regarded as the fuel for animal cells. In a car's engine the petrol is combusted to obtain the energy locked up in the petrol, oxygen is also required and carbon dioxide is produced. An almost similar situation in body cells except that no real fire is produced but the chemical energy locked up in the glucose comes free with accompanying heat.

An important aspect with regard to the fact that poultry breathes air into air sacs of the body cavity is the danger of inhaling bacteria such as *E. coli* that can cause an infection in areas close to the intestines, the liver and reproductive tract.

To have low dust levels in the air is thus a measure to try to limit bacterial infections of the air sacs.

A picture with an *E. coli* infection in the body cavity that has spread from the air sacs to the internal organs, is shown in Figure 5.



Figure 5 Chicken with *E. coli* infection in the body cavity.

The blood circulation system

A simplified approach would be to view the blood system as a pipe-work of tubes, starting at the heart and branching off to enter and diffuse (getting smaller and smaller) into the tissue of organs. Inside they converge (come together again) to form veins that return the blood to the heart.

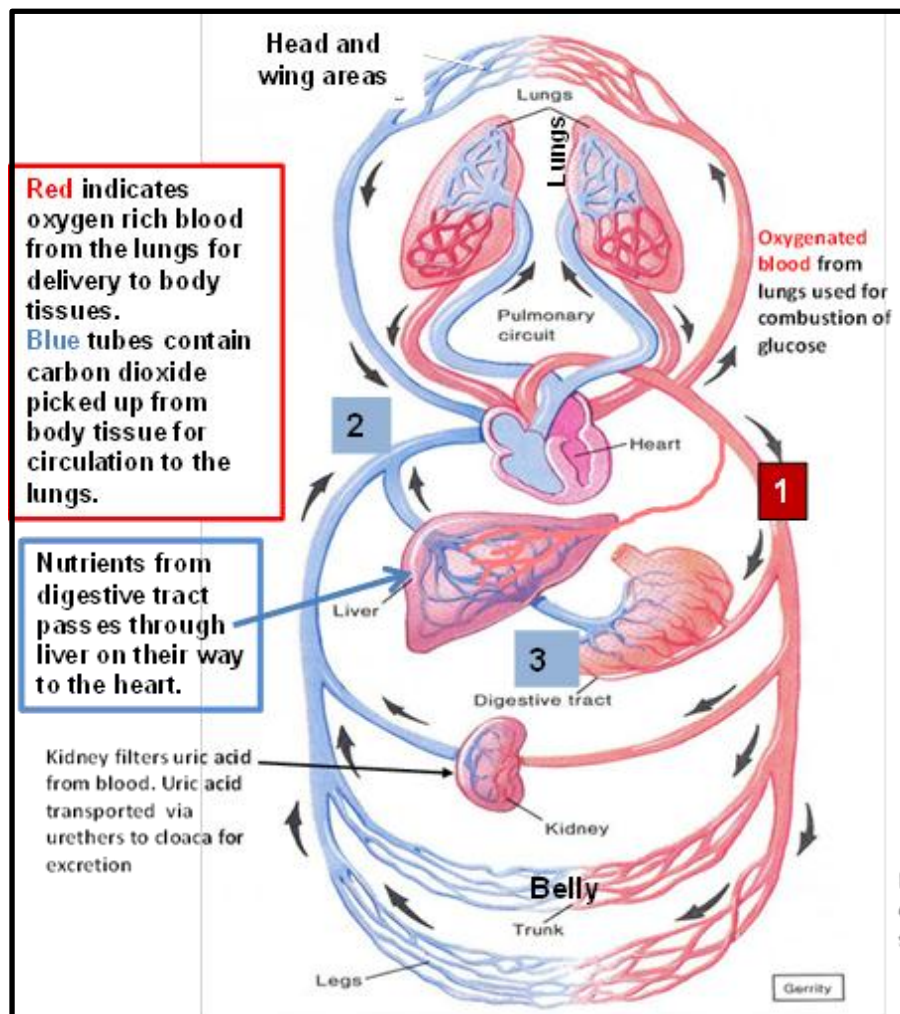


Figure 6 Illustration of a blood circulation system

Identify the functions of the blood circulation system from the sketch in Figure 6 and take note of the direction of blood flow by looking at the arrows:

1. The heart pumps oxygen-containing blood (**box 1**) to tissues of the various body parts where oxygen is given off and carbon dioxide picked up and blood returns to the heart.
2. The carbon dioxide-containing blood (see **Box 2**) returns to the heart and pumped to the lungs. Exchange of carbon dioxide for oxygen takes place and returns to the heart.
3. Nutrients from digested feed is picked up in the digestive tract and transported to the liver and heart for distribution to body tissues (see **Box 3**).
4. Transporting heat from inner organs to the skin. This is not illustrated in Figure 6 but amply discussed in paragraph 0 and illustrated in Figure 1 on page 3. The rate of heat loss from the skin will obviously be determined by the difference in temperature of the body and the surrounding air. It is important to understand what is illustrated by the blood supply to and from the skin as a method of maintaining a constant body temperature by the hen.

The brain and nervous system

The brain and nerve system can almost be seen as a manager with many telephone lines to various body parts and organs inside the body. The brain receives messages by means of nerves that are connected to many organs and muscles and act to avoid injury or discomfort in a particular situation. Loud noises for example will be perceived by the brain as danger and it would send a message via the nerve cells for muscles of the legs and wings to contract and to run or fly.

In a situation of hunger the message will be stimulated by sensors that react to low levels of glucose in the blood and the bird would go to the feeder line for feed, or simply the fact that coarse maize particles are visible can stimulate the hen to eat it. External factors such as lighting patterns have a huge effect to stimulate the brain to produce hormones¹³ that affect the development of sexual maturity in poultry. When pullets are reared under an increasing light pattern (day lengths becoming longer such as after the winter) the pullets will come into production at a very young age. The eggs will be small and cannot be marketed. The normal practice is thus to rear pullets in window-less houses with only 9 hrs light from one week of age to 14 weeks and to stimulate production thereafter by increasing the light period in small increments of one hour to a maximum of 14 hours at 22¹⁴ weeks of age.

The brain responds to fear or stress (for example low levels of disease) and glucose levels in the blood become low. If birds are vaccinated under such conditions immune development is poor because of shortage of glucose (energy) to produce antibodies in response to the vaccine.

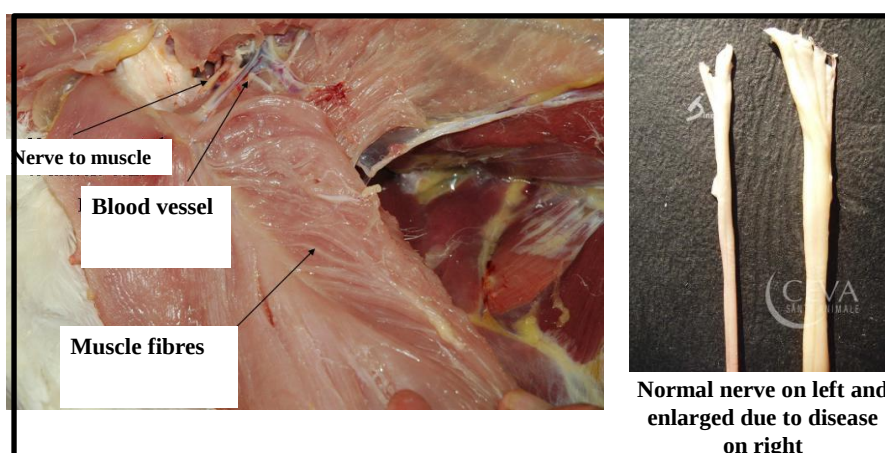


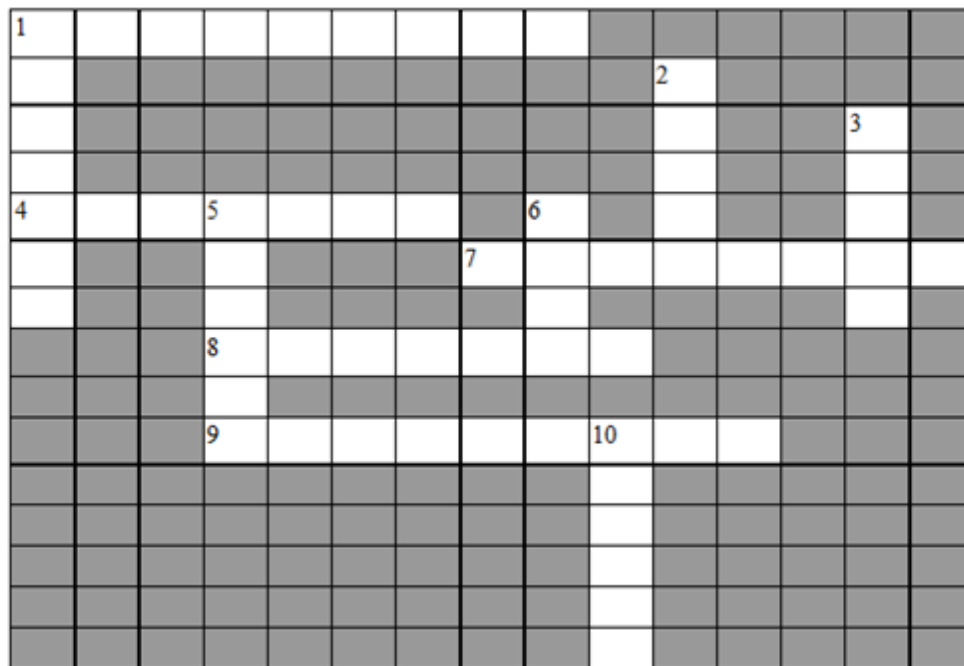
Figure 7. Left: Nerve connected to muscle. Picture¹⁵ on the right: Two pieces of nerve strings.

¹³ Hormones are proteins that stimulate the liver to produce material for yolk formation for follicles in the ovarium.

¹⁴ These figures are approximate and do vary between different pullet rearers.

¹⁵ Permission to use this and other pictures with the CEVA water mark was kindly granted by Prof. Ivan Dinev, Dept. of General & Clinical Pathology, Faculty of Veterinary Medicine, Trakia University, 6000 Stara Zagora, Bulgaria. E-mail: idinev@uni-sz.bg.

Test your knowledge memory change number 3



Clue Across	Clue Down	
	1	These tubes are blocked by uric acid in dehydrated chickens
	10	A network of these cords transmit messages to and from organs in the body
	2	The organ responsible for blood circulation
	3	This organ receive and send messages on signals from other organs in the body
	5	A gas that is essential for the combustion process of glucose inside body cells
	6	Air is inhaled into these body cavities that are connected to the lungs
1		Product of chemical reactions inside cells and excreted by the kidneys
4		A gas produced by bacteria in wet bedding
7		Disease causing organisms that can be inhaled into the air sacs
8		Energy for the functioning of body cells is obtained from this substance
9		The end products of feed digestion that are transported by the blood stream to body cells

Immune system of the hen

The word immunity means to be protected. It means that if a hen is immune against a particular disease it is protected against that disease.

Poultry have several organs and systems that form the immune system. These organs are able to produce antibodies in response to a vaccine.

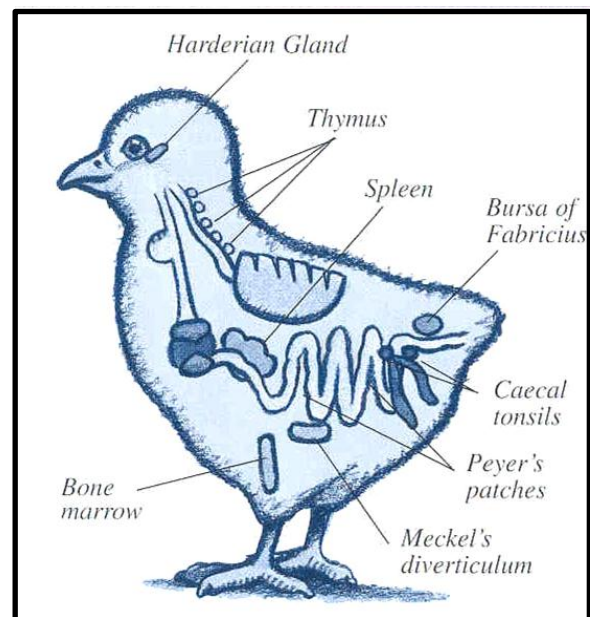
Important knowledge 	Antibodies are chemical substances consisting of proteins.
	Specific organs make antibodies (for example bursa of Fabricius, the thymus glands, the bone marrow, the spleen, etc).
	Antibody production is stimulated by applying a vaccine to the birds.
	Antibodies attach to a disease causing organism and will render it harmless before it causes a disease.

Production of antibodies

Antibodies are proteins. You will also recall that proteins are chemical substances, occurring widely in nature.

Organs that produce antibodies.

Organs involved in the production of antibodies are for example the Harderian gland, the thymus glands, the spleen, the cecal tonsils, the Bursa of Fabricius or the gland-like tissue in the gut wall, known as Peyer's patches.



Stimulating antibody production. Protecting a bird against a disease).

The organs involved in antibody production can be stimulated by putting a vaccine into the blood stream. When the vaccine passes through the tissue of, for example the thymus glands it will start making antibodies against that disease causing organism of which the vaccine was made.

The amount of vaccine that had penetrated the system (body) of the hen is most important: too little will result in low numbers of antibodies formed and the bird will be poorly protected. Too much

on the other hand can make the birds sick because a vaccine contains the disease causing in a weakened form.

A vaccine is the weakened form of a disease causing organism, for example a virus. It does not make the bird sick if the recommended amount is given, it only causes the production of antibodies to fight the virus when it enters the bird in its original strong form.

How is the bird protected by antibodies?

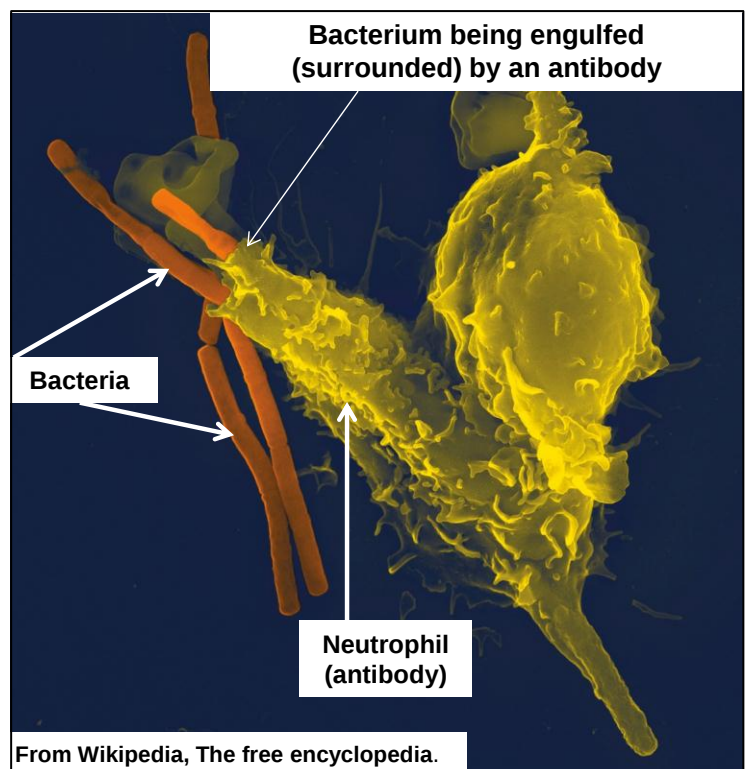
Birds vaccinated against the Newcastle disease virus will have antibodies floating in their blood stream. When the Newcastle disease virus is transmitted onto a farm and penetrates the blood stream of the birds, the antibodies in the blood recognizes these viruses.

Antibodies attach to the viruses and destroy them.

The degree of protection depends on the number of antibodies floating in the blood stream. The term to describe this is level of immunity, the higher the number of antibodies the better is the level of protection.

The picture shows an antibody binding to a bacterium to render it harmless. The antibody will not be able to destroy or bind to another bacterium and this stresses the importance of having many antibodies in the blood, in other words a high level of immunity.

The intake of the correct amount of vaccine by each and every bird is therefore most important.



Reproductive system of poultry

The Male

This material will enable you to understand the reproductive system of poultry and will include the following aspects:

- Formation of sperm in the male.
- Growth of the female reproductive cell, the ovum.
- Fertilization of the female ovum.
- The formation of an egg.

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Terminology:

Sperm – The reproductive cell of the male.

Ovum – The reproductive cell of the female, in everyday language referred to as the “yolk”.

Ovary – Organ in the female containing female reproductive cells, the **ova**.

Oviduct – Tube in which albumen, shell membranes and shell is secreted and deposited around the ovum

Egg – Shell with contents.

The male reproductive system.

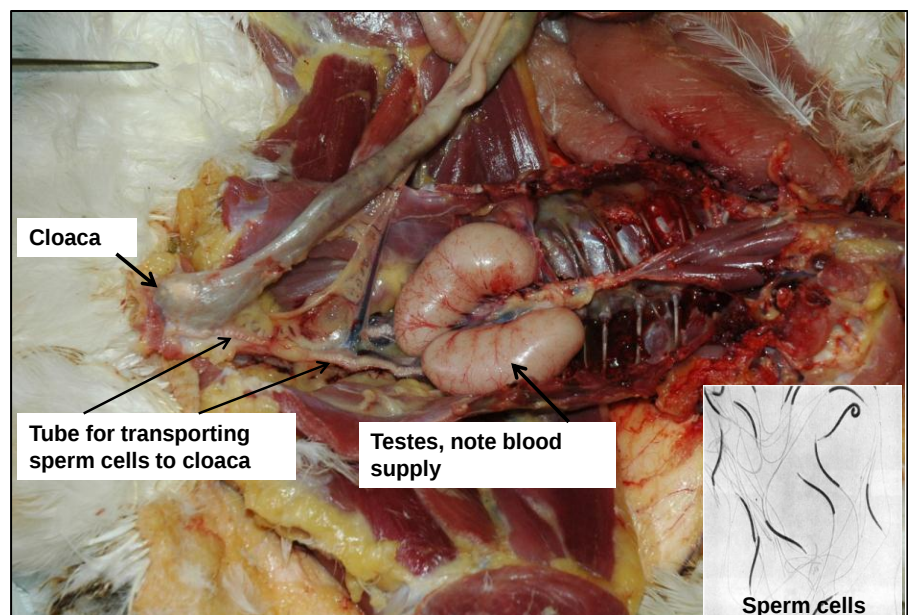
Two testes are located inside the body cavity and are responsible for the formation of sperm cells.

Sperm produced by the testes flows by means of tubes to a storage chamber in the cloaca.

During mating the rooster mounts the hen and places his cloaca over that of the hen and deposits sperm onto the opening of the female reproductive tract inside her cloaca.

During mating the hen would turn the opening of the cloaca upwards, with the inside out, to receive sperm cells.

After mating the sperm is stored inside folds of the oviduct and can stay active for at least 2 weeks.

**The female reproductive system**

Consists of two separate organs: the ovary and the oviduct

The ovary in the day-old hen (pullet) contains all the ova, the reproductive cells with the genetic material of the hen. Each ovum is enclosed by an inner and outer membrane. At about 16 weeks of age, the liver starts to form the yellow yolk

The ovary with small and mature ova



material, which is transported by the blood stream and deposited inside the inner membrane. The ovum thus becomes surrounded by yolk material and is in contact with a source of nutrients, fats, proteins and vitamins, for the embryo during incubation.

In a fully developed ovum the outer membrane will rip open, freeing the ovum, surrounded only by the thin inner membrane.

The ovum is thus what we know as the yolk. The terminology is not quite correct as *yolk* must refer to the yellow stuff surrounding the genetic material of the hen and is therefore the ovum. However, we have become so used to the terminology that it will be difficult to change.

The oviduct

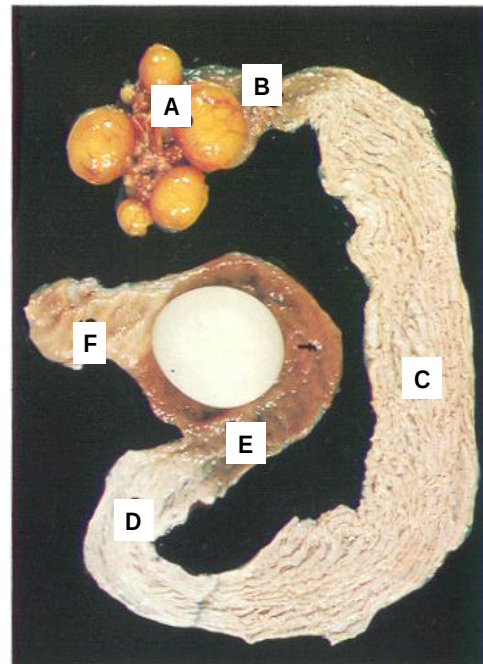
The ovary, marked A in the picture, is surrounded with the funnel-shaped upper part of the oviduct, marked B in the picture.

The oviduct thus *catches* the ovum when it comes free from the ovary.

Sperm cells have moved up from the cloaca, marked as F, and are present in the funnel portion, marked B.

Thus when the ovum enters area, B, sperm will penetrate the membrane of the ovum and one of them will fuse with the genetic material of the hen. This is called fertilization. When an egg is placed in an incubator a chick will hatch.

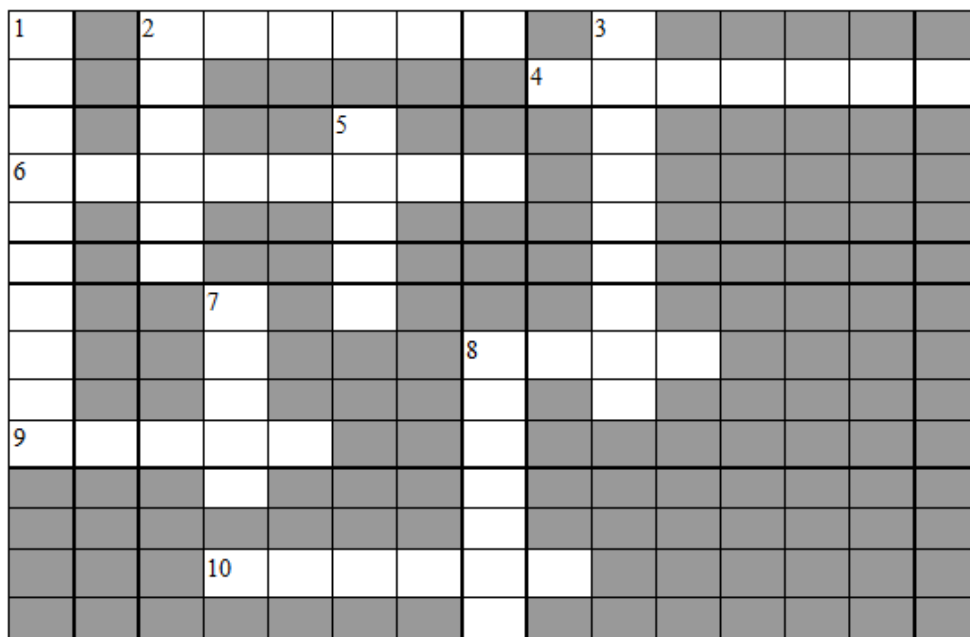
Other components such as egg white (albumen), is secreted in section C and the egg shell in section D.



- A. Ovary with ripening yolks in follicles. Note blood vessels.
- B. Infundibulum, with sperm storage site for fertilization within minutes.
- C. Magnum, 30 cm, secretion of albumen over a 3 hr period.
- D. Isthmus. Secretion of two shell membranes, 75 minutes.
- E. Uterus 12 cm, shell formation 18 – 20 hours.
- F. Vagina, 10 cm with sperm storage site.

Startup Farming

Test your knowledge memory challenge number 4



Clue Across	Clue Down	
	1	These chemicals are proteins that protect the bird against a diseases
	2	These glands along the neck of the bird produce antibodies in response to a vaccine
	3	The name of a bursa that is involved in the production of antibodies
	5	A weakened form of this disease causing organism is used in the production of vaccine
	7	Organ in the female containing female reproductive cells
	8	Tube in which albumen, shell membranes and shell is secreted
2		Organs in which sperm is formed
4		Antibodies are formed in response to the application of this substance
6		This word means to be protected against a disease for which the bird was vaccinated
8		The reproductive cell of the female
9		The reproductive cell of the male
10		This organ houses a storage chamber for sperm

Solutions to memory challenges 1-4

Challenge number 1

Across	Down		
	1	Saliva	Fluid secreted by cells in the mouth of the chicken
	2	Calcium	One of the main minerals in bone cells
	3	mical	The type of reactions responsible for the warmth generated in the body
	5	Down	The feather-like structures with which the day-old chicken hatches
	8	Protein	One of the four components of the body that is not water, minerals or fat
4		Anatomy	Word describing the structure of the body
6		Skeleton	The framework protecting inner organs of the bird
7		Cells	The working units in tissue of organs
9		Minerals	One of the four components of the body that is not protein, water or fat
10		Glucose	This substance serves as the source of energy for a chicken
11		Amino	These acids are the building blocks of proteins

Challenge number 2

Across	Down		
	1	Glucose	This is the source of energy used by cells and is the result of the digestion of starch
	2	Hydrochloric	The acid secreted by the wall of the glandular stomach that assists with the digestive process
3		Salivary	Glands that secrete saliva
4		Crop	In that part of the digestive system feed is softened by water
5		Amino	Acids resulting from the digestion of proteins
6		Pancreas	The organ in the loop of the small intestine that produces enzymes for the digestion of proteins, fats and starch.
7		Fibre	This material cannot be digested by enzymes and excreted in the faeces
8		Gall	Produced by the liver to break fats up into small droplets to for enzymes to react with the fat.
9		Gizzard	The organ that grinds feed to increase surface areas on which enzymes can act to digest proteins, starch and fats in feed.
10		Colon	The last part of the gastro-intestinal tract where water that was contained in faecal matter, is absorbed.

Challenge number 3

Across	Down		
	1	Urinary	These tubes are blocked by uric acid in dehydrated chickens
	10	Nerves	A network of these cords transmit messages to and from organs in the body
	2	Heart	The organ responsible for blood circulation
	3	Brain	This organ receive and send messages on signals from other organs in the body
	5	Oxygen	A gas that is essential for the combustion process of glucose inside body cells
	6	Sacs	Air is inhaled into these body cavities that are connected to the lungs
1		Uric acid	Product of chemical reactions inside cells and excreted by the kidneys
4		Ammonia	A gas produced by bacteria in wet bedding
7		Bacteria	Disease causing organisms that can be inhaled into the air sacs
8		Glucose	Energy for the functioning of body cells is obtained from this substance
9		Nutrients	The end products of feed digestion that are transported by the blood stream to body cells

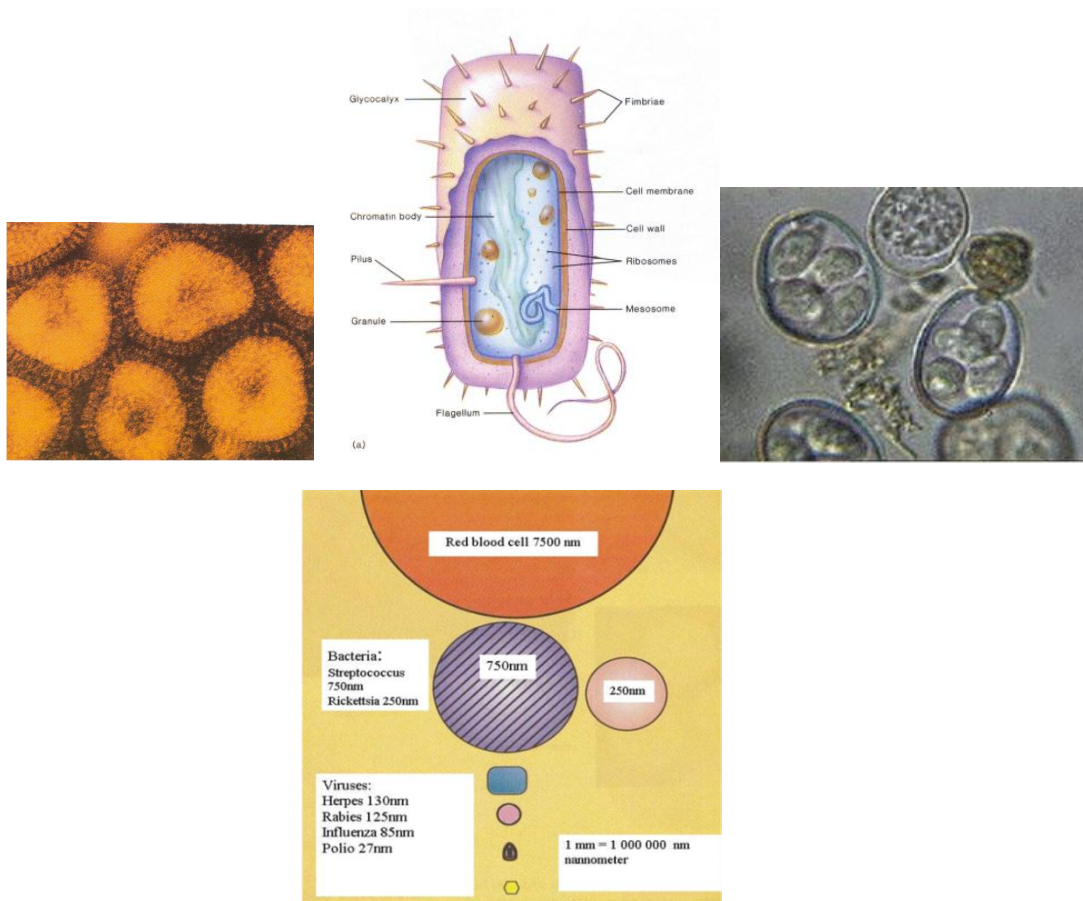
Challenge number 4

Across	Down		
	1	Antibodies	These chemicals are proteins that protect the bird against a diseases
	2	Thymus	These glands along the neck of the bird produce antibodies in response to a vaccine
	3	Fabircius	The name of a bursa that is involved in the production of antibodies
	5	Virus	A weakened form of this disease causing organism is used in the production of vaccine
	7	Ovary	Organ in the female containing female reproductive cells
	8	Oviduct	Tube in which albumen, shell membranes and shell is secreted
2		Testes	Organs in which sperm is formed
4		Vaccine	Antibodies are formed in response to the application of this substance
6		Immunity	This word means to be protected against a disease for which the bird was vaccinated
8		Ovum	The reproductive cell of the female
9		Sperm	The reproductive cell of the male
10		Cloaca	This organ houses a storage chamber for sperm

Startup Farming Agricultural

Training | Education | Empowerment

BIO-SECURITY, VACCINATION AND CLEANING POULTRY HOUSES



Startup Farming

Egg Production Bio Security

The term bio-security would normally be used for actions to prevent contact between the laying flock and the disease causing organisms (commonly known as *germs*). Such actions include access control of people onto a farm and the control of wild birds, insects, rodents etc.

These are, however, not the only actions to protect the health of the birds. Other important measures include the prevention of the large scale multiplication of germs and implementing actions to allow chickens to produce in a stress-free environment.

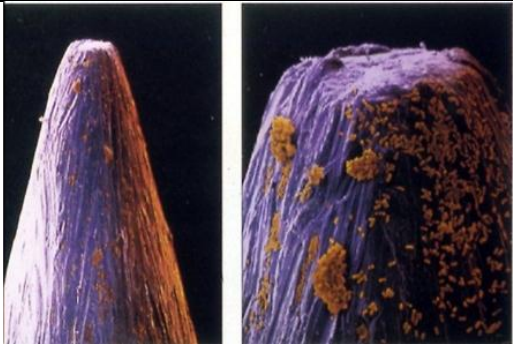
The purpose of this material is:

1. To allow you to gain an understanding of the nature and spreading of germs that threatens the well-being of the birds. (In further discussion the words disease causing organisms will be used.)
2. Be aware of factors that favour the multiplication of disease causing organisms.
3. Be aware of factors that put stress in layers that favour the disease causing organisms to overwhelm the health of the birds.

Bio-security and the various disease causing organisms

The types of disease causing organisms

There are **four** different types of disease causing organisms that can kill or make chickens sick. The fact they all need **food and water** for multiplication and a **protective environment** for their survival should thus be the **first line of approach** to **kill** or stop their **multiplication**:

Lines of approach	Actions to take
Not to feed them	Remove sick and dead birds and damp material. Prevent feed spillage. Disease causing organisms multiply in dead and sick birds and also, in damp material such as spilled feed.
Not to give them water	Prevent water leakages from nipples and rain water into feed bins.
Not to give them protection	Remove protective material such waste around poultry houses, dust on louvers and fan blades, open mortality drums because flies can carry germs.
This figure shows bacteria right on the tip of a needle. Compare the size of the bacteria with the sharp end of the needle. The picture under enlargement gives one an idea how very small the bacteria are. Viruses are generally at least ten times smaller than bacteria. The structure of viruses can only be studied under enlargement of a very strong microscope.	 Left: Sharp end of a needle under enlargement Right: Same needle showing bacteria on the tip

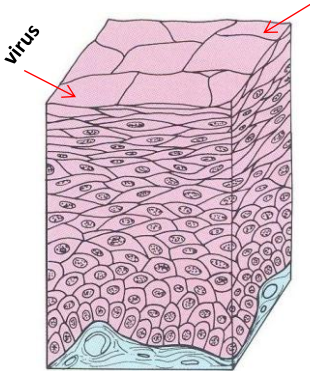
The following aspects will be addressed:

The ability of viruses, bacteria, protozoa and fungi to survive in the environment.

What they need to reproduce themselves.

How sick birds can infect healthy birds.

Table 1 Characteristics of viruses, bacteria, protozoa and fungi

There are basically five types of disease causing organisms:		Piece of tissue showing the layers of cells with viruses penetrating outer membranes into cells  Attached to bone or other tissue Figure 1 Cross section through body tissue Cells are the smallest working units of the body and are responsible to perform the functions of a particular organ.  Fungi, (mould) growth
Viruses	Extremely small, can pass through the cell membrane into the cell. Can survive outside the body if protected against the sun. Reproduce themselves inside live cells. Contaminate healthy birds: viruses can be present in exhaled air and saliva (moisture secreted in the mouth). Cell reactions become disrupted, formation of new cells stops.	
Bacteria	Protected by a membrane, survive in any kind of material. Reproduce by forming spores in dead chickens. Feed on wet bedding and uric acid, produce ammonia. Attack cell membranes and cause infections <i>E. coli</i> infections, yellow puss in air sacs and abdomen.	
Protozoa	Very hardy organisms, survive in soil for months. Reproduce in lining intestine, cause bleeding of tissues. Reproductive cells, called "oocysts" are excreted in faeces. Can't reproduce in dead birds.	
Parasites	Worms live and produce eggs inside the intestinal tract, cause bleeding in intestines. Mites live on the hens but others in cracks of the equipment. Mites multiply by means of the eggs they lay.	
Fungi (Mould)	Primitive plants grow on any damp material, feed, eggs etc. Reproduce by forming spores (seeds) can survive under severe and harsh conditions Deposits poisonous substances, mycotoxins, during growth. Mycotoxins suppress growth and immune development.	

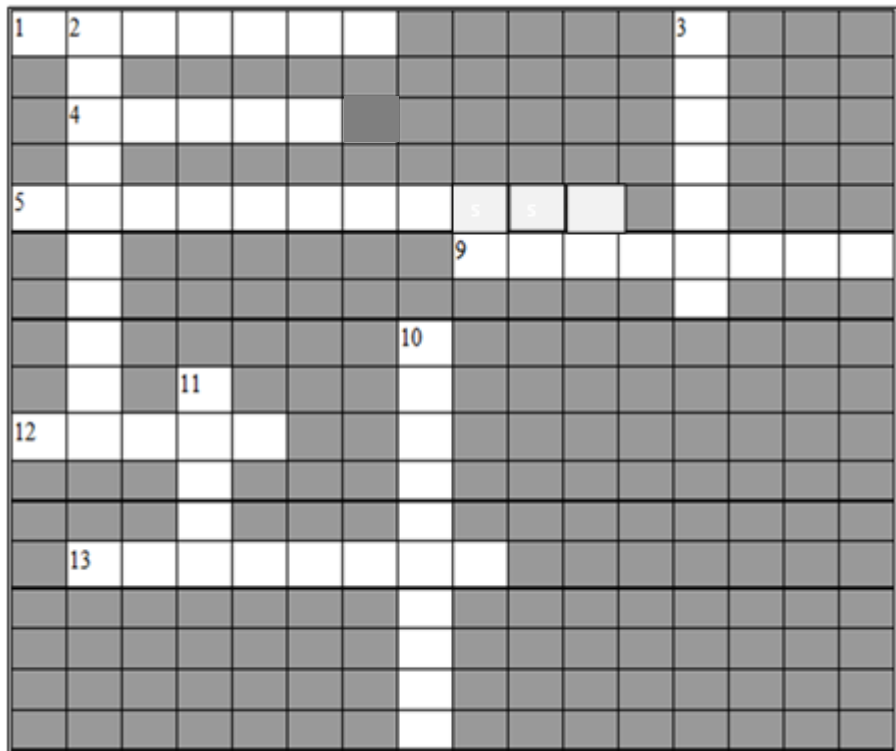
How do you kill disease causing organisms? To put the right amount of the right a disinfectant onto them for the right period of time!

Always follow the instructions on the container.

When in doubt ask your supervisor.

Startup Farming

Test your knowledge memory challenge number 1



Clue Across	Clue Down	
	2	This instrument is used to look at the structure of disease causing organisms under enlargement
	3	These organisms disrupt cell functions and need live cells for their multiplication.
	10	Poisonous substances secreted by mould
	11	These acids can be produced by bacteria to supplement certain nutrient deficiencies in feedstuffs.
1		The gas that is formed by micro-organisms in wet bedding
12		This word is collectively used for the disease causing organisms
13		These organisms invade the linings of the intestinal tract to cause coccidiosis
4		The smallest working units that make up all the different types of tissue in the body
5		The name of the disease where the wall of the intestinal lining is invaded by the organisms that cause the disease
9		These organisms fulfil useful functions but they also cause infections in tissue of the air sacs

Important knowledge: The means by which disease causing organisms can come in contact with the chickens.

A disease will develop if organisms such as viruses, bacteria, protozoa or mycotoxins infects (penetrates) the body of the bird. **The essence of bio-security is to prevent contact.**

A healthy chicken will remain healthy as long as there is no direct contact between the chicken and viruses, bacteria, protozoa or mycotoxins.

Means of spreading	Control measures to prevent spreading
Carried by man. (Staff and maintenance crew): People visit the shops in town and make contact with persons that had handled poultry.	Staff must wear protective clothing after showering in. People are the main spreaders of disease causing organisms.
Carried by rodents. Rats and mice excrete bacteria, for example Salmonellae, in their droppings. This organism causes diarrhoea in humans.	Bait stations to control rats and mice must be inspected regularly. Mowing of grass around buildings.
Carried by birds. Viruses that cause IB and Newcastle disease are carried by wild birds and can infect the chickens.	Control wild birds by preventing feed spillage outside buildings. Keep wild birds out of buildings.
Carried by insects (flies and litter beetles). Carry viruses and bacteria on body hair.	Control flies at their breeding sites and spraying walls with insecticide and to cover mortality containers. Litter beetles controlled by means of band-spraying insecticide at depopulation of a building. Mowing of grass around buildings.
Carried by wind, dust and feathers. Wind carries dust and feathers from sick birds on trucks that pass the farm.	During housecleaning restrict as far as possible the spreading of dust and feathers to surrounding areas and thus lowering the population of disease causing organisms as much as possible.
Carried by equipment. Equipment that is brought onto the site by the maintenance teams can carry disease causing organisms.	Equipment such as toolboxes used by maintenance personnel should be disinfected at the point of entry to a farm, especially their bottoms, of the toolboxes!
Carried by water. Slime (fungi) grows inside water lines and produce poisonous substances that make chickens more at risk to get sick.	Water lines have to be flushed with the right cleaning agent to remove the fungi (slime) that produces growth depressants.
What else can be done to control contact between disease causing organisms and the chickens?	Always have an open eye for possible means by which disease causing organisms can enter a farm or a poultry house. You are fighting an invisible enemy.

Success of biosecurity practices starts with you!!

In Figure 2 some of the contact and transmission routes of disease causing organisms are illustrated. See what has been omitted and make a short summary for yourself.

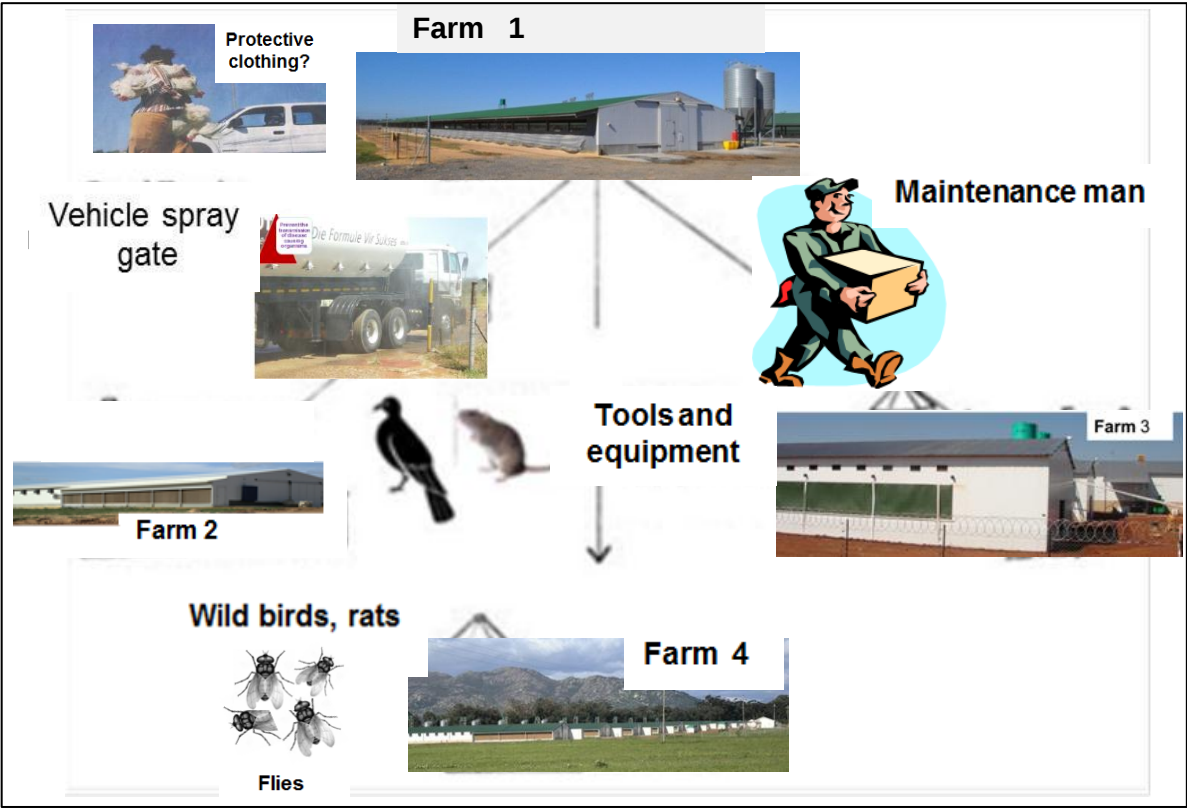
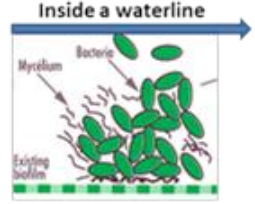


Figure 2 Possible entry and contact routes for disease causing organisms to the poultry

Not mentioned in Figure 2, and which is of great importance, is the water supply to the chickens¹. Bacteria grow inside the water line forming a jelly-like mass known as **biofilm** see Table 2. **Water, if contaminated**, can thus indeed be regarded as a carrier of disease causing organisms.

Table 2 Biofilm in water lines

	Portions of this biofilm with bacteria come free from time to time.
	They form more clusters that block the water nipples.
	Biofilm can form within a period of 2 – 4 days after a cleaning operation.
	After depopulation all pipe work should be thoroughly cleaned with a dedicated water line cleaner and flushed.

¹ Permission for reprinting was kindly granted by the author of the booklet: Rational Antibiotherapy In Poultry Farming, page 17, by L. Mogenet, Ceva Santé Animale.

The role of stress in biosecurity.

Stress is the result of harmful or uncomfortable situations and the brain is stimulated to prepare the body for action:

- The heart increases its rate to pump blood.
- Breathing rate increases and muscles become tight in preparation to fight or flee.

These actions use energy and cause a decrease of glucose in the blood. Birds become more at risk to get sick because of the lack of glucose to supply energy for the formation of antibodies to fight disease causing organisms. Once a disease outbreak occurs, more and more birds get sick. Viruses multiply in sick birds and their numbers simply overwhelm the birds. It thus means a total collapse of biosecurity.

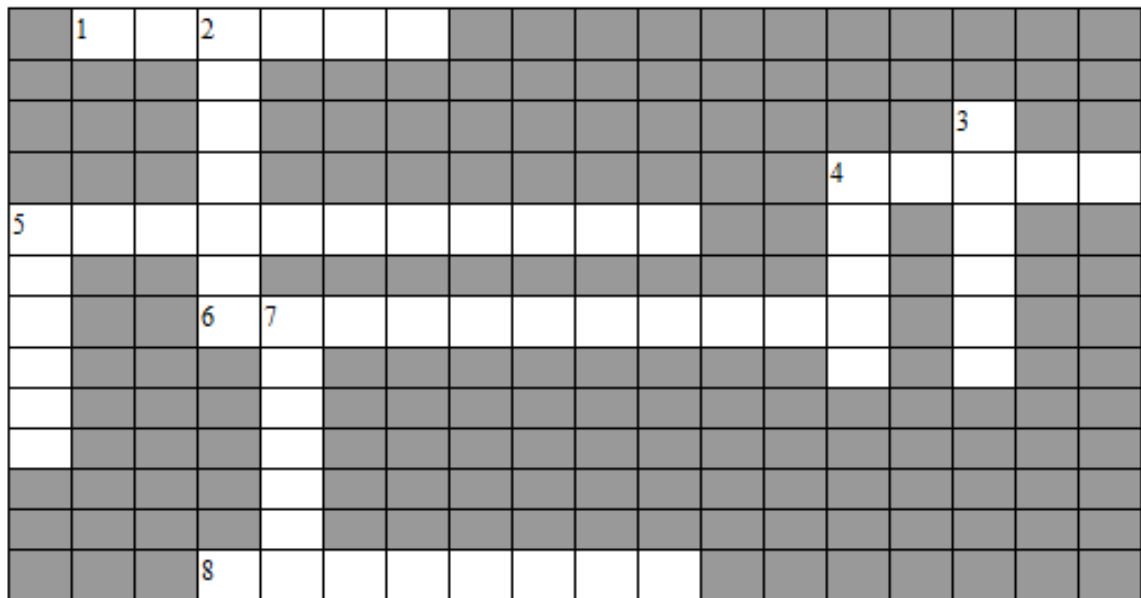
Factors that can be causes of stress: Feed, Light, Air, Water, Sanitation and Space (acronym FLAWSS).

Stress factors	Possible shortcomings	Effect of the particular shortcoming: A breach in biosecurity likely to develop
Feed	1. Feeders out of reach	Low feed intake results in low energy reserves in the body and the birds are thus unable to fight the disease causing organisms.
	2. Feed structure	Birds refuse to eat dusty feed or feed with high salt content.
	3. Mouldy feed	Contains poisonous substances, mycotoxins that lower resistance to disease. Immunity is suppressed.
Light	Light and dark areas (some light bulbs are out.)	Insufficient lighting in lower tiers. Overcrowding of birds in the more brightly lit areas in free-range houses.
Air	Ventilation not right, too much or too little.	High ammonia and dust. Tissue in respiratory tract damaged and easy penetration of inhaled bacteria into tissue of the air sacs.
	Over-ventilated especially at night.	House temperatures low, poor moisture removal from bedding material. Ammonia levels high due to wet bedding. Respiratory diseases develop.
	Air speed low at night	Cold spots near intakes. Layers in free-range houses congregate in centre areas of the house. Bedding wet.
Water	Waterlines out of reach	Dehydration of the inner lining of the respiratory tract and easy penetration of disease causing organisms into the cracks.
	Bacteria in waterline due to improper cleaning.	Bacteria produce poisonous substances that cause birds to be more susceptible to diseases.
Sanitation (or cleanliness)	Mortalities stored in unsealed bins	Flies increase in numbers and carry viruses and bacteria to healthy birds.
	Bait stations, footbaths in poor condition	Rats and mice carry Salmonella bacteria into feed troughs. People's feet and clothes carry organisms into layer houses.
	Wild birds present in large numbers.	Feed spillage attracts wild birds; they are carriers of viruses and bacteria.
Space	Over-crowding due to wrong placing in cages or in free-range houses.	Feed and water not available to all, runts develop. Wet bedding and ammonia develops in free-range houses.

Test your knowledge memory challenge number 2

 Memory challenge	
Write down seven means or processes by which disease causing organisms can be transmitted to layers. Important to say how transmission or infection can take place and what you will do to prevent transmission.	1.
	2.
	3.
	4.
	5.
	6.
	7.
Why can poor feed intake be seen as a stress factor?	
Why can water become a stress factor?	
How can air become a stress factor?	
How can poor sanitation become a stress factor?	

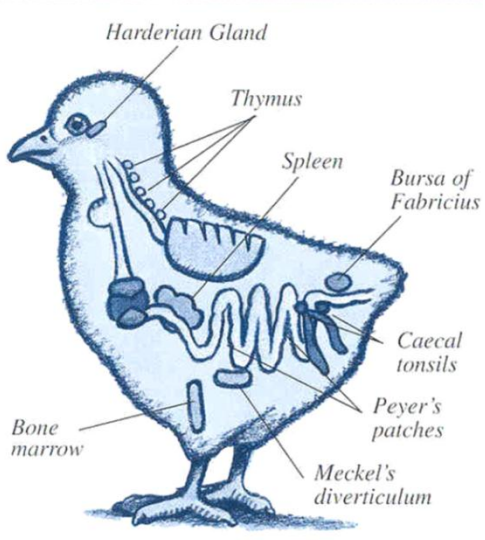
Test your knowledge memory challenge number 3



Clue Across	Clue Down	
	2	A single word for describing rats and mice
	3	Required for an action to take place
	4	Insects that can distribute viruses by means of their body hair
	5	Feed in this condition contains poisonous substances that lowers resistance to disease
	7	This gas causes damage to tissues of the respiratory tract in chickens
1		The condition in reaction to harmful and uncomfortable situations
4		It grows inside water lines blocking water nipples and can depress growth of layers
5		The crew responsible to fix broken equipment might be carriers of disease causing organisms
6		The bacterium carried by rats and mice and causes diarrhoea in humans
8		These micro-organisms form films inside water lines and cause blockage of water nipples

Role of vaccines in bio-security

Terminology explained.

Disease	An abnormal condition of the body. Cells of an organ have been attacked by disease causing organisms. The organs show symptoms such as inflammation and unable to perform their normal functions.	 The cells of inner tissue of intestine damaged by organisms. Symptoms, blood in droppings, are clearly visible
Symptoms	The visible signs of a disease in an organ. Sometimes very specific in an organ for a particular disease but mostly not the case. Picture on right infection of intestine due to coccidiosis.	
Vaccine	It is not medicine!! It contains the disease causing organism in a weakened state. In an overdose it can kill the birds. Correct dosage stimulates the formation of antibodies. Organs involved in antibody production to protect the bird against a particular disease are shown in the drawing of a chicken at the bottom of the adjacent column. In adult hens the Bursa of Fabricius does not function any more.	 Dry powder at the bottom of the vial is the dry vaccine, can be viruses  Day-old chickens being sprayed with vaccine. Taken up into the body is via the membranes of the eye lid and nose.
Vaccination	The process by which a vaccine is given to the birds: in the drinking water, sprayed or by injection. It must penetrate the body.	
Antibodies	Chemical substances that were produced by certain organs in the body in response to the application of a vaccine.	
Immunity	To have defences: Antibodies in the blood as protection against a specific disease. A well protected bird will have high numbers of antibodies in blood stream. Organs involved in antibody production include the Bursa of Fabricius ² , the thymus glands along the neck, the bone marrow, spleen and other, see picture.	
Gland	An organ with cells that secrete substances such as mucus or absorb substances such as vaccine.	

² The Bursa of Fabricius not active in adult hens, has degenerated.

Factors that determine the success of the vaccination process (development of immunity)

It is well known that human errors are the main causes of failures when vaccinated birds do not develop sufficient immunity. This means that either only a small portion of the flock developed antibodies or the antibody levels in the blood was low.

Table 3 Important considerations to take into account when vaccinating

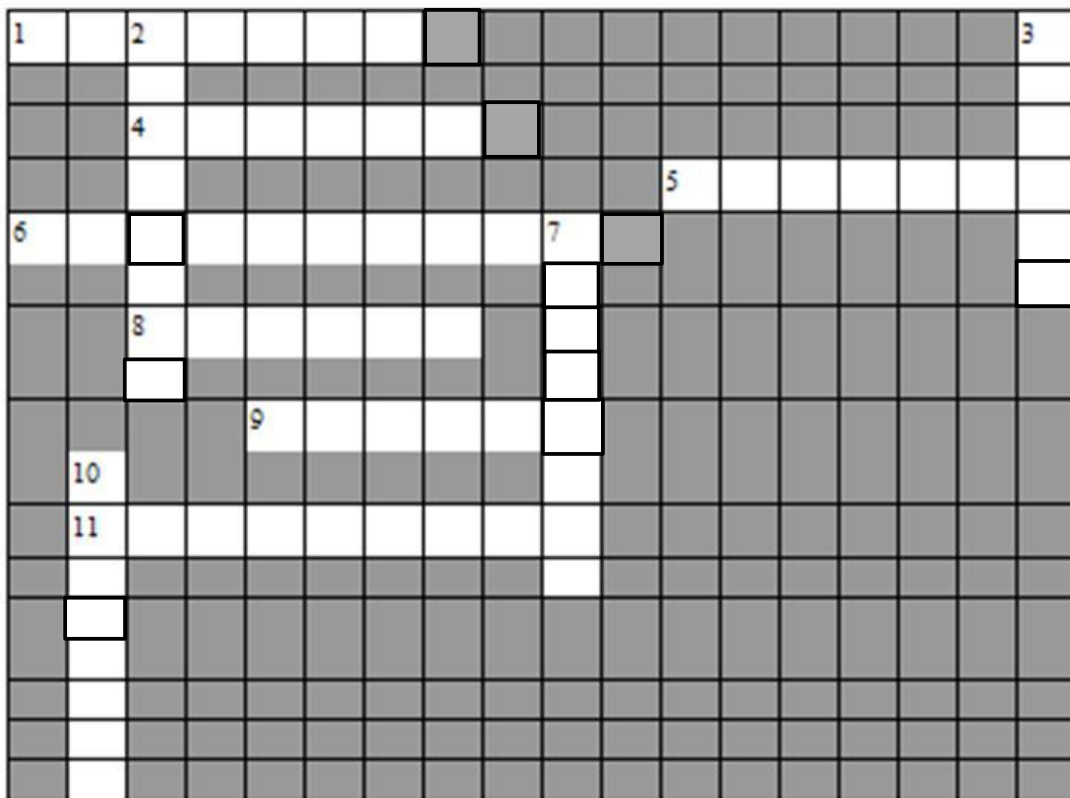
1. The vaccine has to be kept in a cool-box at 4 – 8 °C during transport until mixing into water takes place.	A vaccine consists of the live form of the disease causing organisms. Temperature fluctuations destroy them.
2. The number of vaccine doses mixed into drinking water, or sprayed onto the chickens, must correspond to the number of birds that have to be vaccinated.	The number of doses of vaccine a bird consumes determines the number of antibodies (the level of immunity) that will develop.
3. Important to check the expiry date on the vials containing the vaccine.	Live vaccines have a limited lifetime and will lose their potency with time.
4. The drinking water containing the vaccine, or the water used for spraying, must be free from chlorine. (Procedures to ensure low chlorine levels in drinking water have to be strictly followed.)	Chlorine is a disinfectant and will kill those organisms (viruses or bacteria) that were used in the manufacturing of the vaccine.
5. Each bird must receive its full share of the vaccine solution to ensure uniformity of immune levels. House temperatures should be taken into consideration to ensure sufficient water volumes for drinking or spraying.	Birds that have not consumed the right amount of vaccine will not be immune against the disease they were vaccinated for.
6. Birds suffering from some form of stress must not be vaccinated.	Stress causes a shortage of energy. Not enough energy will be available to form antibodies in response to the vaccine. The result is a low level of antibodies and the birds are poorly protected.

Fill in the missing words challenge

Table 4 Missing words to be filled in.

1. Symptoms: The visible _____ of a particular disease.
2. Vaccine: It is the _____ in a weakened state
3. Dry powder at the bottom of the vial is the dry _____ can be viruses.
4. The _____ by which a vaccine is given to the birds: in the drinking water, sprayed or by injection.
5. To have sufficient defences, meaning _____, to avoid a disease to develop in the body of the chicken.
6. Antibodies are _____ that are able to recognize the organism that was used for making the vaccine and will _____ to that organism when it penetrates the bird.
7. The vaccine has to be kept in a cool box at _____ during transport
8. A vaccine consists of the _____ – _____ of the disease causing organisms and temperature fluctuations will destroy them.
9. Chlorine is a _____ and will destroy the viruses or bacteria
10. Birds that have not consumed the _____ amount of vaccine will have low levels of antibodies.
11. Stress causes a _____ of energy.
12. Birds _____ from some form of _____ must not be vaccinated.

Test your memory challenge number 3



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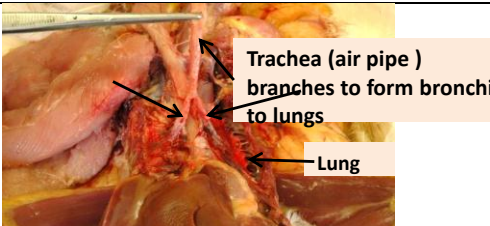
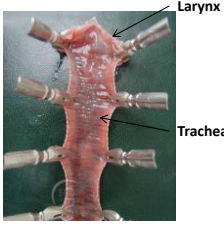
Clue Across	Clue Down	
1		During such a condition typical symptoms might be visible
	2	The visible signs of a disease
5		A substance used to stimulate immunity against a disease in birds
6		The chemicals produced in responses to successful vaccination
4		Tissue inside bone cavity that is involved in antibody production
8		The name of a diverticulum that is involved in antibody production
	7	One of the methods by which a vaccine can be applied
11		The name of a gland that is can absorb a sprayed vaccine
9		This date is important to check on the vaccine vials
	10	Drinking water used for mixing with a vaccine must be free of this disinfectant
	3	Birds suffering from some form of this condition should not be vaccinated

Diseases of importance in laying birds

Some diseases might have very typical symptoms (visible signs) by which they can be recognized. However, many diseases show symptoms that are the same for different disease causing organisms (viruses or bacteria). In many cases of a disease outbreak the veterinarian will take tissue samples and have them analysed in the laboratory to identify without doubt the organisms responsible for causing the disease. In Table 5 a summary is given of the main diseases of relevance to layers.

Table 5:

Six commonly occurring diseases that threaten the well-being of layers.

Name	Organ affected	
1. Infectious bronchitis³ (IB)	The name tells you that the bronchi, the tubes to the lungs, are infected.	
2. ILT (Infectious laryngo tracheitis) or laryngotracheitis.	Both parts of the respiratory tract, the larynx as well as the lower portion, the trachea, are infected.	 Permission ⁴
3. Newcastle disease (Newcastle disease)	Nervous system is infected, no control of neck muscles. Blood spots visible on surface of the proventriculus.	 
4. TRT, (Turkey rhino-tracheitis). Swollen head syndrome or Dikkop	Tissue inside sinuses (cavities) of the nose, the head and upper respiratory tract gets infected.	
5. Coccidiosis	Intestines show spots of infection on the outside of intestine. Bleeding on the inside of intestine.	
6. Worm and mite infestations (Worms are a problem in free-range hens. Mites invade hens in cages as well as in free-range systems)	Lower intestines can be blocked by the worms. Birds lose appetite and production is reduced. Mites suck blood and birds lose condition.	

³ Very common to hear chickens snicking after they had been vaccinated for IB, it means they have absorbed the vaccine.

⁴ Permission to use the CEVA pictures was kindly granted by Prof. Ivan Dinev, Faculty of Veterinary Medicine, Trakia University, 6000 Stara Zagora, Bulgaria.

Role of sanitary conditions

The word sanitizing has the same meaning as cleaning or decontaminating or washing and can even mean disinfecting. All these words are applicable to the processes of cleaning a layer house after depopulation. The main aim is to decrease the number of disease causing organisms and to destroy (kill) those that might have remained behind after the cleaning process.

For the sake of revision answer the following questions regarding the disease causing organisms:

Table 6 Characteristics of the disease causing organisms

Give a short description to the questions in the first column		
Viruses	How do they multiply?	
	Can they penetrate cells of the body and what is the effect?	
	Can they feed on dead birds and increase in numbers?	
	How can they survive outside the body?	
	Name three ways in which they can be spread to infect healthy birds	
Bacteria	How do they multiply?	
	Can they penetrate cells of the body and what is the effect?	
	Can they feed on dead birds and increase in numbers?	
	How can they survive outside the body?	
	Name three carriers by which bacteria can be spread to infect healthy birds. Continues on next page	

Table 7 Characteristics of the disease causing organisms (continued)

Give a short description to the questions in the first column		
Protozoa	How do they multiply?	
	Can they penetrate cells of the body and what is the effect?	
	Can they feed on dead birds and increase in numbers?	
	Can they survive outside the body?	
	Name the most important way in which they can be spread to infect healthy birds	
Fungi (mould)	What is fungi?	
	How does it multiply?	
	What does it need to multiply?	
	What negatives effects does mould growth has on chickens?	

Cleaning poultry houses after depopulation

(The organism counts for

Figure 3 were found⁵ for broiler houses but in principle it should equally well also apply to laying houses).

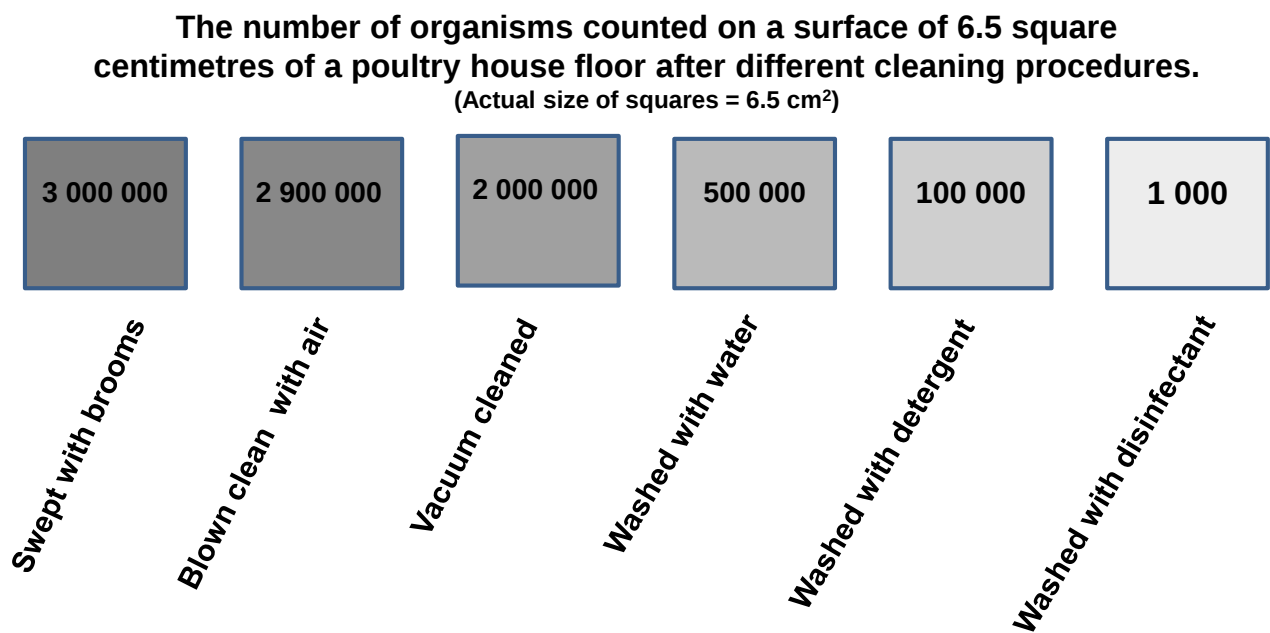


Figure 3 The effect of washing and using detergents on the removal of disease causing organisms in poultry houses

The effect of different cleaning procedures on the number of organisms on a surface area of 6.5 square cm, is illustrated in

⁵ Quoted by L. Ledoux, The importance of hygiene and terminal disinfection, page 1 – 6 in Chick Quality 2004, hosted by International Hatchery Practice and Poultry Production.Hannover, Germany.

Figure 3. It will be noted that after each step the number of organisms decreased. A dramatic change occurred after washing with water: the numbers decreased from 2 million to 500 000 per 6.5 sq cm, a four times (4X) decrease in numbers. Using a detergent had a still larger effect, from 500 000 to 100 000, thus a decrease of five times. The disinfectant had the largest effect to decrease microbe numbers, namely a hundred (100) times, from 100 000 to 1 000 organisms per 6.5 cm². This stresses the need to use and apply disinfectants correctly.

Table 8 is a summary of actions and the reasons for actions during cleaning operations. The steps probably differ between companies but it is important to take note of the reasons why actions are performed and to pay special attention to those actions that have the largest effect on the elimination of microbial counts in a layer house, namely the application of a disinfectant on a clean surface, take another good look at the steps in

Figure 3.

Table 8 Cleaning of poultry houses: Steps taken after houses have been depopulated

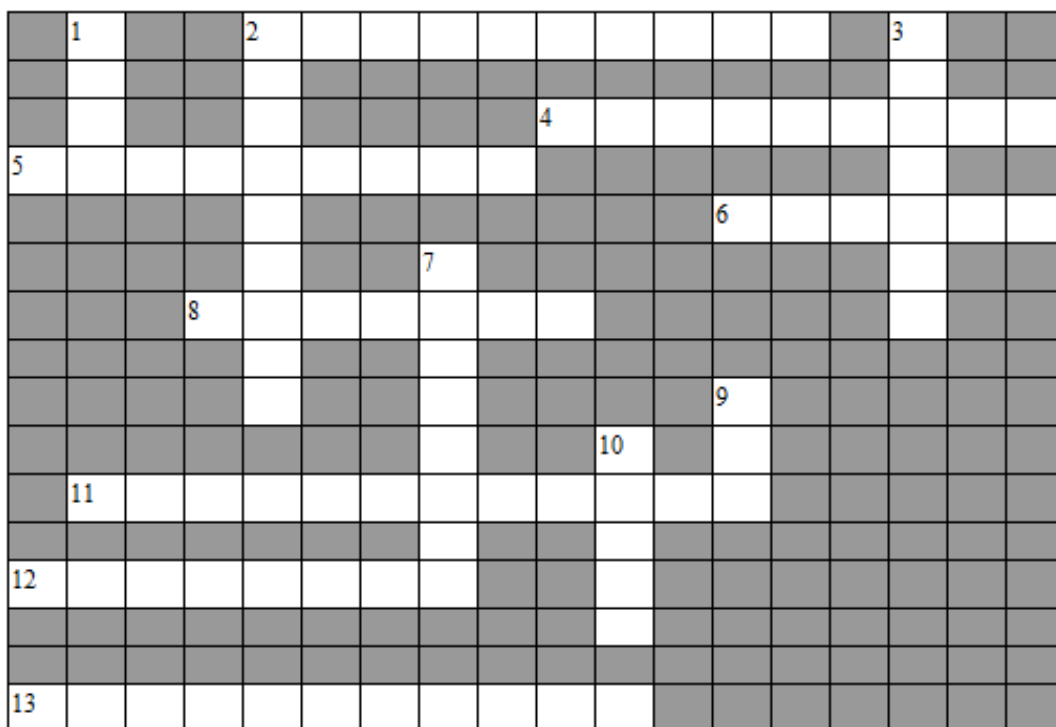
Steps	Actions	Reasons
1. Apply health and safety regulations	Wear protective clothing (PPE) and masks	Inhalation of dust irritates eyes and membranes of the respiratory tract. Mould spores in air can grow in human lungs.
2. Total depopulation of the poultry house	Eliminate all loose and stray poultry (yard birds) outside the house	Poultry are carriers of disease-causing organisms and allow viruses to multiply.
3. Switch off electricity supply to the building and equipment	Mains are turned off	Water that is sprayed onto an electric circuit can cause the death of a worker.
4. Removal of all remaining feed	Augers, hoppers and feed bins completely cleaned and all feed	Mould spores give rise to mould growth in new feed.

	lumps containing mould removed.	Mycotoxins are produced during mould growth and depress immune development.
5. Removal of loose equipment.	All movable equipment to be taken apart and moved out for the cleaning operation.	Thorough cleaning is made easy on a wash bay. Disease causing organisms killed when exposed to sunlight
6. Removal of all bedding material	Spreading of feather and dust must be minimized. Do not pile or spread litter near poultry houses, it attracts rats and mice.	Bedding material contains very high numbers of microbes. Microbes spread by means of dust. Minimize microbes in the surroundings of a poultry farm.
7. Dry cleaning of building. This would include the first three steps illustrated in Figure 3.	Sweeping of large particles and then using air under pressure to remove dust from fans and louvers and to concentrate dust on a particular area before vacuum cleaning to remove dust. After vacuum cleaning there would still be 2 million microbes per 6.5 cm ² . (equal to 20 billion per sq meter.)	Bedding material and dust contain large numbers of microbes including <i>E. coli</i> bacteria. The removal of visible material has a very large effect to decrease the bacterial load in a house. (Poultry litter contains 8 billion <i>E. coli</i> bacteria per gram (8 billion = 8 000 000 000 000). Poultry house dust contains between 200 000 to 800 000 coli bacteria per gram.) (Table continues on next page)

Steps	Actions	Reason
8. Washing with water.	This would entail the use of high pressure washers to remove stubborn organic matter adhering to the floor.	Loose material provides protection to microbes. Direct contact between disinfectant and organism is necessary to kill the organisms.
9. Washing with detergent (This is often combined with the previous step namely washing with water.)	A detergent is added to the washing water according to the instructions on the container. From Figure 3 it will be noted that a detergent lowered the microbe count from 500 000 to 100 000, thus a five-fold lowering.	Function of a detergent is to make fats soluble in water and be easily removable. Fats will protect organisms from coming in contact with a disinfectant and they will thus not be destroyed.
10. Applying a disinfectant	The function of a disinfectant is to kill microbes, this action depends on: The concentration of the mixture is most important; too weak will have little effect. The temperature: Too low will have a poor effect. Period of contact: Too short will not be effective. Disinfectant solution must not become dry before the specified disinfection period is over. From Figure 3 it will be noted that the disinfectant lowered the microbe	To kill as many microbes as possible. Day-old chickens should not be exposed to high levels of disease causing organisms as their immune system is still poorly developed.

	count from 100 000 to 1000, thus a 100 fold lowering.	
11. Placing of equipment, performing maintenance and placing of bedding material.	All repairs and replacements complete before fumigation	Maintenance teams should not need to visit poultry houses after disinfection. The risk of bringing in disease causing organisms is too big.
12. Final fumigation	Perform the correct procedures for mixing and applying fumigant with regard to temperature, 25 °C, humidity and length of time period.	This is the final attempt to ensure an environment with a bacterial load as low as possible for point-of-lay pullets.
13. Cleaning of entrance paths to doors.	Remove feathers and bedding material that offer protection to disease causing organisms.	The outside surroundings with a low bacterial count decrease the possibility of carrying disease causing organisms into the poultry house.

Test your memory challenge number 4



Clue Across	Clue Down	
5		Used in the cleaning process to remove fats and stubborn material from floors and equipment
	2	The evaluation of the success of cleaning is based on such counts
6		Face masks should be worn to avoid the inhalation of these seeds from primitive plants
2		Substances produced by mould that depress immune development in poultry
8		This material can contain up to 8 billion <i>E. coli</i> bacteria
	1	The factor by which the number of organisms on an area can be decreased by using a detergent as cleaning agent
	3	The factor by which the number of organisms on an area can be decreased when a disinfectant is applied
	7	They keep chickens warm but also offer protection to disease causing organisms
11		This is used to kill microbes
12		This word refers to all types of disease causing organisms
	10	The protective equipment that covers your nose and mouth
4		Tissue of the respiratory tract that is irritated by dust
	9	The substance that becomes soluble when treated with a detergent
13		The teams that should not enter poultry houses after a final fumigation

Solutions to memory challenges

Challenge number 1

Clue Across	Clue Down		
	2	Microscope	This instrument is used to look at the structure of disease causing organisms under enlargement
	3	Viruses	These organisms disrupt cell functions and need live cells for their multiplication.
	10	Mycotoxins	Poisonous substances secreted by mould
	11	Amino	These acids can be produced by bacteria to supplement certain nutrient deficiencies in feedstuffs.
1		Ammonia	The gas that is formed by micro-organisms in wet bedding
12		Germ	This word is collectively used for the disease causing organisms
13		Protozoa	These organisms invade the linings of the intestinal tract to cause coccidiosis
4		Cells	The smallest working units that make up all the different types of tissue in the body
5		Coccidiosis	The name of the disease where the wall of the intestinal lining is invaded by the organisms that cause the disease
9		Bacteria	These organisms fulfil useful functions but they also cause infections in tissue of the air sacs

Challenge number 2

Clue Across	Clue Down		
	2	rodents	A single word for describing rats and mice
	3	Energy	Required for an action to take place
	4	Flies	Insects that can distribute viruses by means of their body hair
	5	Mouldy	Feed in this condition contains poisonous substances that lowers resistance to disease
	7	Ammonia	This gas causes damage to tissues of the respiratory tract in chickens
1		Stress	The condition in reaction to harmful and uncomfortable situations
4		Fungi	It grows inside water lines blocking water nipples and can depress growth of layers
5		maintenance	The crew responsible to fix broken equipment might be carriers of disease causing organisms
6		salmonellae	The bacterium carried by rats and mice and causes diarrhoea in humans
8		Bacteria	These micro-organisms form films inside water lines and cause blockage of water nipples

Challenge number 3

Clue Across	Clue Down		
1		Disease	During such a condition typical symptoms might be visible
	2	Symptoms	The visible signs of a disease
5		Vaccine	A substance used to stimulate immunity against a disease in birds
6		Antibodies	The chemicals produced in responses to successful vaccination
4		Marrow	Tissue inside bone cavity that is involved in antibody production
8		Meckel	The name of a diverticulum that is involved in antibody production
	7	Spraying	One of the methods by which a vaccine can be applied
11		Harderian	The name of a gland that is can absorb a sprayed vaccine
9		Expiry	This date is important to check on the vaccine vials
	10	Chlorine	Drinking water used for mixing with a vaccine must be free of this disinfectant
	3	Stress	Birds suffering from some of this condition should not be vaccinated

Challenge number 4

Clue Across	Clue Down		
5		detergent	Used in the cleaning process to remove fats and stubborn material from floors and equipment
	2	microbial	The evaluation of the success of cleaning is based on such counts
6		Spores	Face masks should be worn to avoid the inhalation of these seeds from primitive plants
2		mycotoxins	Substances produced by mould that depress immune development in poultry
8		litter	This material can contain up to 8 billion <i>E. coli</i> bacteria
	1	Five	The factor by which the number of organisms on an area can be decreased by using a detergent as cleaning agent
	3	Hundred	The factor by which the number of organisms on an area can be decreased when a disinfectant is applied
	7	Feathers	They keep chickens warm but also offer protection to disease causing organisms
11		disinfectant	This is used to kill microbes
12		microbes	This word refers to all types of disease causing organisms
	10	Masks	The protective equipment that covers your nose and mouth
4		membranes	Tissue of the respiratory tract that is irritated by dust
	9	Fat	The substance that becomes soluble when treated with a detergent
13		maintenance	The teams that should not enter poultry houses after a final fumigation

Solution to Error! Reference source not found. - 7	
Write down seven means or processes by which disease causing organisms can be transmitted to birds in a house. Important to say how transmission or infection can take place and what you will do to prevent transmission.	1 Waterlines can contain bacteria that grow inside them. Prevention by proper cleaning with the right products at the right concentration.
	2 Staff that enters the site after shopping in town or having contact with contaminated persons carry organisms on their clothes and shoes. Prevention is by showering and wearing protective clothing.
	3. Rodents carry Salmonellae bacteria and these are excreted in their droppings. Prevention is by means of maintenance of bait stations.
	4. Wild birds carry viruses of Newcastle disease and IB. Feed spillage that attracts birds must be prevented.
	5. Flies and litter beetles carry disease causing organisms. Regular application of insecticides at breeding places.
	6. Contaminated feathers and dust is carried by the wind into poultry houses. Areas around poultry houses must be kept clean and spilling of bedding material during clean-out prevented.
	7. Equipment used by maintenance teams gets contaminated. Proper disinfection must be applied before entering a site.
Why can poor feed intake be seen as a stress factor?	With low energy reserves birds are unable to fight against the disease causing organisms.
Why can water become a stress factor?	Water lines that have not been cleaned properly can contain poisonous substances formed by bacteria inside the line.
How can air become a stress factor?	Air with high levels of ammonia will cause cracks in the lining of the respiratory tract and thus easy penetration of disease causing organisms into the body.
How can poor sanitation become a stress factor?	Dead birds lying around, spilt feed and wet conditions creates conditions for bacterial growth that will overwhelm the bird's ability to stay healthy.

Solution to Table 4 Missing words to be filled in.13

1. Symptoms: The visible signs of a particular disease.
2. Vaccine: It is the disease causing organism in a weakened state
3. Dry powder at the bottom of the vial is the dry vaccine , can be viruses.
4. The process by which a vaccine is given to the birds: in the drinking water, sprayed or by injection.
5. To have sufficient defences, meaning antibodies , to avoid a disease to develop in the body of the chicken.
6. Antibodies are chemicals that are able to recognize the organism that was used for making the vaccine and will bind to that organism when it penetrates the bird.
7. The vaccine has to be kept in a cool box at 4 – 8 °C during transport
8. A vaccine consists of the live form of the disease causing organisms and temperature fluctuations destroy them.
9. Chlorine is a disinfectant and will destroy the viruses or bacteria...
10. Birds that have not consumed the right amount of vaccine will have low levels of antibodies.
11. Stress causes a shortage of energy.
12. Birds suffering from some form of stress must not be vaccinated.

Solutions to Table 6 Characteristics of the disease causing organisms

		Your comments and answers in this column
Viruses	How do they multiply?	They can only multiply inside the cells of a particular tissue type in a live bird.
	Can they penetrate cells of the body and what is the effect?	Can penetrate the cell and interfere with the normal functioning of the cell such as the secretion of saliva,
	Can they feed on dead birds and increase in numbers?	They can survive in a dead bird but cannot multiply themselves.
	How can they survive outside the body?	As long as they are protected from sunlight or adverse conditions such as dryness, they will die.
	Name three ways in which they can be spread to infect healthy birds	Drinking water. Carried by flies. Carried by people on their clothes. Carried on feathers or dust.
Bacteria	How do they multiply?	Reproduce by forming spores in dead animals or bedding material
	Can they penetrate cells of the body and what is the effect?	Bacteria attack cell membranes to cause infections
	Can they feed on dead birds and increase in numbers?	Use organic matter and uric acid as nutrients.
	How can they survive outside the body?	Protected by a membrane that surrounds the bacterial body
	Name three carriers by which bacteria can be spread to infect healthy birds. Continues on next page	People. Rodents. Wild birds.

Table 7 Characteristics of the disease causing organisms (continued)

Protozoa	How do they multiply?	Reproduce in intestinal lining, cause bleeding of tissues. Reproductive cells, called “oocysts” are excreted in faeces
	Can they penetrate cells of the body and what is the effect?	Only penetrate the tissue of intestinal lining, not into cells, cause bleeding of tissue
	Can they feed on dead birds and increase in numbers?	Can’t reproduce in dead birds.
	Can they survive outside the body?	Very hardy organisms, survive in soil for months.
	Name the most important way in which they can be spread to infect healthy birds	Underneath the boots that people wear and when foot baths are not containing active disinfectants
Fungi (mould)	What is fungi?	Primitive plants.
	How does it multiply?	By means of spores formed.
	What does it need to multiply?	Any organic damp material such as feed, bedding material and dust.
	What negatives effects does mould growth has on on layers?	Deposits poisonous substances, mycotoxins, during growth. Mycotoxins suppress growth and immune development.

Parasites elders

Parasites can occur internally e.g. worms or externally such as mites, lice, fleas and mosquitoes. Some of these parasites can transmit viruses and bacteria. The most common example is probably the malaria mosquito, which transmits the malaria organism to humans. Mosquitoes also transmit the virus causing fowl pox in chickens and it is most important that chickens will be vaccinated against pox if they are to be reared to over six weeks of age.

Modern poultry practices have resulted in less problems with internal parasites because the cleaning has become more efficient on cement floors and solid walls than on soil and wooden structures such as in the olden days. The parasite eggs can survive for very long periods in the ground and or crevices where they are protected. Under favourable conditions of temperature and moisture parasite eggs will develop and poultry will become infected if the embryonated eggs are swallowed.

Internal parasites such as worms of the intestinal tract cause a lack of thriftiness and poor feed conversion in layers that are kept on the floor or on free-range. Parasites put stress on the immune system and can result in the onset of disease.

External parasites that often cause problems on poultry farms are mites. Mites lay their eggs in crevices and these will hatch under favourable conditions of temperature and moisture. Thorough cleaning with high-pressure hoses is an important step to assist in the control mites. Insecticides are however necessary for effective control.

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MANAGE COMMERCIAL LAYERS

Introduction

The intention with this booklet is to discuss management aspects from the arrival of point-of-lay pullets and during production. The emphasis throughout the discussion will be to try and give information to enable the reader why certain management practices are in place.

Receiving and housing point-of-lay pullets at 16 / 17 weeks of age

Removal from crates and placement in cages / on the floor.	Handle with care, avoid jerking and injury. Avoid fractures to wing and leg bones; the healing puts stress on the bird and nutrients are used to heal damaged tissue.
Access to feed and water as soon as possible.	Birds are still in a growth phase and forming muscles and internal organs. Reproductive organs enlarge and liver is forming yolk for deposition in ovary. A few birds already in lay and forming egg shells.
Avoid as far as possible the factors that cause stress: Exposure to sun, rain, wind, banging of trolleys, absence of feed and water.	Stress is a condition in which the brain stimulates muscles to contract. Glucose levels become low and not enough energy is available for panting, to shiver or move to water and feeder lines.
Obeying stocking density figures.	Overcrowding of cages or floor space causes production drops. There is a code of practice for cage and floor densities to which farmers have undertaken to obey for welfare reasons.
Safeguarding of documentation received from the pullet rearing company: 1. Light programs 2. Vaccination program during rearing (This column continues on the next page)	1. Light program. The pullets have to be placed under an increasing pattern of light (photoperiods increasing ¹) to stimulate egg production. Layers subjected to a decreasing photoperiod (the number of light hours decrease) will start losing feathers and go out of production. The setting of time switches for a particular flock is therefore part of the documentation and must be displayed in the laying house. 2. Vaccination program during rearing. This important information enables the veterinarian to decide on a vaccination program for the new flock when there is disease outbreak in a nearby area. Especially if the new flock had not been vaccinated for that particular strain of the virus.

¹ Such as after the winter the days get longer and longer.

Receiving and housing point-of-lay pullets, continued.

Safeguarding of documentation from the pullet rearing company:	3. Growth and uniformity figures. The values on body mass give an indication of how well the pullets developed during rearing and achieved the target weights according to the standards for the breed. The figure for uniformity, the so-called CV, coefficient of variation, gives an indication of the spread around the average weight of the birds. In other words a low CV, say 8% would mean that there are not a large number of very light or very heavy birds, they are grouped closely around the average weight, the majority of the birds are on the same level of development and that a high figure during peak production could then be expected.
3. Growth and uniformity figures	
4. Production graphs	The graphs from the pullet grower give an indication of the potential production of the particular breed at a particular age. One will thus know whether the hens are performing better or worse than what they are capable of doing. The same applies for egg weight ² , feed intake and mortality figures. Egg size at a certain age is largely determined by a particular breed. However, the number of eggs that a hen will produce depends on management factors such as availability and quality of feed, house temperature and health of the hen.

The effect of environmental temperatures on laying hens.

The ideal temperature range of the environment for layers is between 18 – 24°C.

Within a temperature range of 18 – 24 °C the hen is able to maintain a constant body temperature without applying processes such as shivering to increase heat production because of cold conditions or to lose heat by means of panting because of very hot conditions.

The effect of temperature conditions outside the ideal: cold conditions.

During cold conditions the hen will lose more heat to the surrounding air than what is being produced inside the body by the many metabolic reactions associated with the life processes. This will result in shivering (muscle contractions) and the energy (from the feed) is obtained from glucose and those reactions are accompanied with heat production.
Feed intake is always higher in winter than in summer.

² Egg sizes are according the following weights in grams: medium 43 - 50; large 51 - 59; extra-large 60 - 67; jumbo more than 68.

The effect temperature conditions outside the ideal: Very hot conditions.

During hot conditions the hen will not be able to lose sufficient heat to the surrounding air. It means more heat is produced than what is being given off to the environment.

This causes an increase in body temperature and the brain reacts to depress appetite so that the digestive processes (muscle contractions) will not add additional heat to the body.

Hens start to pant to cool themselves by means of evaporation of moisture from the moist surfaces the inside of the respiratory tract.



Ventilation of laying houses

Purpose of ventilation, the four functions:

1. Removal of heat produced by the hens.
2. Removal of moisture produced by the hens and leaking water lines.
3. Removal of ammonia from the excreta.
4. Removal of dust from feed and bedding.

Removal of heat produced by hens, the first function of ventilation.

Origin of heat: Due to the many chemical processes occurring in the body, eg.

- Respiration and pumping of blood.
- Formation of the components of eggs.
- Digestion of feed.
- Replacement of worn tissue.
- Activity associated with movements to feed and drink etc.

Heat from the hens is passed on to the surrounding air in the building provided that the air temperature is much lower than 42°C, the hen's body temperature. Warm air is ventilated and replaced with cool air and the hens will be comfortable.

At outside air temperatures of 35°C the flow of heat from the hen to air at that temperature will be slow and hens will be panting to cool themselves by means of evaporation of moisture from the respiratory tract.

Increasing ventilation rate with air at 35°C will not have a cooling effect, cooling can only be achieved by pulling air through wet cooling pads and ventilating with air at a lower temperature than 35°C. (The factors affecting efficiency of cooling pads and panting will be the topic for a later discussion).

Removal of moisture produced by hens, the second function of ventilation.

Origin of moisture in the laying house.

1. From the urinary system.

Large amounts of water are used by the kidneys to flush uric acid out of the body by means of the kidney tubes. Uric acid (the white substance in excreta) is formed during the metabolic processes that occur in the body and because it is insoluble in water it has to be moved in a stream of water

almost like washing sand from a pavement. (Excretion of water by a hen is close to 100ml/day.)

2. From the digestive system.

Poultry are unable to digest fibre, such as in bran or the hulls of sunflower oil cake meal. Such indigestible material can only be expelled out of the digestive tract when it contains a lot of moisture. (Excretion of water close to 50 ml/day.)



Water changes to vapour and is taken up into the air

Removal of moisture from the laying house.

Moisture from the two aforementioned sources, and leaking water lines can be added, can only be removed from a building by means of ventilation. The water has to evaporate, become a vapour and taken up into the inside air of the building, and then ventilated. Evaporation is illustrated by boiling water that changes to steam, (vapour) and is taken up into the air, picture on the right.



During warm weather and low humidity in the air, evaporation will take place and bedding and manure under cages will dry out.

However, during winter the capacity of air to hold moisture is limited and wet bedding becomes a huge problem. In buildings equipped with temperature and timer switches that will stop the fans during the night to allow the temperature to increase and the moisture to evaporate before switching on again, is a procedure that can be used to remove moisture from bedding and manure. The setting of curtains to allow the inside temperature to increase so that moisture from bedding material can evaporate and ventilated, takes a lot of dedication and experimentation to succeed. There is no solution for condensation of moisture against a corrugated iron or asbestos roof except to have ceilings installed. In free-range houses the removal of wet spots and the turning of bedding to expose the underlying material to the air so that evaporate can take place, is the only way of controlling the moisture content in bedding material.

For all housing systems the management of the drinker lines is most important, all leaks have to be fixed with minimum delay.

3. From the respiratory system.

The water the hen excretes is by means of the respiratory system in the form of water vapour. Under normal conditions it will amount to 40 ml/day but during high temperatures when panting, it will most probably be twice that value. Under such conditions the hens are thus adding additional moisture to the air inside buildings where cooling pads are used in summer.

Removal of ammonia: the third function of ventilation

Origin of ammonia:

Ammonia is a gas that is formed by bacterial action on uric acid excreted by the hen.

Ammonia causes the degeneration of the inner linings of the respiratory tract and thus makes it easy for bacteria to infect the respiratory tract. High levels of ammonia also cause a drop in egg production. **Control of ammonia is to control the moisture content in litter under the cages or in the bedding material.**

Removal of dust by means of ventilation: The fourth function of ventilation

Origin of dust:

Dust in laying houses originates from the feed and from dry bedding in free-range houses.

It is important to control dust as it is a carrier of disease causing organisms as well as a contaminant on eggs. In houses with fans ventilation will remove a lot of the dust provided that inlets and fan blades are clean and fan belts are tight enough to prevent slipping.

Principles of air flow in poultry houses

1. Open-sided houses (Naturally ventilated houses)

Wind that blows against the building forces the air into and through the building. The size of the opening of the curtains or the flaps determines the amount of air that flows through the building and these are adjusted according to prevailing wind and temperature conditions.

Cold conditions:

Hens are able to withstand temperatures as low as 5°C without difficulty but that puts some stress on their energy reserves as they will shiver to maintain a constant body temperature. Increases in feed intake during cold weather is an attempt to obtain energy to maintain their body temperature. Regular visits during such conditions are important to ensure bird comfort.

Hot conditions:

To alleviate adverse conditions, roof sprayers will help and should be turned on long before midday. The evaporation of water from the roof cools the asbestos or iron roof and makes a big difference to the inside temperature of the building.

High pressure mist sprayers, sometimes in combination with circulation fans from the roof, will also make a big difference to the inside temperature on hot days. It is most important that when using such sprayers to be certain that some air movement due to a breeze is taking place and that there is no built-up of humidity in the inside air. Mist sprayers on a timer switch can cause a built-up of humidity, a constant evaluation of the situation is necessary to switch sprayers off in time before humidity gets too high, for example more than 65%.

The pump supplying the mist must be in good working condition and that the size of the droplets is such that they evaporate within seconds. Water must not drop onto the floor, as that will result in catastrophic high humidity and high mortalities.

2. Closed houses: Mechanically ventilated layer houses

Fans are used to create an area of low pressure where it blows the air out of the building at one end and the air enters through louvers along the side walls or through inlets at the other end of the building, the so-called tunnel ventilation system.

Factors determining success:

1. Air speed at inlets. The air has to enter the building at high speed (2.5 meter per second) to ensure proper turbulence and mixing of the air. For a certain volume of air that is being moved by the fans, air speed through a louver will increase when the size of the opening is decreased.

It means that when more fans come on all louver openings must adjust to make the opening larger in order to ensure that wind speed remains the same. The main problem with low air speeds is,

especially during winter, is that the air does not mix with inside air but drops to the floor causing cold, and wet, spots in those areas.

2. Air leaks should be sealed to ensure that wind speed passing through the louvers is the same for all and that no short circuiting of air takes place. Air takes the shortest route to the extractor fans.

3. Mechanical condition of the equipment. Maintenance is most important, fan blades and inlets that have accumulated dust decrease wind speed, fan belts that are not tight enough will slip and fans will deliver less air, louvers that are sticky or remain open will cause uneven distribution of air.

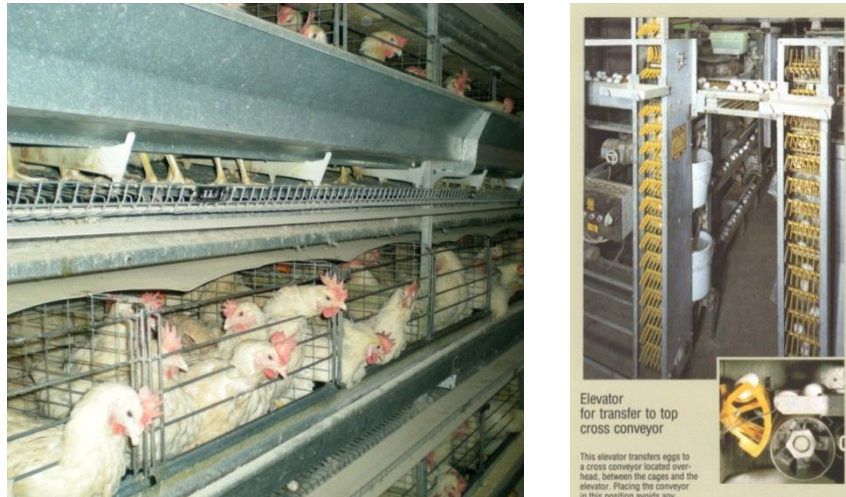


Figure 1 Battery cage system with automatic egg collection belts running in front of cages and end collection

Evaporative cooling of mechanically ventilated laying houses

1. The principle of evaporative cooling is that when water evaporates, cooling takes place. The proof of this statement is that the temperature of water in a boiling kettle remains the same as long as the kettle contains water, thus heat was taken up from the water and no temperature increase occurred. When air is drawn through a wet pad, evaporation of water takes place and heat was removed from the air. The surface of the pad is cooled and so also the air moving through the pad.

The temperature of the water is not important, cooling occurs because the water changes from a liquid to a vapour.

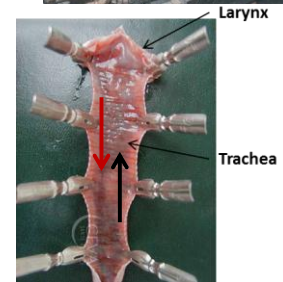
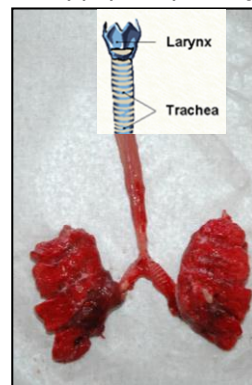
2. The decrease in air temperature is determined by the amount of water that is present in the air before going through the cooling pad. If the air already contains a lot of moisture, it is obvious that not a lot of water will evaporate and the cooling effect will only be one or two degrees. However if the air is dry, in other words of low moisture content, the cooling effect will be much greater, for example six to eight degrees.

Evaporative cooling: the mechanism of cooling when hens pant

Hens will start panting at air temperatures of 28 – 30 °C.

The air inhaled during panting cause evaporation of moisture from the wet membranes lining the mouth cavity and upper regions of the respiratory tract. This results in cooling of the blood flowing through these membranes and the cooled blood that returns to the inner body cools those tissues. This enables the hen to maintain a constant body temperature.

Windpipe (trachea) and lungs



When inhaling air (red arrow) evaporation of moisture takes place on the wet inner surface of the trachea. Blood in contact with the trachea is cooled and returns to body tissues and cools the bird. Black arrow shows air leaving the body.

The very same principle applies as was mentioned in paragraph 0, item 2, namely that the decrease in temperature will be determined by the amount of water present in the air inhaled by the hen. If the air already contains a lot of moisture, not a lot of water will evaporate and the cooling effect will only be one or two degrees. However if the air is dry, in other words of low moisture content, the cooling effect will be much greater, for example six to eight degrees. Inside the laying house when evaporative cooling is on, the air inhaled by the hens is high in moisture content and evaporation from the membranes in the respiratory tract is low and very little cooling takes place. That is why it is important to switch the mist sprayers off when humidity inside the building becomes high, say more than 65%.

Effect of environmental temperature on feed intake

Effect of low temperatures

During low temperatures, for example 15°C, the hens will be losing more heat than what is produced by the normal metabolic processes inside the body. The brain will react and will “tell” the muscles to start shivering. Shivering is a process of muscle contraction and like all actions of muscle contraction it requires energy to take place and as you know, in all processes the utilization of energy is accompanied with heat production and that enables the hen to maintain a normal body temperature of 42°C. (Hens increase their feed intake during low environmental temperatures to obtain energy for shivering).

Effect of high environmental temperature on feed intake

The muscle contractions by which feed is propelled through the digestive tract and by which undigested feed residues are transported require energy and are thus accompanied with heat

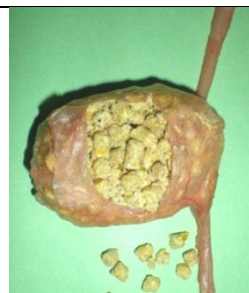
production. During high temperatures the hen has already difficulty to maintain a normal body temperature and the brain senses the additional heat load and “tells” the hen not to eat by suppressing her appetite. The decrease in feed intake causes a drop in production as well as a drop in egg shell quality due to the lower calcium intake. In an attempt to prevent poor shell quality additional shell grit or limestone grit is occasionally added into the feed troughs. It has been found that chilled or cool drinking water has a beneficial effect to alleviate heat stress; flushing the water lines a few times during hot days is also beneficial.

The provision and maintenance of drinking water for layers

Functions of water

Water³ is one of the most important chemical compounds⁴ in the animal body. Poultry can survive much longer without feed than without water. Only a few hours without water causes serious changes within the body that will have a marked reduction in growth rate and health of growing chickens and in hens it can result in a drop in egg production and the birds might go into a molt (lose feathers). If feed is withheld poultry can lose 40% of their body weight and still stay alive whereas the loss of only 10% in body water causes serious disorders and death occurs when 20% of the water in the body is lost.

Water is essential for the passage of feed into and through the digestive tract and the excretion of indigestible material. Picture of a chicken that was deprived of water shows that no movement of feed took place. Water is the medium for the digestion of feed. The chemical reactions between the digestive enzymes to break down the proteins, starch and fat in feed into their simplest components, the nutrients such as amino acids and glucose can only take place in a watery medium. Absorption of nutrients into the blood stream can only take place in a watery medium.



Water is the main substance of mucus secreted by the linings of the mouth and oesophagus. In the absence of water the feed cannot pass from the crop to the rest of the gastrointestinal tract to be digested.

Water plays a most important role during high temperatures to enable the bird to lose heat by means of panting. Without evaporative heat loss the bird will probably not be able to survive temperatures of 35 °C. (Panting starts at environmental temperatures of $\pm 30^{\circ}\text{C}$.)

Water is essential for the excretion of uric acid. Uric acid is the end product of protein metabolism in the body and it is a highly insoluble product. It means it has to be transported from the kidneys to the cloaca in a *stream* of water, almost like flushing sand. When birds are deprived of water the uric acid crystals accumulate in kidney tubes with rupturing of tubes when water is provided and causing instant death.

Water is an essential component of an egg. A 50g egg contains 33g of water and a water shortage

³ Scott, M.L., Nesheim, M.C. and Young, R.J. 1969. Nutrition of the Chicken. Humphrey Press, Geneva, New York.

⁴ *Chemical compound* is a phrase often used by writers to describe any substance in pure form fulfilling a certain function, for example glucose or table salt can be termed chemical compounds

causes an immediate drop in egg production.

Water management

Layers under normal circumstances would drink twice the amount of water than the weight of feed they consume, approximately 220 ml per day. Impurities in water such as high salt content or toxins from biofilms in water lines can thus have a very large effect on bird health and production.

Biofilms are colonies of bacteria that grow inside the water lines and produce poisonous substances that depress the digestive processes and egg production. When houses have been depopulated water lines should to be cleaned with the recommended product at the correct concentration and procedure. This operation forms an important part of the bio-security program on the farm.

Water filters should be cleaned at recommended periods of time to ensure that solid particles are not blocking the flow of water through the pipe line and depriving hens of sufficient drinking water. Taking of water samples must be done at the end of the supply line from which the birds are drinking as this can give an indication of impurities like bio-films inside the pipe. Sampling should not be done from one of the water taps outside the building as this might not be the supply line to drinkers. For the analysis of water quality it is necessary to collect a 2 litre sample from more than one locality into clean containers and samples should be delivered within 6 hours to the laboratory. Needless to say samples should be clearly marked with a water resistant ink on the container.

Water consumption is as important, if not more important, than feed consumption figures. Abnormal high levels of water consumption can be an early warning of a disease condition. Water intake increases and feed intake decreases when birds are becoming ill and show signs of scouring (diarrhoea and high excretion of urine).

Water meter readings should always be taken at the same time of the day and plotted on a graph to make interpretation of trends easy.

The signs of water deprivation: a When the water supply has been turned off accidentally to a row of cages (this happens when drinkers were repaired and it was forgotten to open the stop valve again) the birds will peck at the dry water nipples or drinkers. The next sign is the dry appearance of excreta with very little urine excreted. The feed trough will also show no signs of feed being consumed. The combs of the hens start turning blue and production stops in cages that are without water. A final sign of water deprivation will be when shedding of feathers occur. Production will resume 10 days or more after water had been provided.

Feeding programs for layers

Feed cost is 70% of the production cost of eggs. It thus means that if it costs R1.00 to produce six eggs the cost of feed alone amounts to 70 cents, all other expenses such as electricity, packaging material, vaccines, salaries of staff is only 30 cents. Feed wastage or any factor affecting the hen that she skips a day and not laying an egg will have a big influence on the cost of production process and profitability of the operation. (When an operation is no longer profitable it will close down.)

Feeding the young pullet into production. The quantity of feed the young pullet is able to consume ($\pm$ 85g per day) is limited by crop size and therefore the concentration of nutrients in the feed of young birds is normally higher than in diets for older layers. The feed supplier will formulate a feed

according to the daily feed intake level and assign a code to the feed which is normally an indication for recommended intake to enable the pullet to grow into maturity and at the same time be able to form an egg.

Importance of accurate feed records

1. The feed company includes the various nutrients such as calcium or energy to supply in the needs of the hens at a particular age and level of production. It is, however, important to enable the manager to give accurate feed-back on consumption figures so that the nutritionist at the feed mill will be able to evaluate whether the hens are not being underfed nor overfed.
2. Feed records are essential to be able to calculate the quantity of feed the hens are consuming to produce one kilogram of eggs. When such figures are way above the norm it would be necessary to find reasons for such deviations: for example wastage of feed, conditions of low temperatures in the laying house or a low level of disease that depresses egg production.
3. Presence of poisonous substances in feed will result in a depression of appetite and lowering in production and such problems can only be detected with accurate feed records. Mould growth in leaking feed bins or in feed troughs because of some birds regurgitating onto the feed, will depress production.
4. Detection of the depression of production due to the consumption of unbalanced diets and uneaten feed. The daily 'turning' of feed in the troughs ensures that wet lumps are loosened and that the fines (the vitamins and the micro-minerals) in the feed are also consumed. The feeding times on the programmer for the feed chains should be programmed to operate four to six times per day to ensure that feed is always available but that the feed levels in troughs are not too high and the essential nutrients are not being consumed. Hens prefer to consume the coarse and granular fractions first and to leave the fines in the trough.



Receiving feed deliveries

1. It is important that the person receiving a load of feed will be familiar with the colour of normal feed and of the structure of feed whether crumbs or mash. Abnormalities such as coarse salt, high levels of fibrous substances such as bran or pellets must be reported to the manager.
2. It is essential that a 10 kg sample of every new feed delivery will always be taken and properly marked with the delivery date and invoice number. In cases of disputes with the feed mill a sub-sample of the feed must be retained by the farmer and sealed in the presence of a police officer.

Light programs for layers

The supply of light to layers is one of the most powerful tools to ensure a constant level of production. Before the discovery of the effect of light on birds (some 80 years ago) egg production during autumn decreased and ultimately stopped during winter due to the decreases in hours of day-length. By supplying light to keep the day-length constant it became possible to have hens maintaining their level of egg production regardless of the time of the year.

The mechanism by which light affects commercial layers

1. Light is a form of energy. It is capable to penetrate the skull of the hen and to stimulate the brain to secrete hormones. Hormones are chemical substances that stimulate the liver to produce yolk material for deposition in the ova⁵ contained in the ovary.
2. The stimulatory effect of light on egg production is brought about by the pattern of lighting. Increases in the light period has the effect in young pullets to bring them into production and by maintaining the light period on a constant level of 14 - 16 hours per day, egg production is maintained on a high level throughout the year.
3. Layers should never be exposed to a declining light pattern or variations in light period during the production period. It is thus most important to check the time switches every morning to ensure that they are on time and according to the light program for a particular flock.

Egg formation and egg quality

Organs involved in egg formation of an egg: the ovary and the oviduct.

The ovary. The ovary is the organ that contains the reproductive cells of the hen, each within a follicle (a little bag) into which yolk material, formed by the liver, is deposited.

Prior to sexual maturity the ovary, on the right, is a mass of small follicles containing the germ cells (reproductive cells) of the hen. Several thousand are present in each female, which is many times more than the number that will eventually develop into full sized yolks in the eggs the hen will lay during her lifetime.



The ovary, marked a, in the picture, contains the ova, the reproductive cells of the hen, *yolks* in popular language.

The opening of the oviduct, b, surrounds an ovum which will be taken up into the oviduct, c, after its release from the ovary.

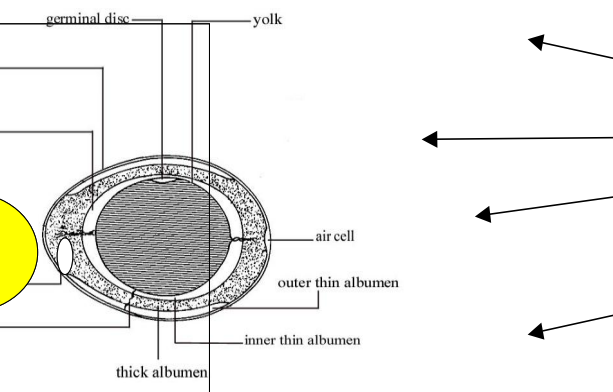
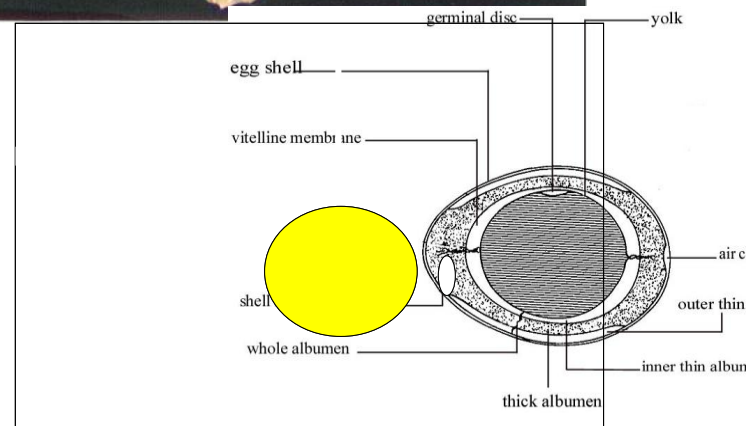
During passage of the ovum through the oviduct, albumen is secreted around the ovum, section c. Shell membranes are then formed in section d, to cover the newly formed egg mass. Calcium carbonate is secreted in sections e and f to form the shell.

⁵ Ova are the reproductive cells of the hen

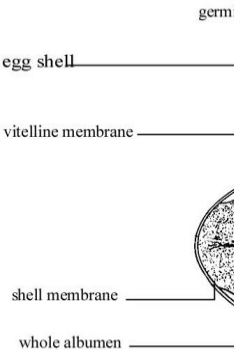
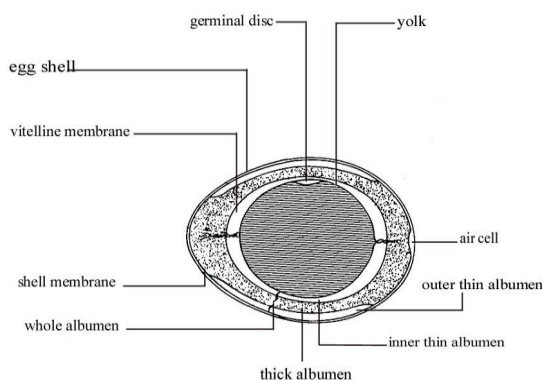
In everyday language the word “yolk” refers to the ovum. However, yolk is actually the yellow material in the ovum and it consists of fats, proteins, minerals and some water. Yolk is so commonly used that the reader must just keep in mind that yolk is a misnomer for the ovum. The colour of the yolk is used as an indication of egg quality, heading, 0.



The contents of an egg consist of egg yolk, two layers of thin albumen, and the layer of thick albumen, generally known as the white of an egg. The layer of thick albumen is used as an indication of the quality of an egg, discussion on this is a separate topic. Also take note of the air cell at the blunt end of the egg which is a rough indication of the age of an egg.



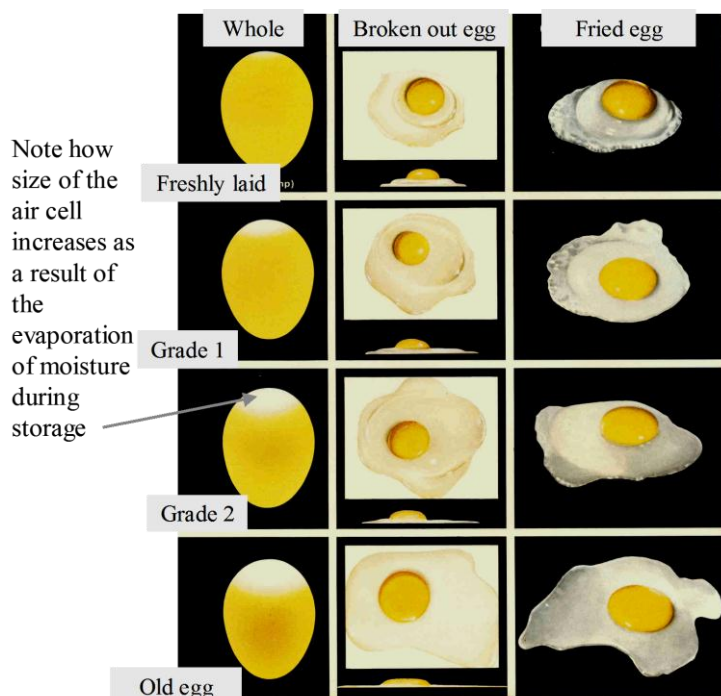
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Startup Farming

Internal characteristics of eggs: Albumen height and yolk colour

The height of the thick albumen is generally used as indication of internal egg quality



In the freshly laid fried egg the thick white (albumen) stands out and has clearly a firm jelly-like appearance. The albumen of the Grade 1 egg still shows some firmness but not to the same extent as in the freshly laid egg. The thick albumen starts to become more fluid and in the so-called old egg the albumen clearly has a watery appearance. It is thus mainly the height of the albumen (egg white) that declines with age.

The height (firmness) of the thick albumen is used as a characteristic of quality and is expressed in Haugh units. A Haugh unit takes into account the weight of an egg as well as the height of the albumen. The height of the albumen from a flat surface is measured with a micro-meter mounted on a tripod as shown in the picture.

During storage of eggs, especially under high environmental temperatures, the albumen becomes watery very rapidly and that results in a low Haugh unit value. This can happen within two days after an egg is laid, it can thus by far not be described as an *old egg*. The recommended⁶ storage temperature for eggs is 12 – 15 °C and a relative humidity of 70 – 80%.



The yolk colour is also used as indication of internal egg quality

Yolk colour has been standardised by the "Roche" colour fan, which is a set of yellow coloured blades varying from a very light yellow (number 1 on the fan) to a dark or almost reddish yellow (no 14) and values between 10 to 12 are acceptable. Yellow maize is the main source of pigments for yolk colouring. Layers on free-range would have a much higher level of the yellow pigments in their egg yolks due to the pasture to which they also have access to. Yellow pigments are covered with the green chlorophyll in leaves and therefore not visible.



⁶ Egg quality handbook. Queensland Dept of Primary Industries, Q190014.

Abnormalities of internal egg contents

Blood and meat spots. These originate from the membrane surrounding the ovum. When this membrane rips open to free a fully developed ovum a fragment of tissue or a blood spot is included with the ovum in an egg. These are often mistaken for an *embryo* by a customer.

Double yolked eggs. At the onset of production when a flock of pullets come into production a higher number of double yolked eggs will be noticeable. This is because of unstable levels of hormones that have been involved in the stimulation of sexual maturity and had caused more than one ovum in the ovary to be ovulated, the ovums come free simultaneously. The situation reaches normality once the birds' metabolic systems have settled down. More often is the cause of double yolked eggs a light program that was increased too rapidly. It also occurs where young pullets are placed with older hens in the same building in which the light program is already at the maximum number of hours, for example 16 hours.

Bacterial and fungal contamination of eggs.

The greatest threat to internal contamination of eggs by bacteria is from the persons collecting the eggs and handling eggs during packing. *Salmonella enteritidis* is a bacterium that can be transmitted from human carriers to eggs and equipment. This bacterium causes diarrhoea in humans and it is most important that persons handling eggs should be aware of the importance to wash their hands after they have been to a toilet. Soap that contains a disinfectant and paper towels should be available in all toilets and rest rooms on an egg farm.

Other routes of contamination:

- The cloaca, if hens are suffering from scouring (diarrhoea).
- Egg collection belts, packing material and nests contaminated with faecal and egg contents from broken eggs.
- Poor handling during egg collection results in hairline cracks causing easy penetration and access for bacteria to egg contents.
- **Poor environmental conditions, such as dirty equipment, floors, clothing of workers, rodents, and cockroaches etc.**

External quality characteristics of eggs

Factors affecting shell defects (Such eggs cannot be marketed)

Age of the bird: Shell thickness decreases with age because hens have lower calcium reserves and eggs from older hens should thus be handled with more care than eggs from younger hens.

Shell strength is related to the thickness of the shell. Shell thickness is typical to particular a breed.

High environmental temperatures lead to decreases in eggshell strength probably because of lower feed (calcium) intake during hot weather.

Diseases such as EDS (egg drop syndrome) affect shell quality, picture on the right.





Picture on the left show shells are dented and/or have thin shells and albumen is watery due to Infectious bronchitis, IB.

Factors affecting the appearance of egg shells (Not marketable)

Cleanliness of the shell.

It is a most important aspect from the consumer's point of view that eggs will be clean without adhering dust or faecal matter. Dirty cage floors, egg collection belts, dirty nest material, used egg trays, hands that handle eggs can all contribute towards eggshells being contaminated with dirt (Washing of eggs removes the waxy layer and spoilage bacteria that can be drawn into the egg to cause rot).

Stained shells and fly marks.

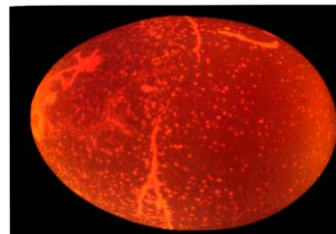
Staining on the shell surface could be as a result of various substances such as blood caused by prolapsing, faeces and contamination from broken egg matter.

Open cracks

Are associated with the shell membranes being damaged or broken. The careless stacking of egg trays and the handling during collection all cause damage to the shell.

Hairline cracks, (left)

Are very fine cracks that are only detectable by candling⁷. Main causes are rough handling during collection.



Pinholes, (right)

Are very small holes in the shell. Older flocks, poor nutrition and sharp objects in the cage system could be the possible causes.

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⁷ Candling is the process whereby eggs move over a strong light to enable the detection of shell defects

Diseases that affect layers in cages and on free-range systems.

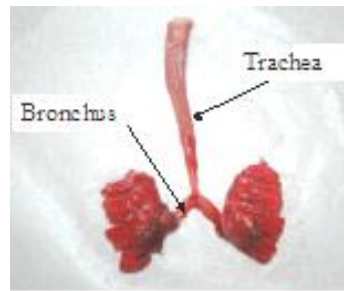
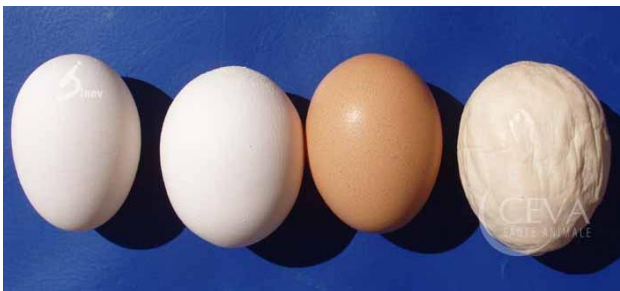
Diseases caused by viruses

New-Castle disease.

There are three forms of New-Castle disease: the mild form that causes low mortalities but a decrease in egg production, a second form that is more severe and the third form that causes a very high mortality, up to 80% of the flock gets infected. Symptoms are watery nostrils, gasping, trembling, egg shells vary in colour and twisting of the neck. In some cases the inner lining of the stomach, the proventriculus, show blood spots in the tissue.



Infectious Bronchitis (IB). The bronchi⁸, those tubes that connect the lungs with the respiratory tract (trachea) have been infected by the virus. Infections due to *E. coli* causes cheese-like material to accumulate in the bronchi, the bird has problems to breathe and show signs of gasping. Egg shells are rumpled and vary in colour.



Diseases caused by internal parasites

Coccidiosis

The causative organisms of coccidiosis are protozoa. The coccidia need favourable conditions of heat and moisture outside the body to become infective. The chances are thus slight for layers in cages to get infected.

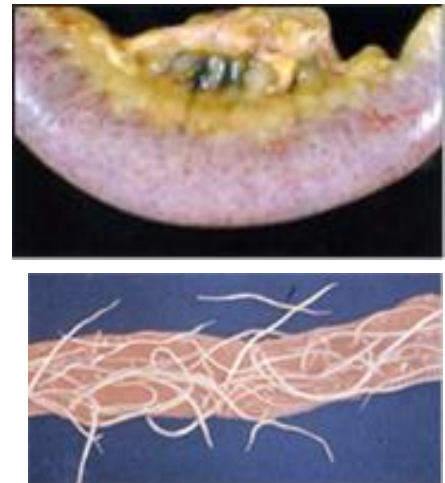
When coccidia are consumed in the active form they will invade the intestinal wall causing large-scale damage to the tissue, visible from outside, and blood can also be seen in the excreta. Floor-reared pullets are thus vaccinated to make them immune against coccidiosis.



⁸ One tube is a bronchus but more than one are called bronchi. Inside the lung many branches of the bronchi, called parabronchi, bring the air in contact with the lung tissue to enable the supply of oxygen to red blood cells

Intestinal parasites, worms

Adult worms in the intestinal tract produce eggs that are excreted with the droppings. After a period of 7 – 14 days outside the body the eggs have become infective and re-infection takes place. Worms damage the intestinal wall, compete with the hen for nutrients and cause blockage of the intestines. The control of worms is by means of inclusion of anti-worm preparations in the feed.



Apply bio-security programs on layer farms.

The purpose of bio-security is to prevent contact between layers and disease causing organisms

Means by which disease causing organisms can enter a layer farm:

1. People are the main transporters of disease-causing organisms onto a farm. Most people visiting poultry farms have had some previous contact or involvement with poultry or with people who deals with poultry.
2. It is most important not to allow visitors into poultry houses before they had gone through a shower and changed into clean clothes and shoes.
3. Wild birds are carriers of viruses that cause Newcastle disease, IB (infectious bronchitis), coryza and MG (mycoplasma gallisepticum) and MS (mycoplasma synovia). It is indeed not easy to keep wild birds out of laying houses but one should stop applying all possible means to achieve this. Nesting of wild birds on rafters and roof beams should not be tolerated.
4. Feed wastage at feed bins is especially bad and wild birds get to know feeding spots.
5. Rats and mice are carriers of a bacterium know as *Salmonellae enteritidis* and eggs that are contaminated with those organisms are not allowed to be marketed. Those organisms are difficult to control and cause diarrhoea in humans.

The role of sanitary conditions in a bio-security program:

1. Sanitary conditions: This means cleanliness and the removal of waste, dust and material such as fats and oils in all working areas. These materials provide protection to bacteria and viruses, for example the Newcastle disease virus can survive for several weeks when protected against the sun and disinfectants.
2. Disposal of dead birds. These should be disposed of in a proper manner, for example incinerated or placed in mortality pits with tight fitting lids to keep flies out. Dead birds harbour viruses and bacteria.
3. Control of flies is most important and should take place at their breeding sites. Wet manure provides an excellent medium for flies to breed in and every effort should be made to prevent water leaks onto manure under the cages. Fly control on a layer farm is also most important to prevent fly marks on eggs.

Stimulation of immunity as measure to control disease

Purpose of vaccination is to stimulate immunity to control diseases

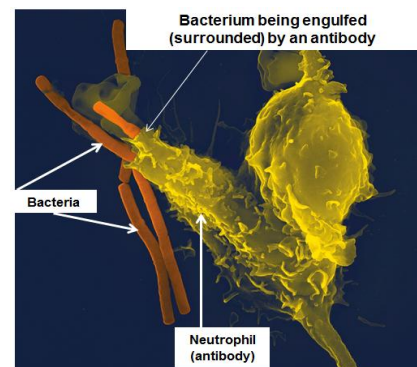
A vaccine contains the viruses of a disease in a weakened form. When these are given to the hens by means of a spray or in the drinking water, it stimulates the production of antibodies.

The most common route of administration by which the vaccine can enter the body is through the mucous membranes of the eyes or mouth and then into the blood stream (eg vaccines administered by means a spray or in the drinking water).

The circulating blood passes through organs⁹ that have the ability to make antibodies against these bacteria or viruses. The antibodies are very specific for the agent that was used to make the vaccine: whether it was a mild or virulent form of New Castle disease virus, an IB or Gumboro virus etc. These antibodies then circulate in the blood stream and assist in protecting the cells of organs that will be invaded by the virus.

The antibodies recognize the virus strain that was used to make the vaccine and that means they will immediately attack that particular virus whenever it enters the blood stream in future. They make it harmless by binding to the virus. The accompanying picture shows the antibody that engulfs (covers) a bacterium present in the blood stream.

(Picture copied from Wikipedia, the free encyclopaedia)



Antibodies are proteins and thus not stable compounds. Their concentration (numbers per ml) decline over time and it might happen that they can be overwhelmed if large numbers of the virus invade the bird. Therefore layers have to be vaccinated with certain intervals to ensure that their antibodies remain on a level sufficiently high to protect the birds against diseases that are prevailing in an area.

The antibody level for a particular disease (also known as the titer count) is therefore a good indication of the degree of protection against that disease. Bear in mind that antibodies are produced specifically in response a particular virus strain, which means the strain that was used to make the vaccine. It does not protect against another strain of the virus or to viruses causing a different disease.

Vaccinating the layer flock: Important considerations

1. Health of the birds. Only healthy birds must be vaccinated. A vaccine contains the disease causing organism and it places a stress on a bird when those organisms are actually put into its body. In some instances birds would indeed show slight signs of the disease for which the vaccine is being applied. The formation of antibodies is poor in unhealthy birds and they are not well protected.

⁹ Organs involved in the production of antibodies include the thymus, bursa of Fabricius, bone marrow, the spleen, Harderian gland, cecal tonsils, Peyer's patches in the intestinal tract and Meckel's diverticulum

2. Handling vaccines for spraying or aerosol:
3. Equipment must be clean and tested for operation before mixing the vaccine solution because live vaccines have a limited lifetime.
4. Ensure that cold chain has been maintained and check expiry dates and that the number of doses matches the number of birds to be vaccinated. The level of immunity depends on the activity of the vaccine and that the correct amount of vaccine will be taken in by the hens.
5. Ensure that the mixing water is free of chlorine or other disinfectants. The organisms in the vaccine will be killed by a disinfectant. (During house cleaning disinfectants are used to kill probably the very same organisms that were used in the preparation of the vaccine.)
6. When spraying make sure that the recommended spray nozzle is on so that droplet size will be correct. The size of the droplet determines how deep the spray will penetrate into the respiratory system of the hen and reach those organs that have to be protected against respiratory diseases.
7. It is most important that all birds receive the correct dose of the spray so that the immune development will be according to the required level. Birds should thus be sprayed twice to ensure the same level of immunity in all birds. (Birds with poor immunity will develop the disease when the virus makes contact with them and will serve as a source of contamination for other birds.)

Monitoring the health status of layers

Estimating the level of protection: Blood sampling

Immune status and blood sampling.

The immune status (level of antibodies) is not on the same level for all birds in a flock. It is thus important that the farmer will have blood samples analysed to establish the situation in his flock. Antibodies for diseases such as New-Castle disease and IB have a limited life span in hens, approximately 4 months, and depending on the disease challenge in an area it might be necessary to revaccinate with fairly short intervals. The veterinarian is the best person to advise.

The number of samples to take.

Important to ensure that a representative number is taken for the size of the flock. At least 30 individual hens must be sampled from a flock of a 1000 birds and blood must never be pooled, that means blood from one bird added to that of another. It is important for the veterinarian to see what the variation is between individual birds. It might be that the average titre count of a flock is within the limits of safety but that up to 30% or more can fall in the danger zone, in other words they would contract a disease, the virus multiplies in those birds and will infect birds in the safe zone.

Handling of samples. Blood is collected by stabbing the vein on the underside of the wing and vials filled to a height of at least 2 cm into the tube. Do not shake the tube as this causes rupturing of blood cells. Allow the blood to clot. If the samples can be taken to the laboratory for analysis on the same day, no further processing is necessary. If this is not possible the clot is loosened from the wall of the tube by means of a sterile paperclip (sterilize by dipping into alcohol) and the samples left for 12 – 18 hrs at room temperature. During this period the serum separates from the clot and can then be poured into a clean tube, or the clot removed and the samples stored at 4°C in a refrigerator. During transportation to the laboratory the samples should be kept cool. If the serum had been frozen it must be kept in a frozen state.

Monitor the performance of the laying flock

Record keeping: The most important tool for success on a farm

A graph is a way of painting a picture from a set of figures and to make sensible and correct decisions. One has to see when production drops occur and be able to relate that to changes in environmental temperatures or a vaccine reaction, water shortage or perhaps to a particular load of feed that was delivered. Accurate records are the most valuable management tools on a layer farm. Hen-day production takes into consideration mortality and gives an indication on the level of production of the number of hens in the house.

Hen-day production figures are calculated by dividing the total number of eggs during a certain period, say 6 days, by the number of hens in the building during that period, multiplied by 6. For example $880 \text{ hens} \times 6 = 5280 \text{ hen-days}$. The total number of eggs collected during that period amounted to 4541 eggs. The hen-day production is then $4541/5280 = 0.86 \text{ egg/hen-day}$. This figure is normally multiplied by 100 and thus expressed as percentage, ie 86%.

Daily mortality figures.

These are essential for calculation hen-day production figures but also to be able to evaluate health status.

The daily maximum and minimum temperatures. These provide information that can be used to explain variation in feed intake, production and even shell quality.

Feed consumption. Feed cost amounts to 70% of the production cost. Accurate records are essential to be able not only to determine feed wastage but also to identify factors such as house temperatures, vaccine reactions, a variation in nutrient density or even changes in raw material composition of diets that could have caused increases in feed intake.

Feed samples. These are essential to safeguard in case a particular batch of feed had caused a drop in production that could not be ascribed to factors such as high temperatures, water shortage in one or more lines, lights that had been out for some time, a vaccine reaction or any other abnormal condition that had existed. It is indeed best to keep at least a 10 kg sample of feed instead of the 500g that is normally delivered with a batch of feed.

Water consumption.

Daily records, and readings must always be taken at the same time every day, is a very sensitive and good indication of conditions in a laying house. Errors, such as a high salt content, at feed mills do occur occasionally and result in extremely wet droppings.

Increases in water intake can be an indication of a disease, provided that temperatures have been on the same levels as on previous days.



Stockman ship

This is the ability of a person to be able to notice or detect when something is wrong or has gone wrong in the laying house or on the farm.

It is skill that has to be acquired by looking at, listening to and sensing conditions inside a laying house and be able to notice whether things are according the norm or whether something will go wrong if not fixed immediately or has already gone wrong and is having negative effects on production.

How does one become a good stockman? It is definitely a never ending journey, you have to teach yourself and the willing person will always be learning and noticing new angles to bird behaviour and situations that when these are understood and correctly dealt with, always have a big impact on effective production practices and lot of job satisfaction for a person.

The following are some common problems to be aware of:

1. Spend time watching bird behaviour. Be familiar with the normal actions when feeding. Be on the lookout for abnormal actions such as only pecking at the feed and not swallowing the feed, feel their crops especially some time before the lights switch off when crops are filled for the night. Be on the lookout for birds regurgitating water onto the feed which could be due to high levels of salt in the feed.
2. Familiarise yourself with the appearance of the excreta and how house temperatures affect the consistency. Watery excreta could point towards scouring due to some form of diarrhoea for which professional advice must be sought.
3. It is important to recognize sounds that the birds make when content and how it changes with conditions such as water shortages. This is something that happens quite frequently when a water line was turned off to replace leaking nipples and it was forgotten to turn the water on again. In the beginning it might only be a slight increase in the normal tone of vocalizing but it will increase with time and should be recognized as unusual. If not corrected the excreta becomes dry, birds don't eat and under serious dehydration they will start losing feathers. The observant stockman will notice the drop in egg production in a particular line long before birds stop eating!
4. Be on the lookout for shell discolouration. Diseases that affects shell colour are Newcastle disease and Infectious bronchitis.

Startup Farming Agricultural

Training | Education | Empowerment

Layer Production

Glossary of terminology

Startup Farming

Note to the learner

The Glossary of Poultry terminology set out below serves to provide you the learner with a list of commonly used terms that are applicable to the Poultry industry. Many of the terms set out below are found in other industries as well, however the context we are focussing on is that of the poultry sector in particular Broiler Production.

GLOSSARY OF POULTRY TERMINOLOGY	
WORD OR CONCEPT	
Air leaks	Doors that do not fit or seal properly allow air to enter. In mechanically ventilated buildings air leaks result in the lowering of air speed through the louvers and the air does not mix properly with inside air. This is because such leaks (openings) have increased the total air inlet size, in other words more space is available for the air to enter into the building causing insufficient turbulence of the air. It is also important that all louvers will open to the correct size.
Ammonia	Ammonia is a gas with an irritating and pungent smell. It is somewhat soluble in water. A product known as Scrubs of Ammonia generally used as cleaning agent by many households.
Ammonia control	Ammonia is a gas that causes movement of cilia on the inner lining of the respiratory tract to stop and to degenerate, be sloughed off, baring the inner tissue layers and making it easy for disease causing organisms to penetrate the body and cause disease. <i>Also see skin cracks</i>
Ammonia on the health	The gas causes a degeneration (sloughing off) of cilia in the respiratory tract and suppresses the functions of those organs involve in the production of antibodies to protect the bird against virus infections
Antibacterial compound	Is a substance that has the ability to destroy bacteria, such as lysozyme, when it comes in contact with those organisms. Lysozyme is present in saliva (spit) and in tears of the eye.
Antibodies	Antibodies are proteins that are produced by organs involved in immune development, such as the thymus glands in the neck of the bird or the bursa of Fabricius in the cloaca. The development of antibodies against a certain disease is stimulated in response to a vaccine that was made from organisms (bacteria or viruses) that causes that particular disease, say IB or Newcastle disease. Antibodies will also develop in birds in response to a live virus transmitted by wild birds and they might die if large numbers of the virus penetrated their bodies and antibodies were not produced quick enough to neutralize the viruses.
Bacteria	Bacteria are more hardy organisms than viruses and many different types occur in poultry houses, in the dust, bedding and in the excreta, not all cause disease symptoms. Many bacteria serve useful purposes by degrading waste material and some types are used for the production of medicine.
Bedding	The main requirement for a suitable material is that it must be clean, free from mycotoxins and be able to absorb moisture excreted in the faeces. Wood shavings are the best but have become expensive and scarce. Other materials such as sunflower hulls, chopped mealie cobs and peanut hulls are also used in

areas where such products are available. A normal practice is to buy bedding that has been fumigated with formaldehyde to ensure that no harmful bacteria and fungi are present.

Belly

The soft part underneath the chicken containing the internal organs such as the intestines.

Carbon dioxide

The gas exhaled by the chicken, the chemical formula is CO₂. It is formed in body tissue as a result of the utilization of oxygen when glucose is oxidised ('*burned*') to render energy for reactions such as muscle contraction, formation of proteins and all the many other metabolic reactions taking place in the tissues of the body. Carbon dioxide is transported to the lungs where it is exchanged for oxygen and exhaled through the respiratory tract. It is used in hatcheries to euthanize (kill) the day-old male chickens of commercial laying-strain poultry as well as other chickens.

Carriers

Disease causing organisms can be transported on peoples' clothes, their shoes, in their hair and on their body. People can thus be regarded as carriers of bacteria and viruses. Viruses can also be present in some organs of animals, especially wild birds or even other poultry. They might not show disease symptoms but the organisms are present in their body's system and they excrete the organism in saliva and in other cases the organism can be excreted in eggs by laying hens.

Cilia

Hair like structures in the respiratory tract that perform sweeping actions to move micro-organisms up the respiratory tract into the mouth cavity to be swallowed by the bird. This prevents infections of the lungs and air sacs. Ammonia causes a degeneration of these structures and makes it easy for organisms to penetrate the blood system and to make the bird sick.

Coccidia

This group of disease causing organisms are able to survive in the soil for years and when carried into the chicken house where it is warm and moist, they become infective (ready to cause disease) and when swallowed they penetrate the intestines causing massive bleeding. The reproductive cells of coccidia are excreted in the faeces and become infective again under favourable conditions of temperature and moisture in the bedding material.

Coccidiosis

A disease caused by coccidia that have penetrated the wall of the intestinal tract.

Collecting body weights

A representative sample of chickens are weighed individually with the purpose of establishing the coefficient of variation (CV) and also to see whether the birds have put on weight according to the standards that have been set by the breeding company.

Cracks to develop in the skin

Cracks in the skin under the feet of broilers are caused by high levels of ammonia in the bedding material. High moisture air in the bedding creates favourable conditions for bacteria to degrade uric acid with the liberation of ammonia.

Crumb and pellet sizes

Crumbs are normally produced by putting pellets through a roller and then to remove the very fine particles by means of a sieve. The crumbs ensure that a day-old chicken would consume a complete diet and thus gets all nutrients for a good start. The small pellets serve the same purpose of crumbs except that less wastage occurs with pellets.

Curtains

The main purpose with curtains is to protect the birds from cold wind. The curtain material has some insulating value which helps to maintain a favourable brooding environment during the early life of the chicken.

CV

CV stands for Coefficient of Variation which is a figure that indicates how widespread the body weights are around the mean value (average value) of the flock. A figure of 8% is regarded as acceptable but values higher than that is an indication that there is too much variation in weights; many chickens are in the lighter ranges and a lot of chickens in the heavy group, those close to the average weight is thus small which means not many chickens are available to the fast-food outlets such as Kentucky, who requires a uniform size that varies between narrow margins, for example between 1750 and 1850 grams and not between say 1600 to 1900 grams.

Dehydration

This means the chicken has lost a lot of moisture from the blood stream and therefore also from the tissues such as muscles and internal organs. Dehydration happens when chickens pant during very hot weather or during transport in the chicken boxes. They lose moisture during panting from the wet surfaces in the mouth cavity and are unable to drink enough water to make up for the moisture loss. Chickens also need a lot of water to excrete urine but when they are deprived of water the white uric acid crystals accumulate in the kidneys and on the liver.

Digestive system

Responsible for breaking up feed particles into absorbable nutrients such as glucose from starch and amino acids from proteins. Fats, minerals and vitamins are absorbed as such. The blood stream is responsible to carry nutrients to the different body tissues to enable them to grow and to fulfil essential functions in the body.

Disease causing organisms

These include the following organisms: viruses, bacteria and protozoa. These organism penetrate the body and attack specific organs and typical symptoms of a disease is caused. Fungi are very small plant-like organisms that produce poisonous substances (mycotoxins) onto the material they grow. These mycotoxins cause lesions (sores) in the mouth cavity and they also interfere with the production of antibodies to protect the bird against a disease.

Dislocation

It means that a bone is displaced from the joint to which it is attached. In some cases it might heal up again but it could also cause a malformed bird that cannot function properly and it becomes a runt.

Down

The hair-like structures with which the chicken hatches. It has very poor insulating value and if the chicken is placed in a cold environment it will lose a lot of heat. The down is replaced with chick feathers within a few days and the chick is then able to better withstand draughts provided the air temperature is not too low.

Draughts

It is air stream moving over the chickens and making them uncomfortable because of the temperature that is either below or above the range in which the chickens are able to maintain their body temperature without shivering or huddling.

Dust

Dust consists of very small particles of feed and material from the bedding. These particles are so small that they float in the air and can thus be removed by ventilation. They will accumulate on fan blades and louvers and can also be inhaled by chickens into the air sacs. Dust carries a very large amount of viruses and bacteria that can lead to a disease situation.

E. coli

The *E. coli* bacteria are the most common type in a chicken house and a chicken in good health will not be affected by these organisms. However, in a chicken that is suffering from a low level of disease these organisms will take advantage of the situation and will first multiply in the air sacs in the abdominal cavity but their numbers increase so rapidly that they spread to the membranes covering organs such as the heart and liver.

Efficiency of feed utilization

This term refers to the quantity of feed utilized to produce one kg of body mass. The terminology that is generally is the FCR value, this is the short for Feed Conversion Ratio. In practice it is calculated by dividing the quantity of feed consumed during the growth period by the weight of the birds delivered to the abattoir.

Egg yolk

The yolk of an egg is normally regarded as that yellow part that is surrounded by the white albumen. It contains the reproductive cell of the hen and after fertilization the embryo grows and utilizes the yolk material (fats and proteins) as well as the white albumen that consists also of proteins, and water. At the end of the hatching period what is left of the yolk material, is still contained in a sac and is drawn into the body cavity as reserve nutrients.

Energy utilization

The bird obtains energy from glucose. It is the same for humans, it is well-known that many energy containing drinks are on the market for long distance runners and other sports persons to serve as source of energy. The energy locked up in glucose is used for various purposes such as muscle contraction to walk, to enable various body systems to perform functions such as producing egg yolk, growing of feathers, growing of muscle, too many to mention. In all these reactions heat is produced as part of the energy that has been unlocked. The same situation exists in the engine of a car. Fuel is ignited to cause movement in the flywheel of the engine but at the same time heat was generated.

Evaporation

Evaporation is the changing of water as a liquid to a vapour into the air. Air movement over the surface of the water is important so that new air comes in to absorb the moisture. It is also important that in the case of drying bedding material one has to expose the wet areas to the air flow so that the water can be taken up by the air. That is why bedding material has to be turned. In a closed container water will not evaporate because the air in the empty space on top of the water is saturated with moisture.

Faeces

Faeces are the indigestible fraction of the feed which contain no more nutrients that can be absorbed and used by the bird. In poultry it is mainly the fibre fraction of the feed that makes up the faeces. An example of a high fibre product is sunflower husks or wood shavings.

Fan blades

Fan blades are the driving forces behind air movement. Depending on the design, a fan can either push the air in a direction or suck the air from an area. The displacement of air results in vacuum and air from a

neighbouring area will then move to fill the vacuum. The larger the blades and the higher the speed of the fan blades the more air will be moved.

Fungi

Fungi are primitive plants, they are also known as mould. They grow in moist conditions on almost any material and is most commonly seen in households on fruit such as peaches, bread, against the ceilings in bathrooms etc. Moist poultry feed is an excellent food source for fungal growth. During the growth process they secrete toxic substances, known as mycotoxins, onto the feed and when these are consumed by the birds they suppress the development of immunity after birds have been vaccinated.

Glucose

Glucose is the main source of energy for humans and animals. Inside tissue cells many reactions are taking place and all these depend on glucose as energy source. Oxygen is necessary for the oxidation reaction and carbon dioxide is the gas that comes free and is exhaled.

Graph

A graph is really the picture of a set of figures that has been collected on say the body mass of birds during the growth period. The line that connects a set of figures and plotted on a time scale gives the trend and shows when growth rate slowed down or when there was an acceleration of growth. By merely looking at a set of figures without plotting them as a graph makes it difficult to identify such dips or increases in growth.

Heart attacks

The modern fast-growing broiler has the genetic inner drive to eat a lot and to put on weight rapidly. This means that a lot of energy is being used for all those reactions in which new tissue is formed. This places the heart under pressure to supply oxygen-rich blood for those reactions and has to pump blood at an increased rate. This leads to injuries of the heart chamber and heart failure is the result. The term often used for these mortalities is *flip-overs*.

Heat removal from chickens

In the fast-growing chicken a lot of heat is constantly being produced as a result of the many reactions that are taking place to form muscle and other tissue, see *heart attacks*. That heat has to be removed on a constant basis to avoid a situation when the body temperature rises so high that death will result. In a cool environment body heat is taken up by surrounding air and the temperature remains on the normal level. However, if this does not happen the bird starts panting and heat is then removed from the body by means of evaporative heat loss. This means that moisture from the wet surfaces in the mouth and respiratory tract evaporates and that cools the blood supplying those areas.

Immobilised

Meaning "cannot move". Typically it would apply to the effect that ammonia has on the cilia of the inner surface of the respiratory tract.

Infect

It means to contaminate, for example passing on the disease causing organism to another chicken

Infectious bronchitis

Bronchitis is inflammation of the inner linings of the tubes that takes air from the windpipe (trachea) to the lungs. Infectious bronchitis is thus the disease caused by viruses that can be passed from sick chickens to healthy chickens and making them sick.

Inner moist surfaces See <i>inner lining of the respiratory tract</i>.
Light to broilers Light enables the broiler to feed but rest periods during a number of hours of darkness are essential to reduce downgrades and increase skeleton development.
Limbs Dislocation of limbs, such as legs or wings, easily occurs due to rough handling during placement. It should thus be avoided as such birds become runts and have to be destroyed.
Lysozyme This is an enzyme, a chemical substance that has the ability to act on bacterial cells and render them harmless. It is formed by the membranes in eyes and thus present in the tears, also by membranes in the mouth cavity and thus present in saliva.
Maize meal Also known as mealie meal. It is a very good source of starch and diets would normally contain between 50 and 70 maize meal. The protein content is low, 8 - 9 per cent, and not of good quality to support growth on its own. Soy bean meal is the source of proteins for poultry.
Mechanically ventilated buildings This is the term used for buildings in which electric fans are used to bring fresh air in and to extract stale air.
Minimum ventilation During early brooding it is essential that some air exchanges shall take place to remove carbon dioxide exhaled by the chickens and to bring oxygen in. Ventilation is normally on a time switch that will come on for a short period of time to ensure that a drop in air temperature will be hardly noticeable.
Moisture secreted by the cells Some cells in the body have the ability to secrete moisture, such as those in the mouth cavity. That moisture is part of the cell contents and it is constantly replenished with moisture from the blood stream to maintain the correct balance.
Mould See <i>fungi</i>.
Muscle contraction Muscle fibres consist of bundles of cells that are able to shorten in length by sliding over each other. This will only happen in response to a message from the brain via nerves that are attached to the muscle. This action to contract and to remain in a contracted state, is accompanied with the use of energy and production of heat.
Mycotoxins Poisonous substances produced by fungi. They interfere with the processes of immune development following vaccination. Mycotoxins also cause poor growth and lesions inside the mouth cavity
Open-sided buildings These buildings are fitted with curtains and rely mostly on a wind blowing to bring about ventilation. In some cases these houses are also fitted with fans to ventilate on those days without any wind blowing. The curtains are then closed and the house is operated as a mechanically ventilated building.

Overheated

Some raw materials, such as soy beans, have to be heat-treated to inactivate substances that have a depressing effect on digestibility of the protein in the soya. Equipment for treating raw soya must therefore not overcook the beans to prevent damaging the protein quality.

Oxygen

This is a gas essential to maintain life in an animal. All reactions in the cells of the body rely on energy from glucose. The release of this energy depends on a so-called oxidation reaction whereby oxygen is used and carbon dioxide is formed.

Panting

Increased rate of respiration whereby moisture in the respiratory tract, the mouth and nasal cavity is evaporated to enable the bird to lose body heat. The efficiency of panting depends to a very large extent on the moisture content of the inhaled air from the environment. If the environmental air already contains a high humidity, say 60%, then evaporation of moisture from the wet inner surfaces of the chickens will be poor before the air becomes saturated with moisture and no cooling will take place.

Penetrates the cells

Each body cell is surrounded by a membrane but fluid and nutrients in solution are able to enter. Bacteria are generally too large and they attach to cell membranes causing an infection. Viruses on the other hand are so small that they can indeed enter into the cell contents where they interfere with the normal processes and functioning of a cell.

Post-brooding

This period follows the brooding period and is characterized by changing to increased levels of ventilation, lowering in house temperature and actions being implemented to ensure dry bedding. The feed also changes to larger pellet sizes and feeder and water lines are raised to prevent wastage.

Protein

Protein is the common name for a vast number of chemical compounds that are essential for all life processes in living animals. It is well-known that protein containing foodstuffs are essential to enable the young chick or chicken to develop into a strong and healthy adult. Such foodstuffs include meat, cheese, eggs and beans. When consumed the proteins in these foodstuffs are digested, broken up, into their simplest building blocks, namely amino acids. The amino acids are absorbed and transported in the blood stream to cells of tissues in the body where they are linked together again to form the various proteins, characteristic of the particular tissue. Proteins differ because of the number of amino acids and the sequence in which amino acids are bound together.

Puss-like material

The yellow fluid or material caused by a bacterial infection.

Ratio of raw materials

A balanced diet consists of a combination of raw materials such as yellow maize, soya bean meal, minerals and vitamins in various ratios to ensure that the chicken's requirements with regard to energy, protein (amino acids), minerals and vitamins are met to ensure optimum growth.

Rations

Some people rather prefer to use the word "diets" for the feeds that are being fed.

Rodent control

Bait stations are normally used to control rodents. The problem on many poultry holdings is that food for

rodents is almost freely available and more success might be achieved by using liquid bait instead of bait in feed blocks. The importance to control rodents cannot be overemphasized as they are carriers of the bacterium *Salmonellae enteritidis*. This organism can infect poultry and if meat is contaminated it may not be sold.

Saliva in the mouth

Saliva is secreted by cells in the mouth cavity. It contains the antibacterial compound "lysozyme" that has the ability to neutralize bacteria

Shivering

At low environmental temperatures when the body loses more heat than what is being generated by the normal reactions taking place inside the animal, it starts to shiver. Shivering is a condition initiated by the brain instructing contractions by muscle tissue. Such a process requires energy utilization and that results in heat production and is thus a mechanism by which the animal tries to increase its body temperature. Shivering in dogs is always easy to be noticed.

Soybeans

Soybeans are well-known as having a high protein content as well as a good balance of amino acids to meet the chicken's requirement. It is the most widely used source of amino acids for poultry diets.

Spreading pattern

The spreading pattern of chickens during brooding is the best indicator of their comfort in the chicken house.

Stockmanship

The ability of a person to evaluate conditions in a poultry house regarding the comfort of the birds and to supply conditions that enables them to grow or produce at an optimum rate.

Target weight

This is the weight that has been set by the breeding company that should be achieved at a specific age.

Tears of the eyes

Tears contain a combination of watery and oily substances that are secreted by a very thin membrane that covers the eyeball as well as a gland in the lower eyelid. These substances serve as lubricants but it also contains the antimicrobial substance, lysozyme, that is able to neutralize bacteria and thus prevents infections by airborne organisms. The important thing to remember is that the capacity of these substances to protect the bird is limited and therefore dust levels should be controlled in the broiler house.

The temperature of the bird

The normal body temperature of the chicken is 42 °C which is attained at approximately 20 days of age. During hot weather at temperatures of 38 °C the bird has difficulty to maintain its temperature at 42 °C. The rate at which it can lose heat by radiation to the environment and by means of panting, is not enough to keep the temperature at 42 °C. In birds close to slaughter age and especially the bigger ones will experience a body temperature of 45 °C and mortalities will occur when body temperatures reach 46 °C.

Tissues

This is a general term for all soft flesh, and fat, on the bird.

Uniformity

Uniformity refers to the spread of body mass around the mean, in other words, how the weights vary. See "CV" in the Glossary for a detailed discussion on this subject.

Uric acid

Uric acid is the end product in the breakdown of surplus protein from the feed as well as proteins arising from cell contents. It is filtered out of the blood and collected by the kidneys and transported to the cloaca for excretion with the faeces.

Vaccination

Vaccination is the process by which a mild form of the virus (or bacterium) is put into the system of a chicken by injection or given in the drinking water or sprayed by aerosol. A vaccine is not a medicine but it is the disease causing organism in a mild form. Inside the body it stimulates certain organs that are able to make antibodies against the organism used as vaccine, say IB viruses. Antibodies then circulate in the blood stream and when IB viruses come onto the farm from outside the antibodies will bind with the virus and make it harmless.

Vapour

The gaseous form of the liquid, for example water vapour from water that had evaporated.

Ventilation

It means the movement of air through a vent (an opening). In mechanically ventilated buildings the fans **push** the air out of the building and creates an area of low pressure which is filled with air further away and ultimately air is drawn in through the louvers from outside to areas of low pressure

Viruses

Very small single cell organism and can only multiply in body cells of a living animal. They are easily destroyed by sunlight but can survive if protected by faeces or in feathers. Flies can carry viruses for example the Newcastle disease virus.

Vitamins

Vitamins are chemicals included in the feed that are necessary to act as facilitators for reactions in the body.

Water-belly

A condition that develops in fast growing chickens, see "**heart attacks**".

Yolk sac

see "**egg yolk**"

Startup Farming

Startup Farming Agricultural

Training | Education | Empowerment

Nutrition, water, ventilation and record keeping



Startup Farming

Nutrition, Environmental Control and Role of Water

Introduction

The cost of feed is by far the largest portion of the production cost of eggs; the efficient use of feed by the hen will therefore determine to what extent a layer operation will be successful. For example say the total cost to produce 1 eggs amounts to R10/dozen then the cost of only the feed alone will be R7.00. Factors that cause feed not being used by the bird to produce an egg, for example a low level of disease, will lead to an increase in feed cost because the hen had eaten some feed that day but without producing an egg.

The purpose with the information in this chapter is to enable you to have an understanding of the following:

-  What must be provided by feed so that the hen can produce at an optimal rate.
-  To provide and manage conditions that has a positive effect on egg production, for example ideal house temperatures or healthy flocks.

Nutrients the hen needs from the feed

Nutrients	Function of the nutrient
Proteins from: oil cake meals for example soya and sunflower	Proteins consist of chains of amino acids. During digestion these chains are broken up to free the amino acids. These can then be absorbed and used for the formation of egg proteins. Egg proteins the best and most complete source of protein for young children.
Energy mainly from maize and other feedstuffs.	Starch in maize digested to glucose. Glucose a universal source of energy for : Movement; Chemical reactions to form egg proteins, Shell formation; Heart contractions to pump blood; Respiration; Feather formation, the list is endless .
Calcium from limestone and phosphorus from rock phosphate.	Mainly calcium from limestone crumbs or grit, for maintenance of the skeleton and egg shell formation. An egg shell contains 2g of calcium. Other minerals such a phosphorus, manganese, zinc, sodium, potassium, etc.required in very small quantities in cell reactions.
Vitamins and minerals added in pure form as a premix	Most important functions as facilitators in cell reactions. Cells are the building blocks of organs in the body. Vitamins and minerals are usually added to the feed as a fine powder that easily separates from the coarser particles. Hens prefer coarse particles and powdery material is not well consumed. Important that feed troughs should be emptied by the hens before new feed is added. When feed becomes wet from leaking feed bins or in the feed troughs, mould (fungi) will grow in the feed and use all the vitamins for their own growth so that egg production is depressed.

Some examples to show the effect of vitamin deficiencies in feed.



Crooked breastbone due to vitamin D deficiency in feed



Bleeding in brains removed from birds with vitamin E deficiency in the feed

Figure 1. Left: Crooked breastbone due to vitamin D deficiency. Right: Symptoms of vitamin E deficiency in a hen, note the bleeding in brains removed from hens showing vitamin E deficiency symptoms.



Figure 2. Embryos without legs due to zinc deficiency. On the right is a hen with deformation of the leg and slipped hock tendon, this condition is known as perosis and is the result of a manganese deficiency in the feed.

Startup Farming



Fungus under enlargement

Lumps of feed due to fungus growth in a feed bin that was not properly sealed against rain water.

Figure 3 Mould growth inside

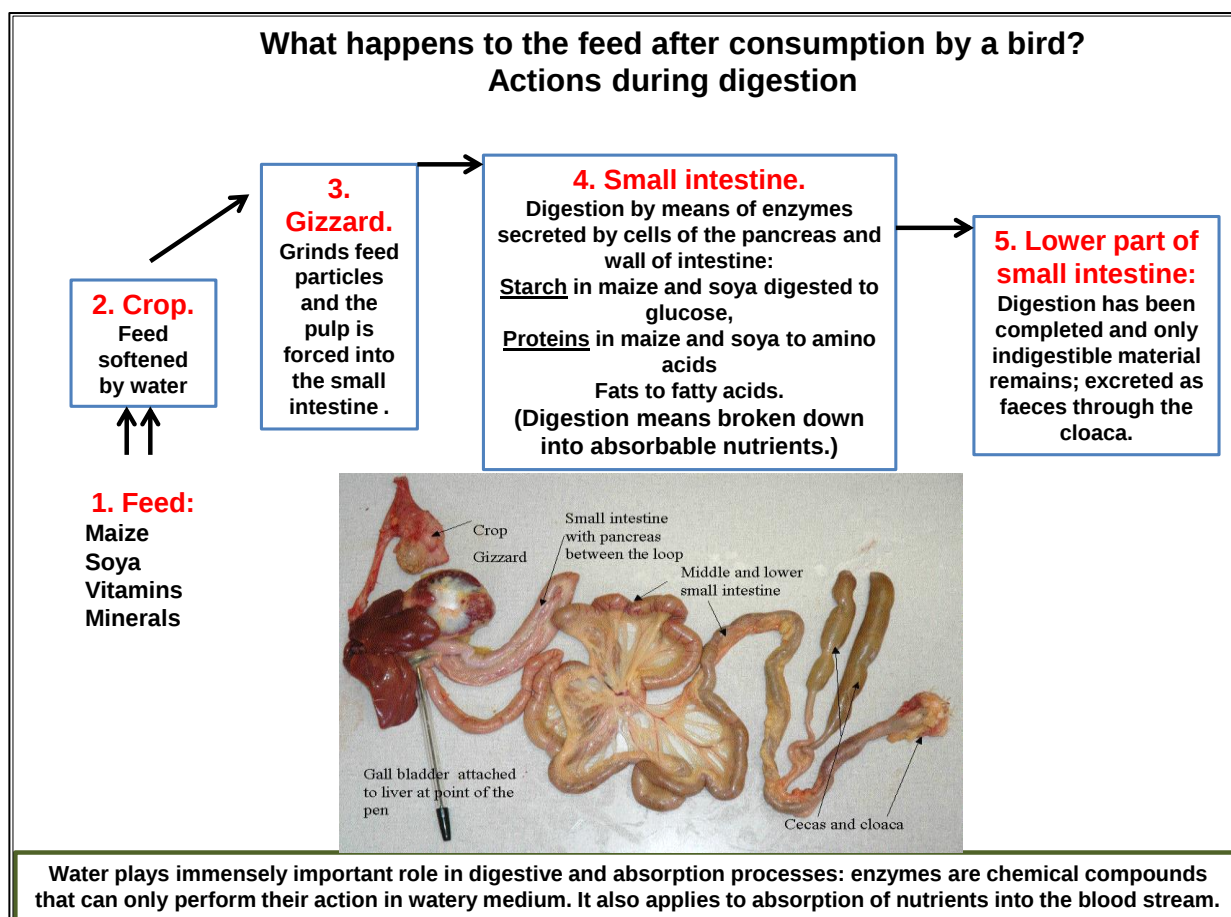
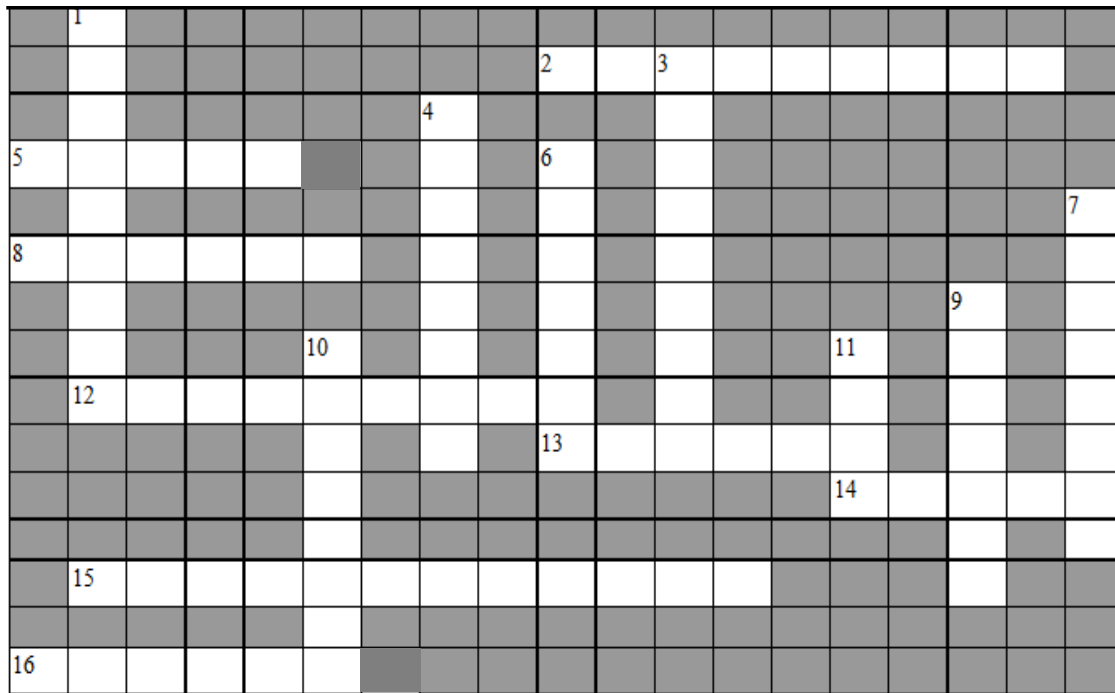


Figure 4 The digestive process in hens

The end products of digestion, namely glucose, amino acids and fatty acids are absorbed into the blood stream that flows through the small intestine and carried to the various organs for utilization by the cells of those organs.

Test your memory challenge number 1 Nutrients and digestion



Clue Across	Clue Down	
	1	The process by which feed is broken up to make the nutrients available
	3	The mineral that is needed by the hen to prevent bone deformation, a condition known as perosis.
	4	Substances in body tissues that consist of chains of amino acids
	6	The nutrient that can be utilized by the hen as source of energy.
	7	A framework of bones that needs calcium for its maintenance
	9	This nutrient is a mineral and utilized in the formation of strong bones
	10	These nutrients are essential agents to facilitate chemical reactions inside body cells
	11	The oil cake meal from these beans is an important source of proteins for hens
2		This product is added as a source of calcium in hen diets.
5		The building blocks of organs in the body
8		This substance is made by plants and renders glucose after digestion
12		The general term that is used for the substances after digestion of feed in the small intestine.
13		The driving force for chemical reactions and obtained from the combustion of glucose.
14		These acids are the end products of protein digestion
15		A person at the feed mill that does the formulation of poultry diets
16		Another word to describe the size of limestone grit.

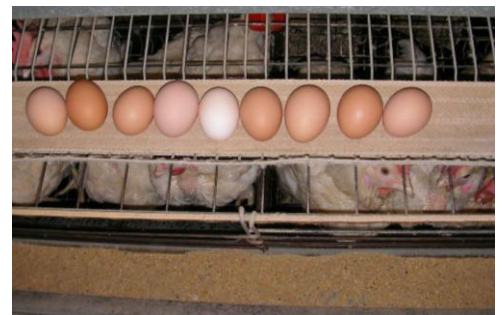
Role of environmental conditions on layers.

Environment includes the following aspects:

1. Temperature of the surrounding air in the laying house.
2. Moisture content of the surrounding air in the laying house.
3. Dust content of the surrounding air in the laying house.
4. Light intensity (illumination) in the laying house.
5. Ventilation (air movement).

Knowledge box

1. The normal body temperature of the hen is 42°C
2. This heat originates from actions such as:
Heart muscles pumping blood.
Abdominal muscles contracting during respiration.
Intestinal muscles contracting during digestion.
Formation of eggs by chemical reactions in oviduct or the liver.
3. All actions use glucose as energy source with heat being liberated.



The effect of the surrounding air temperature on the comfort of layers

- ⚠ Importance of a comfortable surrounding air temperature. Heat production by the hen is an on-going process while the bird is alive. Thus if heat is not lost at the same rate as being produced the body temperature of the hen will increase and the bird will die.
- ⚠ At normal environmental temperatures, for example 25°C, the bird is able to lose heat (mainly from the skin) to the surrounding air at the same rate as which it is being produced.
- ⚠ At high environmental temperatures, more than 30 °C, the body temperature will start to increase. This is because the air does not absorb heat fast enough to enable the hen to maintain a normal body temperature. The birds will start panting to lose heat by means of evaporative cooling from the respiratory tract. (More about this a little later).
- ⚠ At low environmental temperatures the bird will lose more heat than what is being produced by the chemical reactions inside the body cells. Human beings will start shivering. It means some muscles are contracting and heat is being generated. The same happens in hens: although not clearly visible they shiver; they use glucose for those muscle contractions to obtain energy and feed intake creases. We know from experience that feed conversion is poor in winter because a lot of the energy is used for shivering during the cooler climate.

Effect of high temperatures on laying hens

It has been mentioned that at air temperatures of 30°C hens will start to pant. This is because their body temperature has started to increase beyond 42°C and the loss of heat from the body to the surrounding air is not fast enough.



Panting means they increase their respiratory rate to evaporate moisture on the wet surfaces of the mouth and the respiratory tract. Evaporation of moisture¹ from these surfaces results in their cooling and also of the blood in these tissues. The cooled blood returns to the inner body which is thus also cooled.

You can test the cooling effect that is brought about by evaporation of moisture by simply licking the back of your hand and to blow air over that part. You will feel the cooling effect for yourself!

Role of moisture in poultry husbandry

Role in ammonia formation in bedding

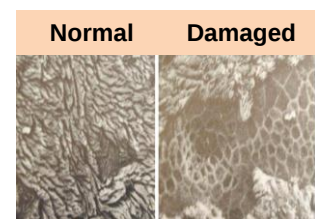
Role in body temperature regulation of hens

Ammonia formation in bedding

In free-range systems of egg production wet bedding can be problem in winter and especially if low temperatures are accompanied with rain, such as in the Western Cape. In wet bedding bacteria causes the development of ammonia. Ammonia is a gas that has serious negative effects on the wellbeing of hens and poultry in general, these include the following:

Ammonia causes skin burn under the feet of hens and this prevents them to visit feed and water lines. Egg production is negatively affected.

Ammonia causes cracks on the inner lining of the respiratory tract and makes it is easy for disease causing organisms to infect it.



Picture on left: Skin burn under the feet. Right: Normal and damaged lining, cilia, inside respiratory tract due to ammonia.

¹ One of the laws of physics states that when a liquid changes to a gas heat is absorbed from the surface of the liquid.

Origin of moisture in bedding:

Excreted in faeces and urine, water content, 80%.

Leaking water nipples can also make a big contribution. Replace leaking nipples as soon as possible.

Removal of moisture (water) from bedding and droppings

Water has to evaporate from bedding into the air and then ventilated. (It is the only way!).

Turning of bedding material (to *dol*) to expose the underlying material to air so that water can evaporate and the vapour taken up into the air and then removed by ventilation.

Factors determining the efficiency of evaporation of moisture from bedding

- a) The temperature of the air inside the building. Cold air cannot hold a lot of moisture before it is saturated. (We all know that washing does not dry easily in winter.)
In winter the problems of wet bedding (and thus high levels of ammonia in the air) is greater than in summer. It is important that curtains shall be positioned in such a manner that temperatures during the day or night do not drop so low that very little or no moisture is removed. A lot of time must therefore be spent to experiment and get the settings right.
- b) The moisture content of the air outside the building. In those areas in the country of naturally high humidity it is difficult to remove a lot of moisture from bedding material. This is because the air has a limited ability at a particular temperature before becoming saturated² with moisture and only limited evaporation takes place.

High moisture in the air makes it difficult for hens to cool themselves in hot weather.

Hens start panting at temperatures of 30°C. This is because their body temperature had increased to above 42 °C. (Not enough heat could be given off to the environmental air.)

Cooling by means of evaporation of moisture from the wet surfaces of the mouth cavity with panting is not efficient when the moisture content in the air is high. The inhaled air becomes saturated with moisture and no evaporation (cooling) takes place.

Cooling environmental air by means of cooling pads: The efficiency of cooling by the cooling pads is also determined by the humidity of the outside air. The lower the moisture content, the more can evaporate and the lower the temperature will be of the air that enters the building through the cooling pad. With a high humidity in the air cooling is poor.

Dust content in the air of the laying house

High levels of dust in the air inside the laying house can have negative effects on layers. The dust accumulates on the wet linings inside the respiratory tract and bacteria on dust cause widespread infections not only in the respiratory tract but also inside the air sacs.

Dust can contain between 200 000 and 800 000 bacteria per gram of dust.

²Saturated means **filled to capacity**, further uptake has become impossible.

Inhaling large numbers of bacteria overwhelm the natural defence mechanism of the hen: Inside the



air sacs ideal conditions of temperature, moisture and nutrients exist for their multiplication. Birds that are suffering from stress, such as a low level of a disease, for example IB, will be overwhelmed by *E. coli* bacteria and show symptoms as illustrated in the picture.

High dust levels in the building can be caused by under-ventilation:

1. Fan speeds or curtain openings have not been correctly set.
2. Fan belts that are slipping and not moving the correct amount of air.
3. Fan blades, cowls and louver openings covered with dust.

Effect of light on egg production

Light is a form of energy, it can penetrate the skull to stimulate a certain part of the brain to form hormones. Hormones are chemicals that are passed into the blood stream and stimulate the liver to start forming egg yolk material for deposition into the ova (the female reproductive cells).

Pullets are reared in light-tight buildings in which only nine hours of light is given to approximately 15 weeks of age. Thereafter the light program changes and the light period is slowly increased. These increases in the number of hours of light stimulates the brain to produce hormones that lead to the deposition of yellow yolk material in the ova as shown in the picture.

After placement in the laying cages the increase in light hours continues, to 14 or 15 hours, to ensure that birds reach peak production. An important aspect is the level of lighting. It can easily happen that if some light bulbs or fluorescent tubes are not working and that the distribution of light is uneven throughout the building. This affects production especially in birds in the bottom rows of battery cages. In a free-range system birds might move away from the darker areas to congregate in the brightly lit areas where bedding will become wet resulting in ammonia formation.



Ventilation

A. Patterns of air flow

Ventilation means movement of air through an opening, whether louvers or curtains. In mechanically ventilated houses fans will pull air out of the building and air from outside will enter the building through any opening to fill the space (vacuum).

The size of an opening determines the speed with which air will enter through that opening. For example if fans would be running at a particular setting, the speed with which air enters the building will be much higher with a small louver opening than with a large louver opening.

The speed of the air will determine the distance it will travel into the building, or height towards the ridge. Air that enters a building at a low speed will drop to the floor instead of moving upwards and mixing with air close to the ridge of the building, see Figure 5



Low air speed. Cold air drops to the floor.

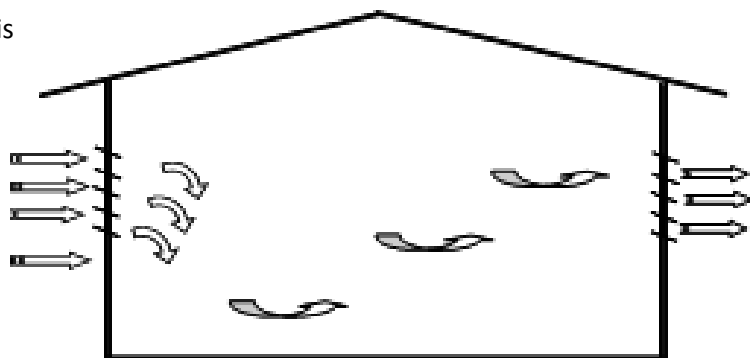


High air speed. Cold air mixes with hot air near ceiling.

Figure 5 Left: Low air speed, only one fan running. Right: High air speed with four fans running at full speed.

In houses with open sides and curtains, ventilation can only take place if wind is blowing. The size of the curtain openings and the wind speed will determine the amount of air that will be replaced inside the building. If no wind is blowing there will be no ventilation!! Most of these buildings have openings in the ridge of the roof through which hot air can move out due to natural convection of hot air that rises and the space is filled with cooler air.

In winter cold air dropping to the floor is especially a problem these houses where control over incoming air is difficult and cold and wet spots will be present close to the wall, direction of the wind is from the left.



Setting of curtain openings will depend on temperature and strength of the wind. With a strong cold wind the opening facing the wind will be small. At the other side the opening will be much larger. During hot weather curtains will obviously drop much larger to remove heat from the house. Pay regular visits after changes to curtains have been made to evaluate the situation.

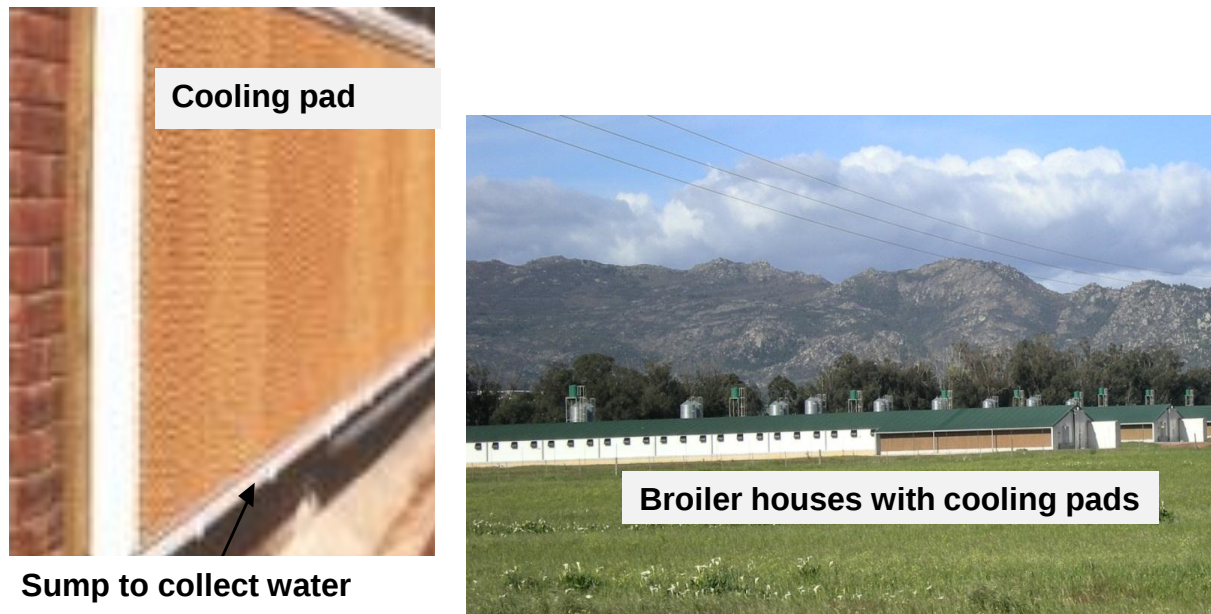


Figure 6 Left: Structure of a cooling pad. Right: Layer houses equipped with cooling pads on side.

B. Ventilation: Removal of heat and cooling of incoming air bmm

Heat from the hen's body will effectively be given off to the surrounding air if temperature differences are big enough, for example the hen at 42°C and house temperature at 25°C. The flow of heat from the body of the hen to a house temperature of 35 °C, however, will be much less than at 25 °C, and the hen will start panting and lose body heat by means of evaporative cooling. There is the belief that an increase in wind speed will have a cooling effect. However, it will only remove the exhaled moisture of panting and some heat in the immediate vicinity of the bird. It cannot cool the bird. If layers had had sweat glands, like humans, from which water could evaporate, then cooling could have taken place.

During high summer temperatures the only means to create comfortable conditions is to pass the air through a cooling pad, Figure 6. The cooling of the air through the cooling pad can amount to 6 – 8°C, which is brought about by the evaporation of the water on the cooling pad.

When water evaporates, it changes from a liquid to a gas, and during this process heat is taken up from the air, in other words, the air temperature drops by a few degrees.

Conditions for the bird has then improved and heat can again flow from the body of the bird to an air temperature of 29 °C (35 – 6).

The efficiency of cooling is determined by the following factors:

1. The humidity of the air before it passes through the cooling pad.

In those areas of the country where the relative humidity is normally high, for example 60%, the ability of such air to absorb a lot moisture is much **less** because it will become saturated sooner than that of air containing only 30% moisture. Less water can evaporate at 60% than at 30% and the cooling effect will thus be lower.

2. The size of the cooling pad and the coverage with water.

Large pad areas as opposed to smaller areas with pads will be more effective because more water can evaporate. The same applies to coverage with water, areas that are clogged and not wetted, decreases cooling.

3. Air speed through the cooling pad.

If the air speed is low, the cooling effect will be poor and temperatures close to the cooling pads might be comfortable. At the other end of the hen house, high temperatures will still prevail. If the air speed is too high water droplets will be carried into the building and cooling will be poor. The temperature of the water has no effect on the efficiency of cooling!

The role of water in poultry husbandry

Water can be regarded as one of the most important nutrients for poultry. Water is one of the four main components of the bird's body; more than 60% of the body mass is water. This means that a hen weighing 2000 grams consists of 1200 g of water.

In the following paragraphs we shall be looking at:

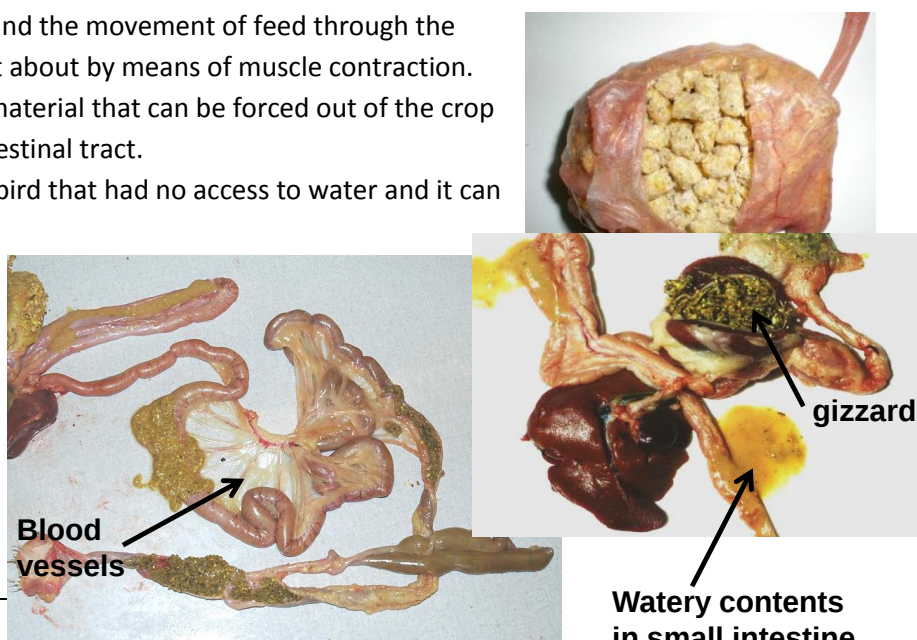
1. Role of water in digestion, absorption and transport of nutrients.
2. Role of water in excretion of waste products.
3. Role of water in body temperature regulation.
4. The role of water in health management.
5. Signs of water shortage.

Role of water in digestion, absorption and transport of nutrients

The swallowing of feed and the movement of feed through the digestive tract is brought about by means of muscle contraction. However, it is only wet material that can be forced out of the crop and down the gastro-intestinal tract.

On right is the crop of a bird that had no access to water and it can clearly be seen that feed could not pass down to the gastro-intestinal tract to be digested³.

The coarse contents of feed in the muscular stomach



³Digestion is the breaking up of starch and proteins in feed by means of enzymes into absorbable substances such as glucose and amino acids.

(gizzard) are clearly visible and show how the grinding action and digestive enzymes transformed it into watery slurry that passes into the small intestine.¹

Starch and proteins in this slurry are broken down by enzymes to glucose and amino acids.

Glucose and amino acids are soluble in water and are taken up by the blood vessels and transported to the various body tissues:

- Glucose is used as energy source.
- Amino acids are used by the cells to renew worn tissue or used by the liver cells to form egg yolk proteins and many other proteins in the body.

Role of water in body temperature regulation

During very hot weather humans will start sweating and the evaporation of the moisture from the skin results in cooling. The cooled blood in contact with the skin returns to the deep body and that helps the person to maintain a constant body temperature. Poultry however, have no sweat glands in the skin and they will start panting during environmental temperatures above 30 °C. (Hens panting were illustrated in paragraph 0 on page 8.) The inner surface of the mouth and the wind pipe to the lungs are the main sites in which evaporation of moisture takes place. This is illustrated in Figure 7. Moisture evaporating from moist areas in the mouth cavity and the trachea results in cooling of those surfaces, and so also the blood serving those areas. Cooled blood returns to the inner body which lowers the temperature of the bird. One can say that this is comparable to sweating in humans and it has the same cooling effect as sweating.

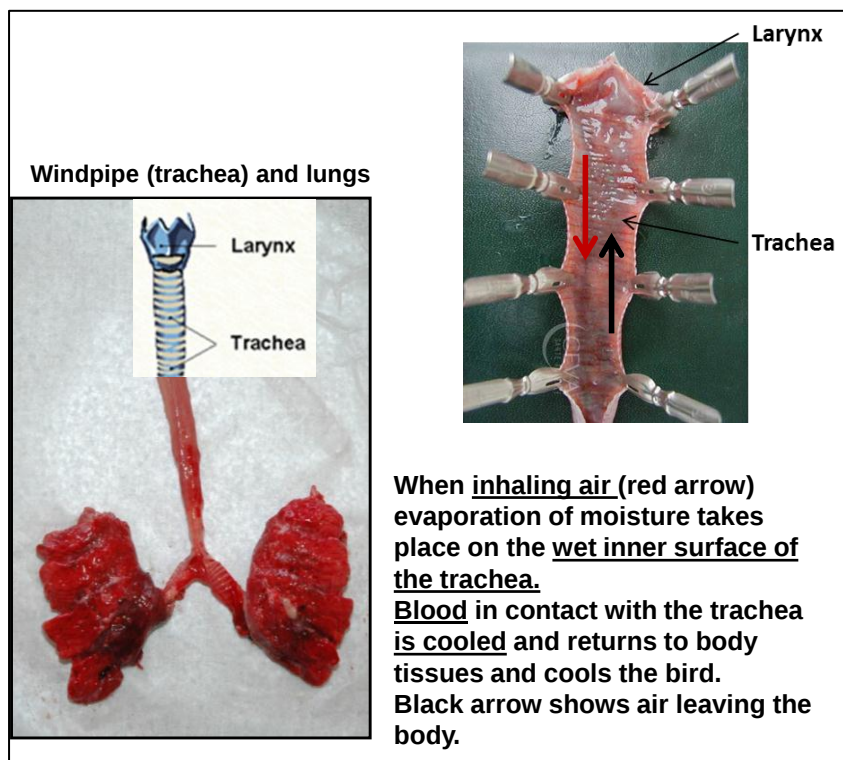


Figure 7 Respiratory system of the bird showing the area where evaporation of moisture on the trachea takes place⁴

The availability of good quality drinking water is of utmost importance during high temperatures when the hen loses a lot of moisture during panting. The water that moistens the inner surfaces of those areas are secreted by the cells in the linings of the mouth and the windpipe and is obtained from the blood stream.

In those areas of the country close to the sea, such as Durban, where the air contains a lot of moisture, the *relative humidity* is high, and the evaporation of sweat is not very efficient. The same applies to poultry. In areas of high humidity during hot summer days poultry are unable to cool themselves by means of panting. Evaporation of moisture from the respiratory tract is poor and not a lot of heat is thus removed from the blood serving these tissues.

The role of water in excretion of waste products: faeces and uric acid

Indigestible substances are the fibrous parts of plants such as the hulls of sunflower seeds or the cellulose layer that surrounds a maize kernel. Products that could not be digested are usually visible as the dark brown contents in the lower part of the small intestine. It has a watery consistency and is thus easily propelled by the muscle contractions of the intestines. In the cloaca a very large portion of the moisture is reabsorbed.

Faecal matter is not the only waste product that has to leave the body. Uric acid is a waste product from the many chemical reactions that take place in the body cells. It is insoluble and floats in the blood stream as small crystals, almost like fine sand. In the kidneys the uric acid crystals are filtered out and collected by the kidney tubes. It then requires a lot of water to be flushed out to the cloaca where most of the water is reabsorbed. The concentrated uric acid is excreted as that white cap on the faeces, see picture. Uric acid is degraded by bacteria in bedding material and is the source of ammonia in the air of the hen house.



The role of water in health management

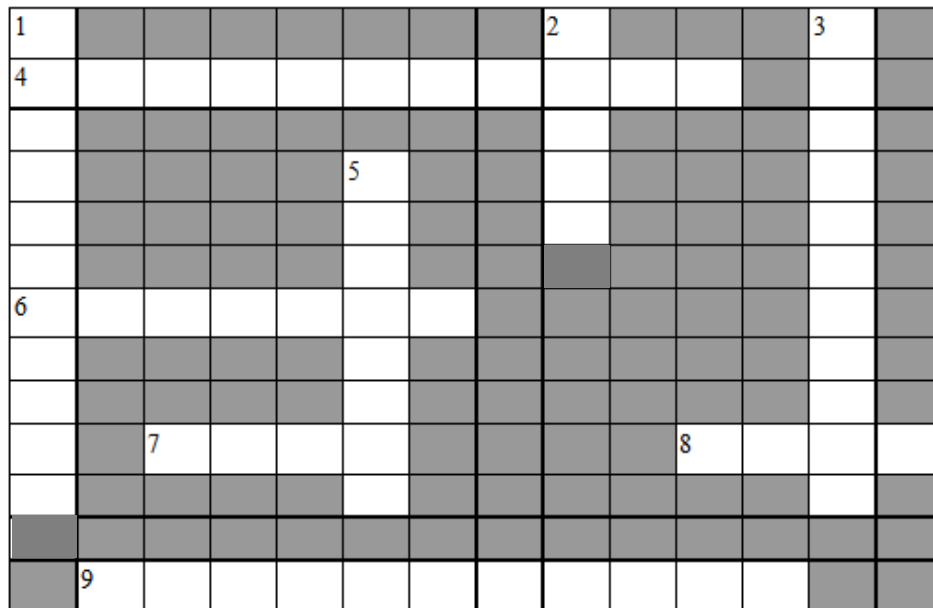
In paragraph 0 on page 8 it was mentioned that the linings of the respiratory tract contains cells that secrete moisture. These cells have the form of tiny hair-like structures, called cilia, which are able to perform sweeping actions to remove bacteria that are inhaled. In birds that have limited access to drinking water the cilia will dry out and the sweeping actions will stop. Bacteria will accumulate on the surface of the respiratory tract and penetrate the underlying tissue to cause infections.

⁴Permission to use the CEVA pictures was kindly granted by prof I.Dinev, Faculty of Veterinary Medicine, Trakia University Bulgaria.

Signs of water shortage

Severely restricted intake of water leads to a condition known as dehydration. In such a situation the body cells have lost so much water that they became wrinkled, especially visible on the toes and legs in day-old pullets that have travelled for more than a day during very hot conditions. In chicks that have died the white spots of accumulated uric acid on the outer surface of the liver and kidneys are clearly visible.

Test your memory challenge number 2



Clue Across	Clue Down	Clues to answers
	1	The inner lining of the tract of this system is affected by ammonia gas
	2	Hair-like structures in the lining of the respiratory tract that remove dust and bacteria
	3	The word for movement of air through an opening
	5	The word that describes the moisture content of air
4		The process by which water changes from a liquid to a gas
6		Skin burn under the feet of layers is caused by this gas
7		This material in the air of the hen house contains bacteria that causes infections on the inner lining of the respiratory tract
8		The hen is able to store feed in this organ for digestion at night
9		A condition where body cells have lost a lot of moisture due to water shortage in drinker lines

Poor performance without obvious reasons

It might happen that hens just stop performing according breed standards without obvious reasons or visible shortcomings in the normal husbandry practices.

Under such circumstances it is useful to use the acronym FLAWSS as guideline for a systematic investigation for causes of such problems. FLAWSS stands for the following six factors: Feed, Light, Air, Water, Sanitation and Space. The procedure would be to look very closely at each of these factors and to establish whether conditions for each of them are in compliance with the norm and standards that are applicable to each.

Feed

Look carefully at the consistency and dustiness of the feed in the trough, is it in accordance to what it used to be or are there many more fines than usual. It is most important to know exactly what the feeding behaviour normally has been.

Taste and smell the feed and be sure that it is the same as it used to be with no traces of rancidity or change in colour. Feed is the most costly item in the production of eggs and it is of utmost importance to be able to identify any deviation that could lead to birds refusing to eat.

Light

It is most important that cages in the bottom rows are not too dark due to light bulbs or tubes not working. An even distribution of light in free-range houses is important to ensure an even distribution of hens throughout the house. Light bulbs or tubes not working must be replaced as soon as possible. Time switches must be inspected every day to ensure that their settings are correct.

Air

Air quality includes aspects such as temperature, dust, gases such as ammonia, moisture and carbon dioxide. The air quality is probably one of the most important factors that determine the comfort of birds in a poultry house and good ventilation is the only means by which changes can be brought about. In mechanically ventilated buildings dust on fans and louvers affects efficient air movement. Fan belts not tight enough results in insufficient air exchanges. In naturally ventilated buildings a lot of time should be spent on evaluating the behaviour of hens after ventilation settings have been adjusted. It is indeed also important to follow up with regular visits after changes have been made.

Water

The availability and quality of water is of overriding importance for high producing layers. An egg of 55g contains 36g of water which must be consumed over and above the normal quantity that is needed for digesting feed and excreting faeces and urine, which is twice the amount of feed consumed. This is under normal temperatures, during hot weather it increases dramatically.

Water nipples that do not deliver water due to blockages or that are sticky should be replaced immediately when noticed. Bacteria in water from contaminated water lines or water sources not chlorinated correctly can cause huge drops in egg production. Thus attention to ensure good water quality is most important.

Sanitation

Sanitary (clean) conditions means that less opportunity is available for disease causing organisms to multiply on dead birds, less opportunity for flies to carry viruses to the birds and less dirt that offer protection to bacteria and viruses.

There is thus less exposure to disease causing organisms.

Wet bedding in free-range houses cause unsanitary conditions: ammonia development and growth of mould that depress egg production.

Space

In free-range systems wet areas develop when curtain settings are too large and the temperature inside the house is cold and no moisture is removed. At night the birds avoid the cold areas and congregate in hotter areas which also become wet. Ammonia develops in those areas with all the negative consequences such as infections of the respiratory tract!

Bedding in wet spots should diligently be turned to expose the underlying wet material during the hot part of the day or removed and replaced with dry material.

Record keeping practices

Of all agricultural industries, poultry production can boast to be practiced on the highest scientific level than any of the other industries. The application of genetic principles to select outstanding poultry lines for meat or egg production, or the accurate formulation of feed based on chemical analysis of feedstuffs to formulate diets to meet the requirements of the different types of birds, are all proof of the science that goes into poultry farming practices.

The measurements that had been collected and expressed in figures formed the basis for the progress that has been achieved. In the following number of paragraphs it will be attempted illustrate the important role of measurements in the everyday poultry farming environment.

Calculating percentages and averages

Percentages

The word per cent means per hundred or per *century* shortened to per *cent*, indicated by %. (The word century is still in use, for example in cricket: "He scored a century (100 runs) during the first hour" or "For a century (hundred years) no murder has taken place in that little village".

It is most important to express some results on the farmer 100 birds with other words in percentages. The following serve as an example:

A small scale farmer bought 200 day-old chicks and found 16 dead on the second day, it thus means eight per one hundred, i.e. Eight per cent.

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His neighbour also had 16 deaths on the second day but he had bought 400 chicks, he therefore had a mortality of only 4 per cent, 4 per 100. He probably had a better brooding system and therefore the lower mortality per 100.

The reason for using percentages is to be able to make comparisons by using the same baseline.

The calculation of the figures in the aforementioned example was fairly easy: You first divide the number of mortalities, 8, by the total number of the flock placed then multiply by 100 to obtain the figure per 100, which gives the percentage.

A further illustration of the importance to express certain events in terms of percentages can be illustrated by comparing two houses with different numbers of layers:

House A was placed with 15 000 day-old broilers and after 10 days the total mortalities amounted to 85.

House B was placed with 20 000 day-old broilers and when they were 10 days of age a total of 100 chickens had been counted as mortalities.

According to the procedure mentioned earlier, mortality can be calculated as follows:

For House A: $85/15000 \times 100 = 0.56\%$

For House B: $100/20000 \times 100 = 0.5\%$.

More chickens had died in House B but when expressed as percentage of the number placed, it was lower than for A. If such a trend persists then one would start looking for some management problems in House A.

Averages

Sometimes the word mean instead of average is used to describe the same concept. An average value is calculated by adding up all values in a range of figures and then to divide the sum by the number of figures in the range.

For example the following weights, in grams, were recorded for five individual day-old chickens: 42, 35, 40, 37 and 41. The sum of these five values is: $42+35+40+37+41 = 195$. The average weight, or the mean = $195/5 = 39.0$ g. (This sample is purely for demonstration purposes, one would never use such a small sample).

Sampling and accuracy of data

Sample size

The more birds one weighs the more reliable would the value be that one calculates as the average value. One or two outliers, extremely light or heavy, will have less influence on the total mass in a large sample than in a small sample. This is reason why sample sizes to estimate the average for a house would seldom be less than 800 birds weighed in houses of 30 000 birds.

The term that is often used is that a representative sample should be taken. This means that birds are fenced-in from particular areas, for example front, centre and the back of the house, and all birds within the frames are weighed. This ensures that the more flighty ones are also included in the sample and their weights were taken up into the calculation.

Accuracy of data

An aspect of immense importance is that the values that are being collected are reliable, whether it applies to bird weights or temperature recordings is immaterial. Conclusions drawn from data will only be valid if the collected data is accurate. For example: Instead of accepting a scale is accurate, why not always use a standard test weight to check the accuracy of the scale each time that birds are weighed.

When taking readings from thermometers make sure they have been tested against a reference thermometer that is reliable and always correct.

There is absolutely no sense in collecting unreliable figures. The reason for data collection is to enable one to identify factors that could have resulted in poor performance of the flock. The most common application is to relate high or low environmental temperatures to fluctuations in feed conversion or egg production figures for a particular flock.

Use of graphs or charts

A graph is a picture of data collected. One wants to know what the trend is for example with mortality or egg production figures. When just looking at the figures as collected it is difficult to see whether there is a slow or rapid rate in the numbers of birds dying or production dropping. When data is plotted on a graph such trends are easy to identify.

When body mass and temperatures are graphed over time one can see how environmental factors had influenced growth or production rate. It means that one can explain a condition and not speculate whether it might have been a problem with feed.

In the poultry industry the keeping of records, and it is assumed that it was done accurately, is one of the most important tools to be efficient and profitable. Problems have to be identified as soon as possible to enable the taking of corrective actions, be it a problem with feed, disease, water or ventilation. Accurate records enable one to relate drops in growth rate with management changes for example in feeding practices, vaccination failures, or poor disinfection results due to changes in cleaning procedures etc. The reader will most probably be able to add more examples to this list.

Solution to Memory challenge number 1 Test your memory

challenge number 1 Nutrients and digestion

Across	Down		
	1	Digestion	The process by which feed is broken up to make the nutrients available
	3	Manganese	The mineral that is needed by the hen to prevent bone deformation, a condition known as perosis.
	4	Proteins	Substances in body tissues that consist of chains of amino acids
	6	Glucose.	The nutrient that can be utilized by the hen as source of energy.
	7	Skeleton	A framework of bones that needs calcium for its maintenance
	9	Calcium	This nutrient is a mineral and utilized in the formation of strong bones
	10	Vitamins	These nutrients are essential agents to facilitate chemical reactions inside body cells
	11	Soya	The oil cake meal from these beans is an important source of proteins for layers
2		Limestone	This product is added as a source of calcium in hen diets.
5		cells	The building blocks of organs in the body
8		Starch	This substance is made by plants and renders glucose after digestion
12		Nutrients.	The general term that is used for the substances after digestion of feed in the small intestine.
13		Energy.	The driving force for chemical reactions and obtained from the combustion of glucose.
14		Amino	These acids are the end products of protein digestion
15		Nutritionist	A person at the feed mill that does the formulation of poultry diets
16		Crumbs	Another word to describe the size of limestone grit.

Solution to memory challenge number 2

Across	Down		
	1	Respiratory	The inner lining of the tract of this system is affected by ammonia gas
	2	Cilia	Hair-like structures in the lining of the respiratory tract that remove dust and bacteria
	3	Ventilation	The word for movement of air through an opening
	5	Humidity	The word that describes the moisture content of air
4		Evaporation	The process by which water changes from a liquid to a gas
6		Ammonia	Skin burn under the feet of layers is caused by this gas
7		Dust	This material in the air of the hen house contains bacteria that causes infections on the inner lining of the respiratory tract
8		Crop	The hen is able to store feed in this organ for digestion at night

9		Dehydration	A condition where body cells have lost a lot of moisture due to water shortage in drinker lines
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