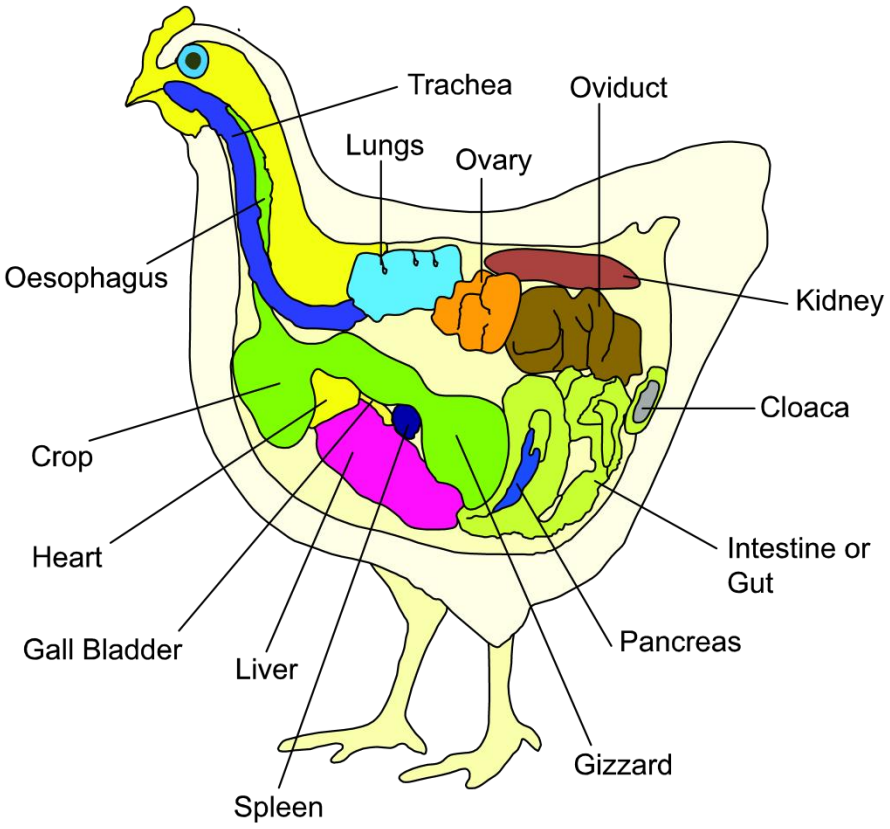
SOUTH AFRICAN POULTRY ASSOCIATION
SUID-AFRIKAANSE PLUIMVEEVERENIGING

Learning Module 2 Layers
ANATOMY AND PHYSIOLOGY OF THE HEN



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1. Anatomy and Physiology of the Hen

Introduction

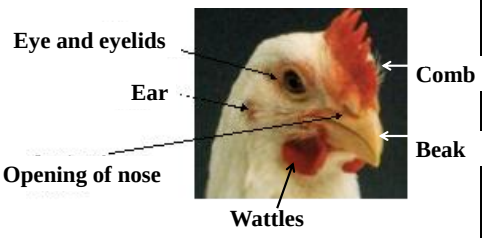
The word anatomy means structure of the body and the organs in the body of the hen. Physiology has more to do with the functioning of organs of the body, for example the digestion of and absorption of feed. This knowledge is essential not only to enjoy your work more but also to empower you to be in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

The external body parts

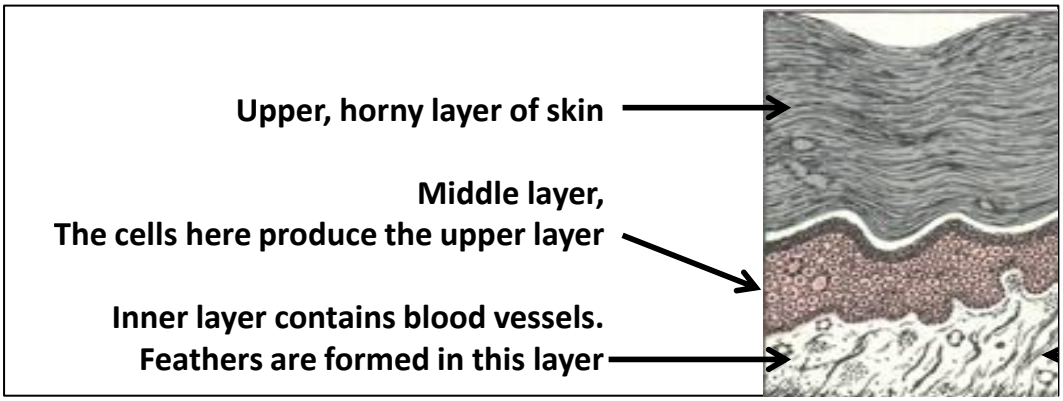
The external organs include the skin, eyes, ears, nostrils, comb and wattles and will be discussed first before proceeding to internal organs such as the digestive tract, reproductive system etc.

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.

Poultry have good eye-sight: detect colour; prefer green and yellow.Shining objects such as water droplets on a nipple line attracts attention and birds learn to drink quickly.	
Can smell and will detect offensive smells. Avoid areas where ammonia is in the air e.g. wet spots under drinker lines for birds housed on the floor.	
Can hear very well. Noises such as banging of trolleys or crates and people shouting, cause stress and affect immune development after vaccination.	
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.

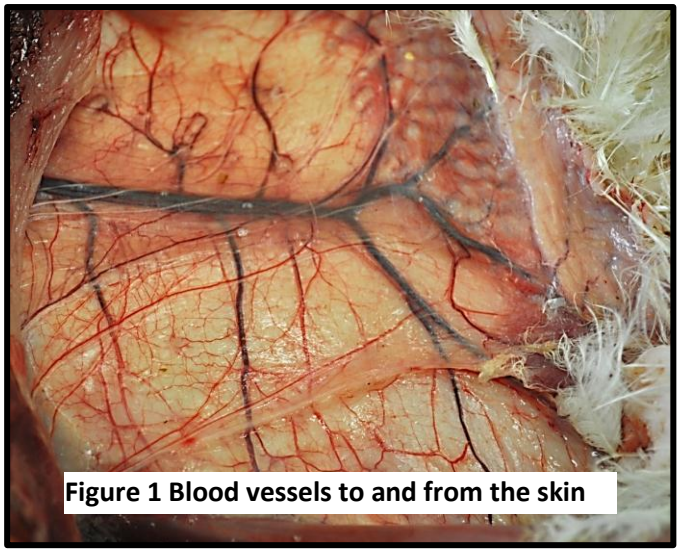
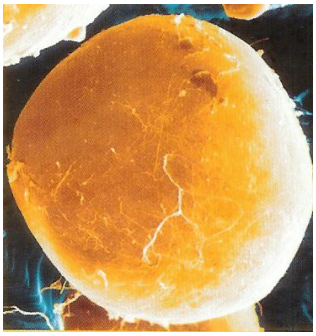


Figure 1 Blood vessels to and from the skin

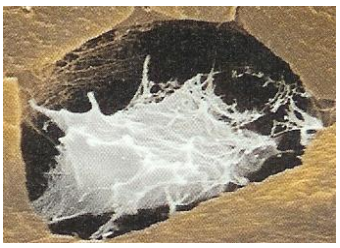
The normal body temperature of the hen is 42 °C and the ideal temperature in the laying house is 25 °C.

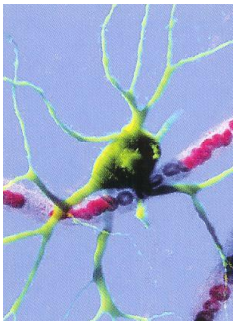
Red blood cells



Fat cell

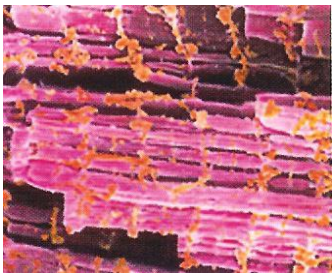
Bone cells





Nerve cell

Muscle cells



The skeleton of the bird.

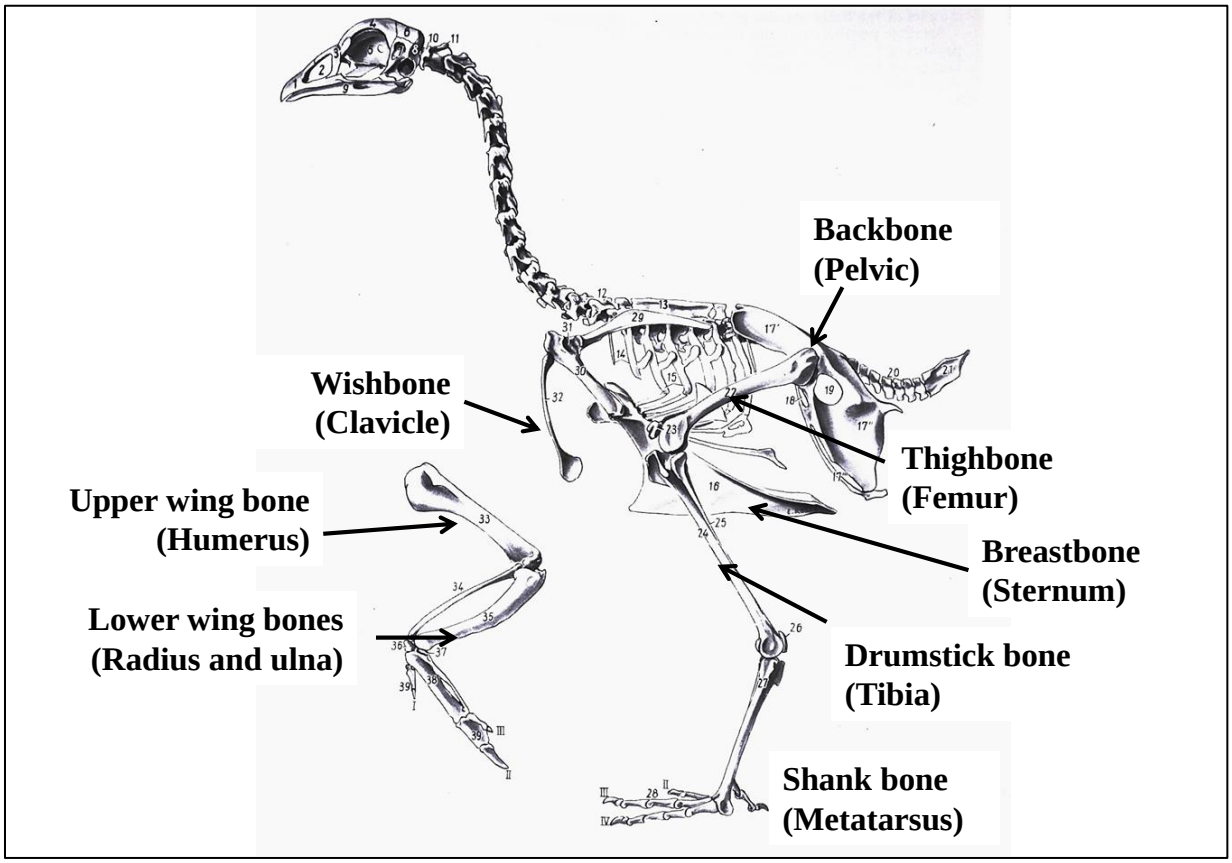


Figure 2 Skeleton of an adult chicken

Important knowledge:

The bones of the skeleton[1] 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.

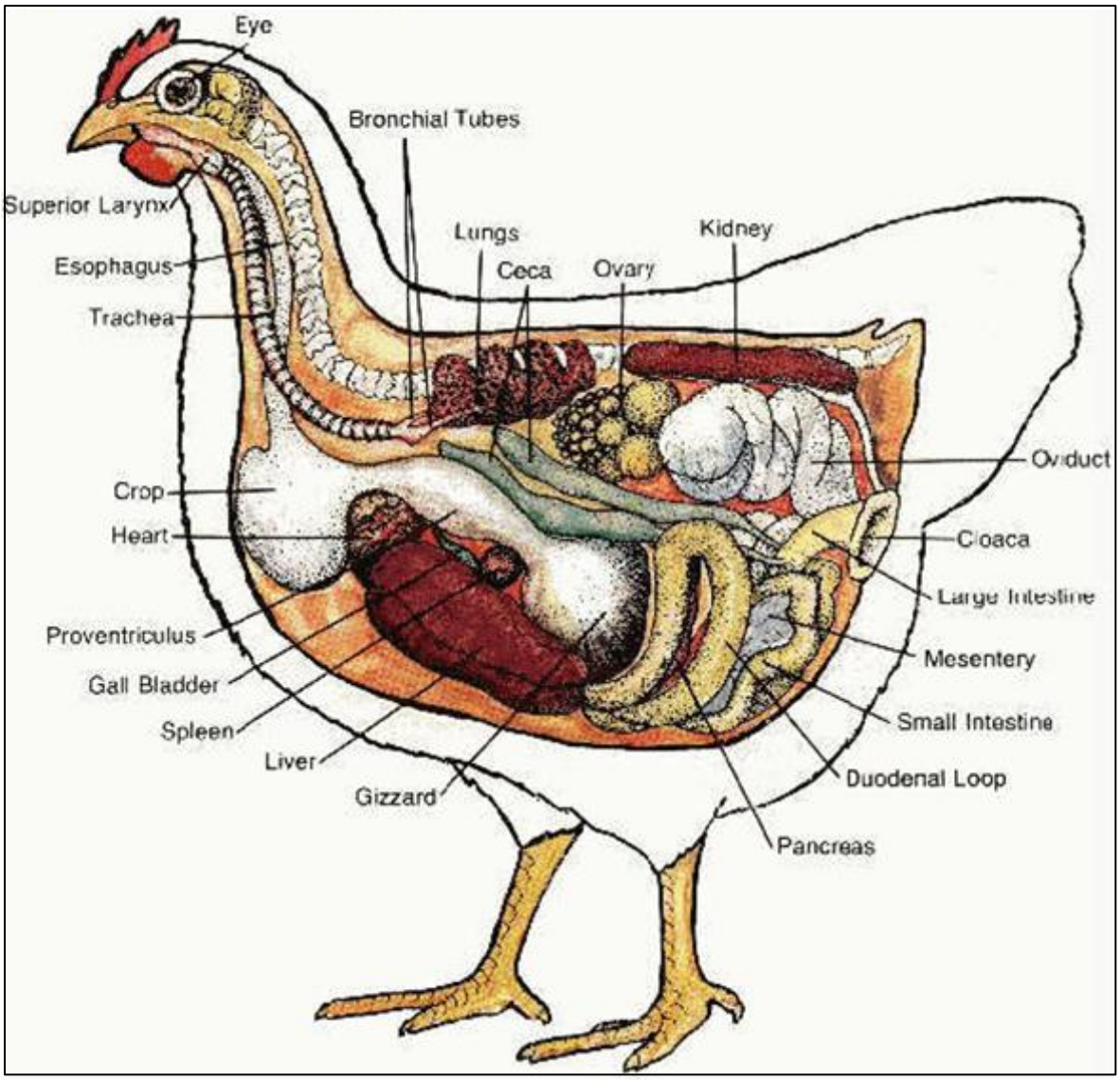


Figure 3 Cross-section through the body of a hen.

The digestive tract[2]: 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.		

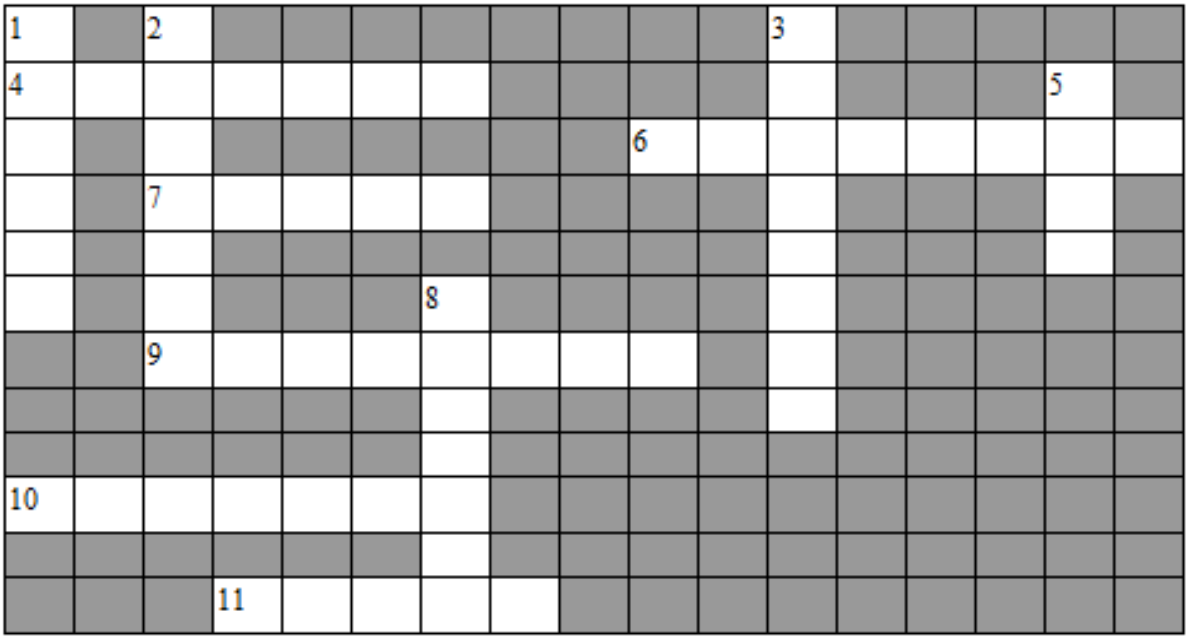
Body substances: their origin and functions		
Substance	**Origin**	**Function**
WATER	Supplied by the water lines.	All the many reactions inside cells of an organ[3] can only take place in a watery medium.
FAT	From starch and fats in feed	Source of energy and used to produced yolk fats
MINERALS	Limestone 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

The functions of the different parts of the digestive system

Mouth and crop

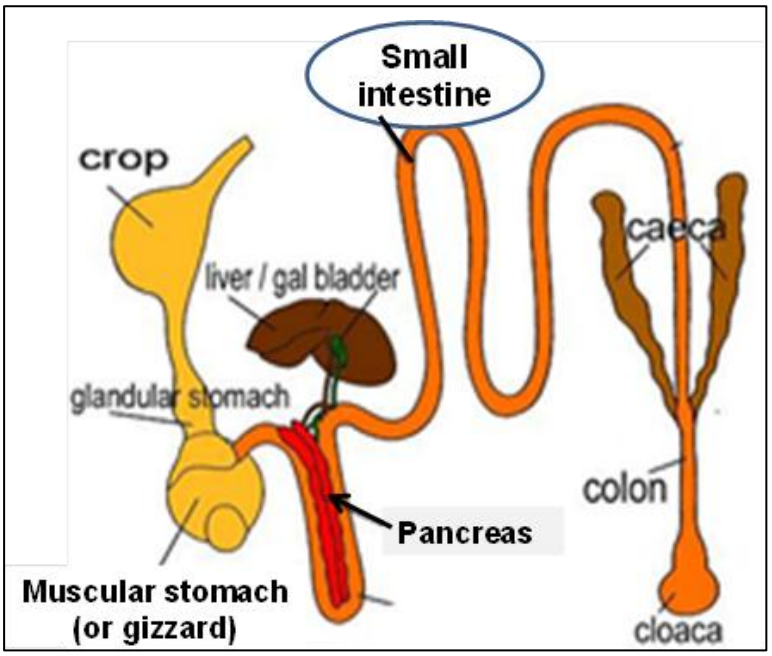
Important knowledge  **Refreshing your mind**	Digestion is the process by which nutrients in feed is made available for absorption into the body: Proteins in feed are digested to amino acids. Starch in feed is digested to glucose. Fat is digested to fatty acids. (Water and minerals are not digested but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

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

Salivary glands[4] 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 rancid[5] 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 acid[6] which improves the digestion process, availability of water is most important.

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

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

[6]Hydrochloric 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.

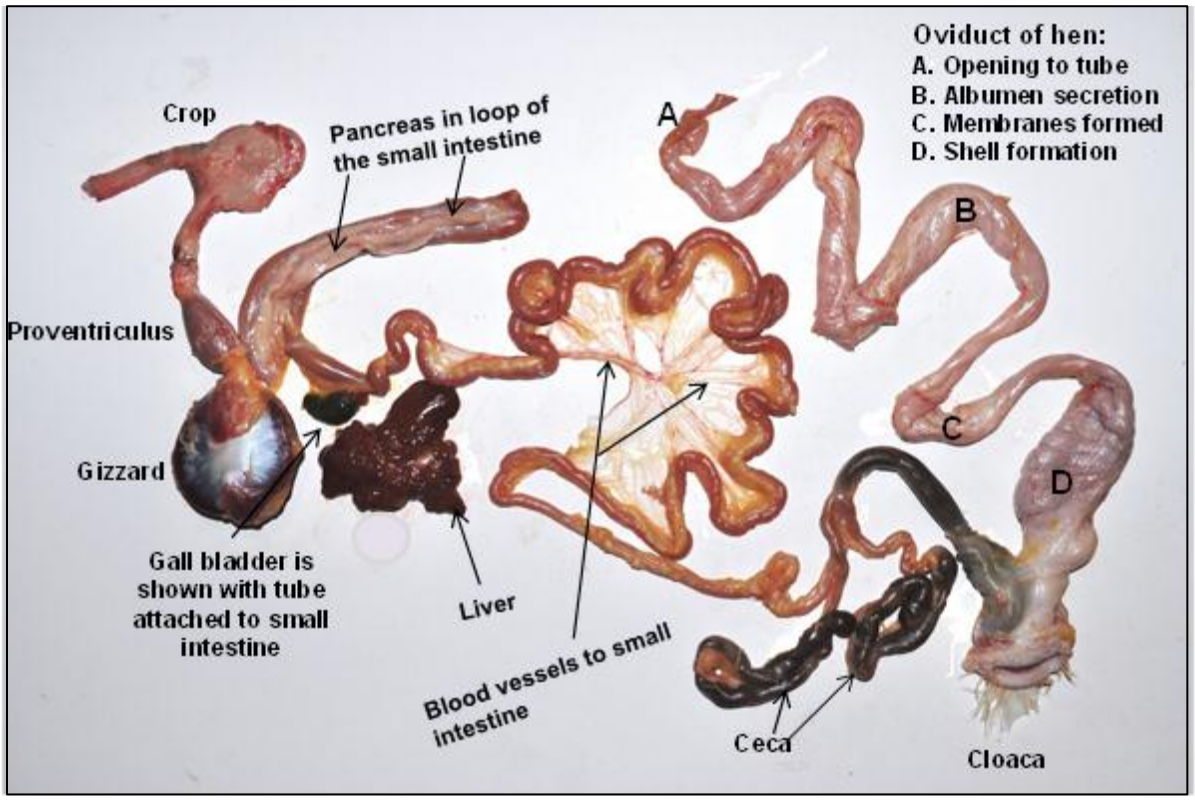


Figure 4 The digestive tract and oviduct of the hen

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 it bluish-green colour. Gall is produced by the liver and the function is to break up fats and oil into very small droplets that mixes with water. The reaction between enzymes and the fat can then take place to break it down into fatty acids.

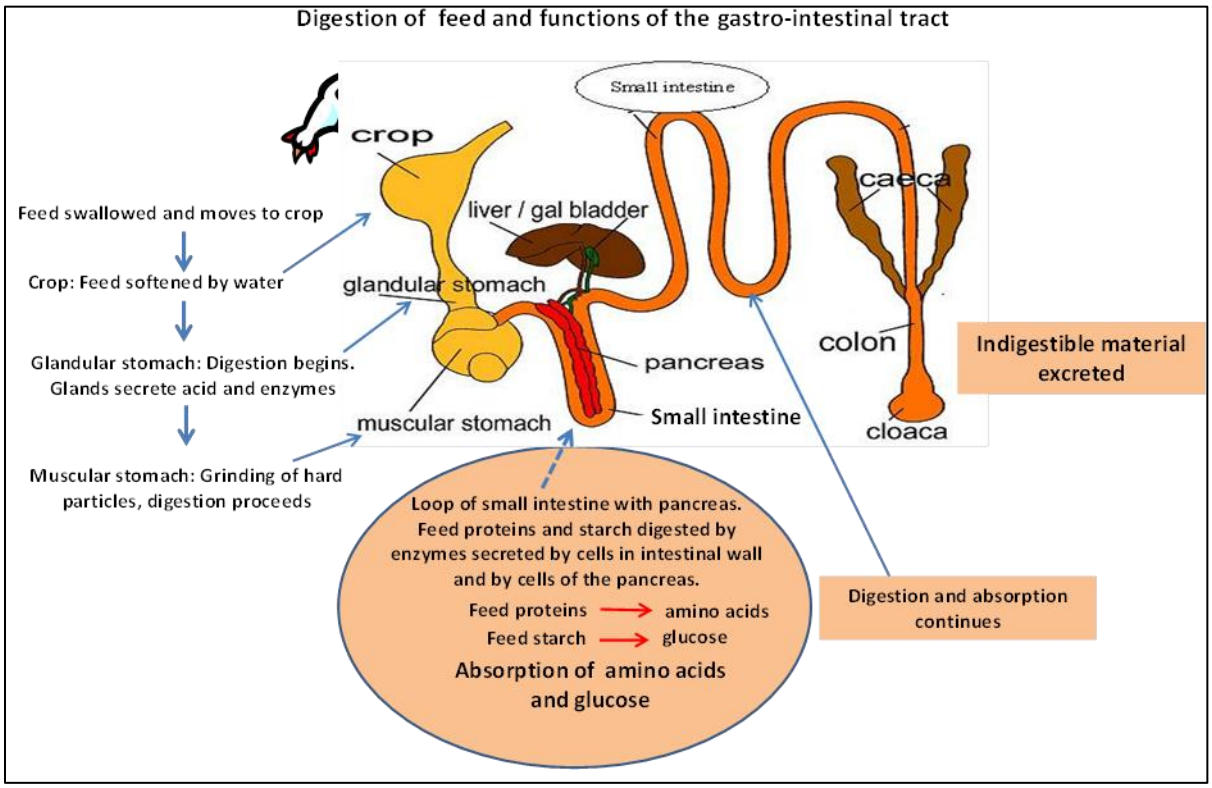
Caeca and colon

The lower portion of the intestinal tract consists of the two caecas, 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 starch[7] 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.

Maize starch is used for the production of glucose powder or glucose syrup. (for making sweets such as nougat.

Glucose powder as a source of energy for humans

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 tendons[8], 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.

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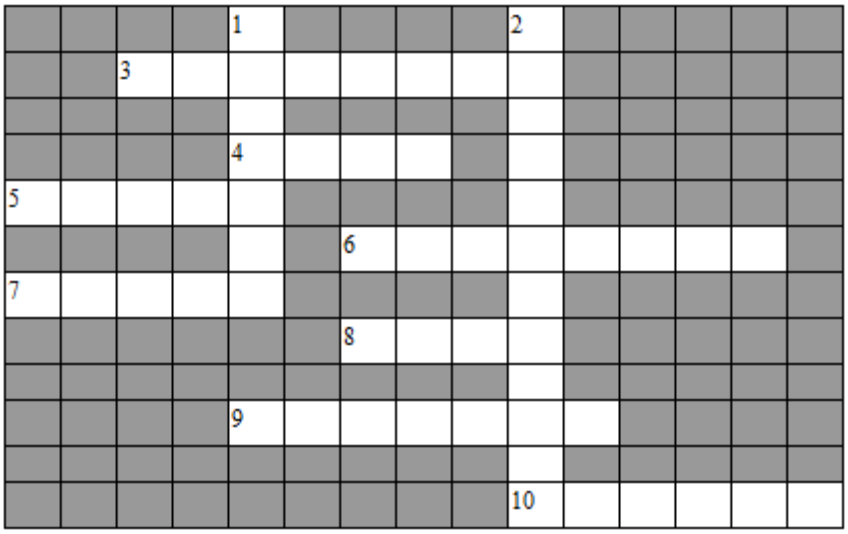
[7] Starch is also the major component in products such as rice, potatoes, wheat and oats and there are indeed also many industrial uses for starch in foodstuffs and in glues.

[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.

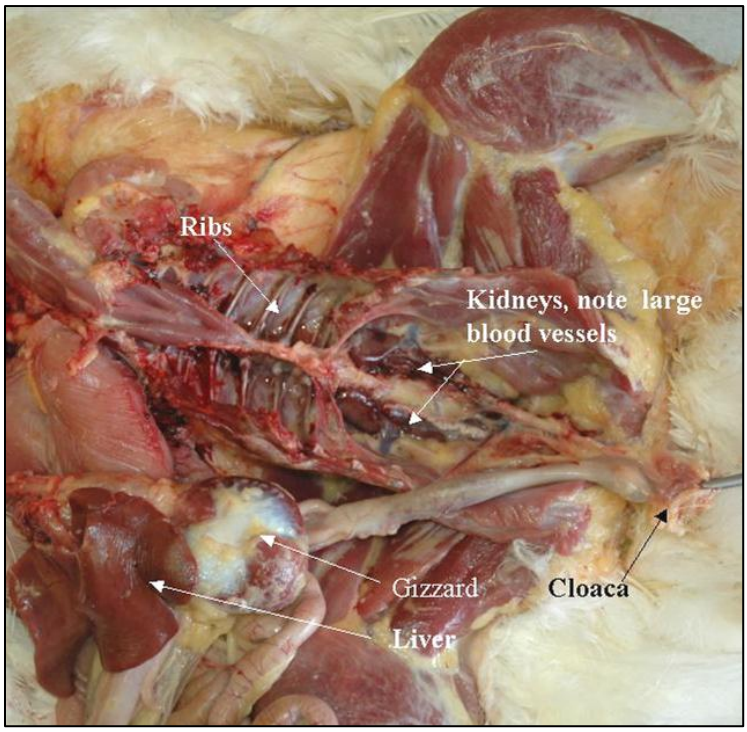


Clue Across	Clue Down	
	1	This is the source of energy used by cells and is the result of the digestion of starch
	2	The acid secreted by the wall of the glandular stomach that assists with the digestive process
3		Glands that secrete saliva
4		In that part of the digestive system feed is softened by 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.

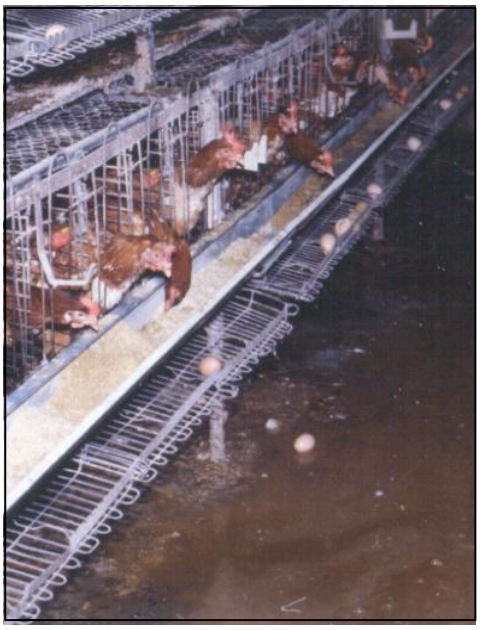
In poultry the white topping on the faeces is the hen's *urine*. It consists of uric acid, and is stored as a paste in the cloaca and excreted with the faeces.

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 dehydration[10] (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.)

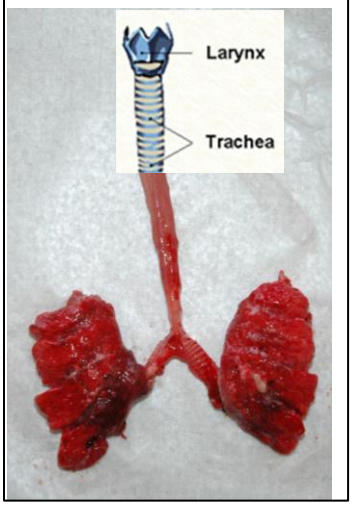
In poultry houses with wet bedding material, bacteria acts on uric acid and convert it to ammonia gas. Under dry conditions these reactions by the bacteria cannot take place.

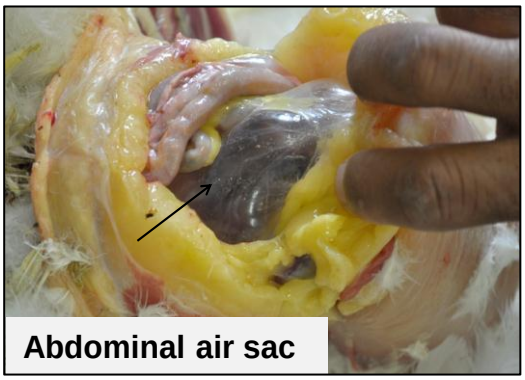
[10]Dehydration is when the bird has lost water from the body cells. This can happen during excessive panting in hot weather or accidental water restriction for prolonged periods of time.

Respiratory system: lungs and air sacs

Important knowledge. 	Chemical **reactions** in body cells **use oxygen**[11] to obtain **energy** from **glucose**[12] 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**.

Windpipe (trachea) and lungs





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.

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[11]Oxygen is only required as long as the animal is alive, when death sets in no more O_2 is needed!
[12]Glucose 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.

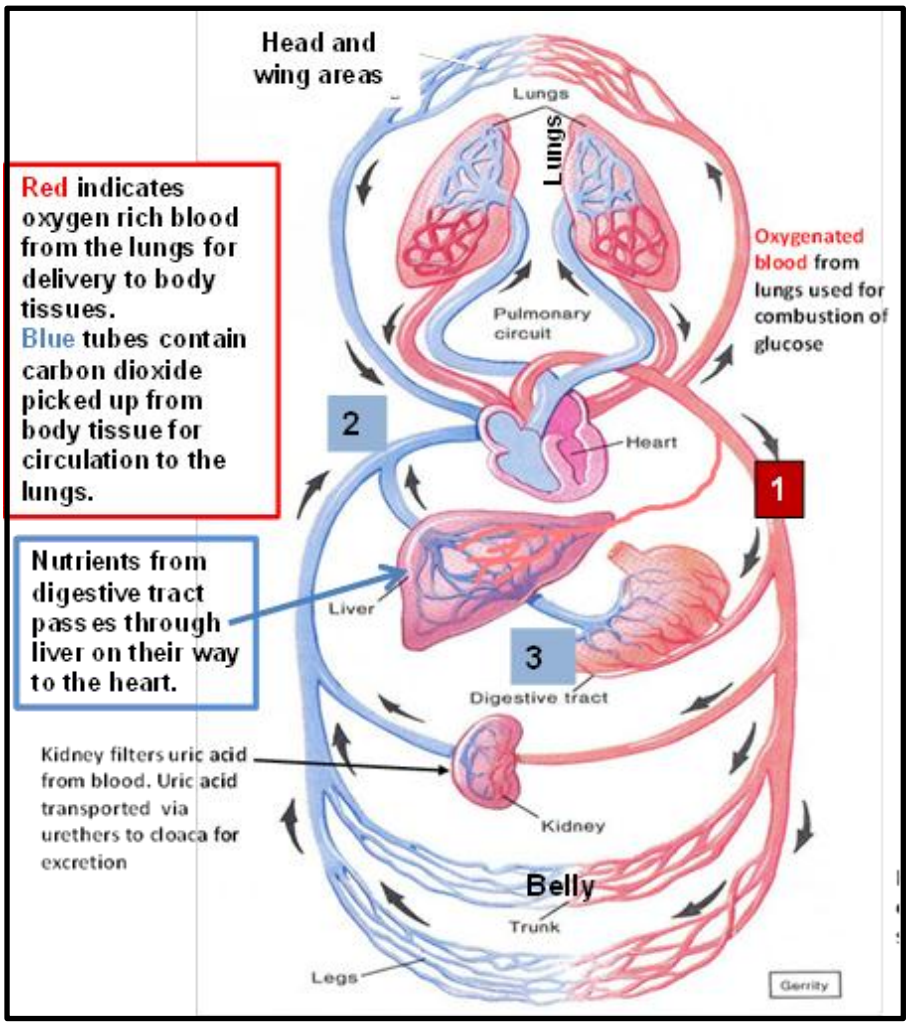


Figure 6 Illustration of a blood circulation system

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 course 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 hormones[13] 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 22[14] 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.

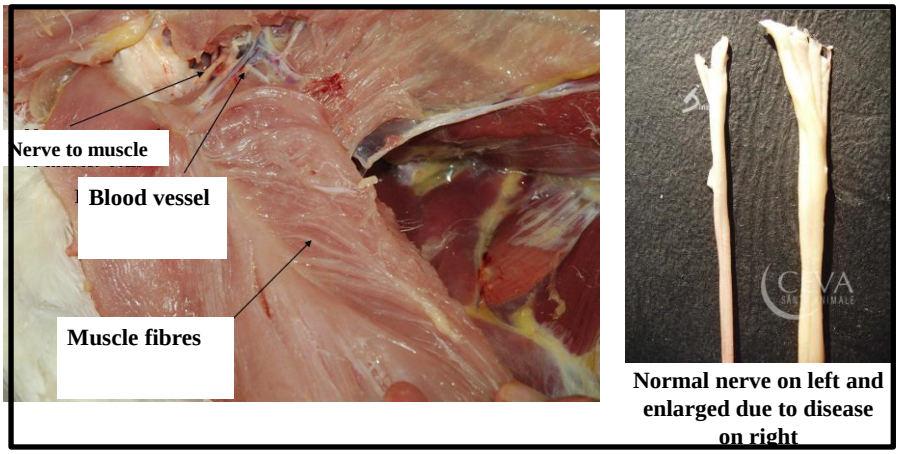


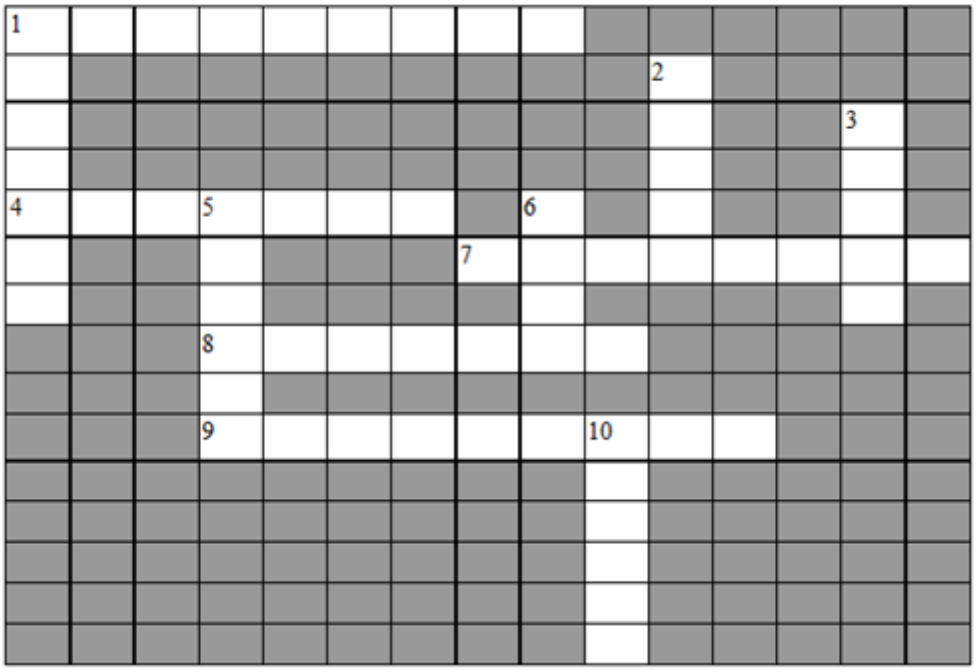
Figure 7. Left: Nerve connected to muscle. Picture[15] on the right: Two pieces of nerve strings.

[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.

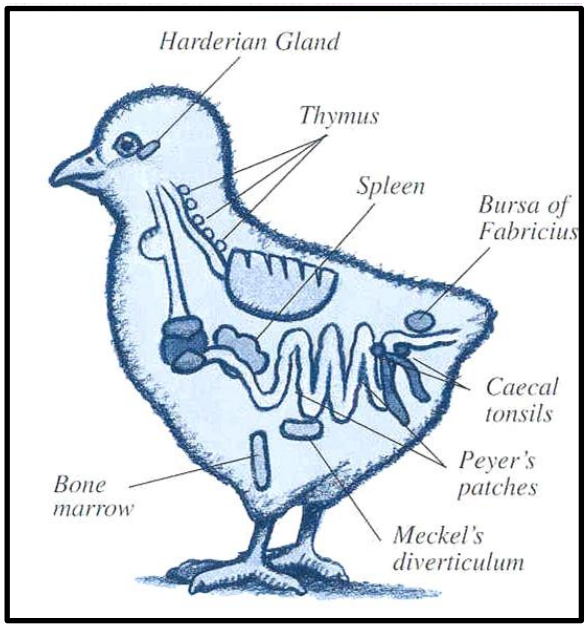
Important knowledge 	Antibodies are chemical substances consisting of proteins.
	Specific organs make antibodies (for example bursa of Fabricius, the thymus glands, the bone marrow, the spleen, etc).
	Antibody production is stimulated by applying a vaccine to the birds.
	Antibodies attach to a disease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

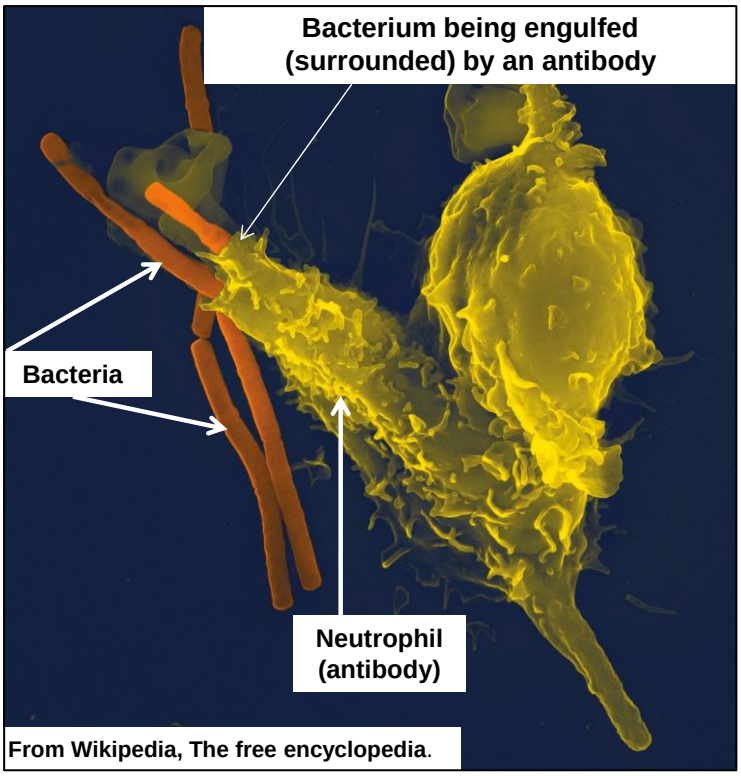
Birds vaccinated against the Newcastle disease virus will have antibodies floating in their blood stream. When the Newcastle disease virus is transmitted onto a farm and penetrates the blood stream of the birds, the antibodies in the blood recognizes these viruses.

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.

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.

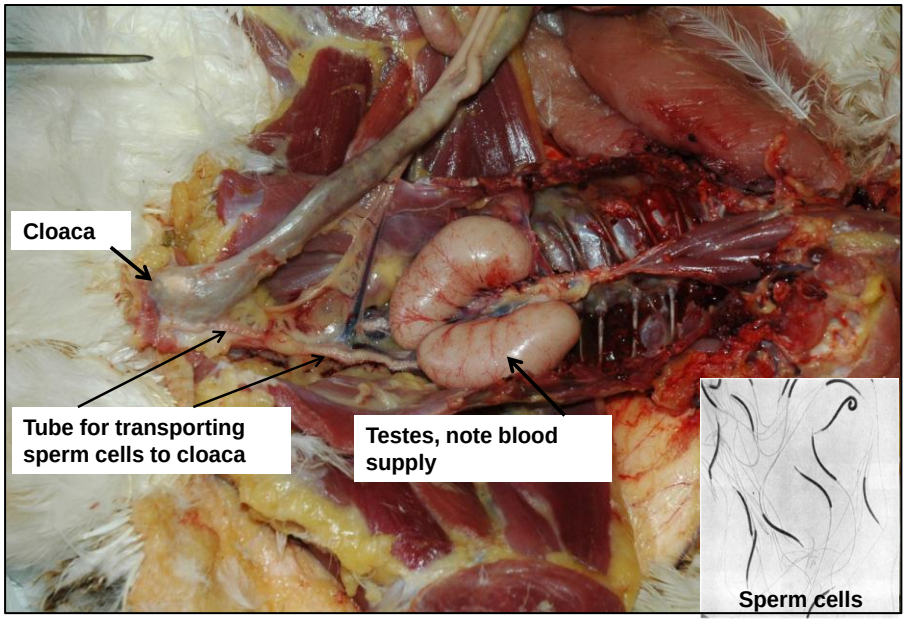
The male reproductive system.

Two testes are located inside the body cavity 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

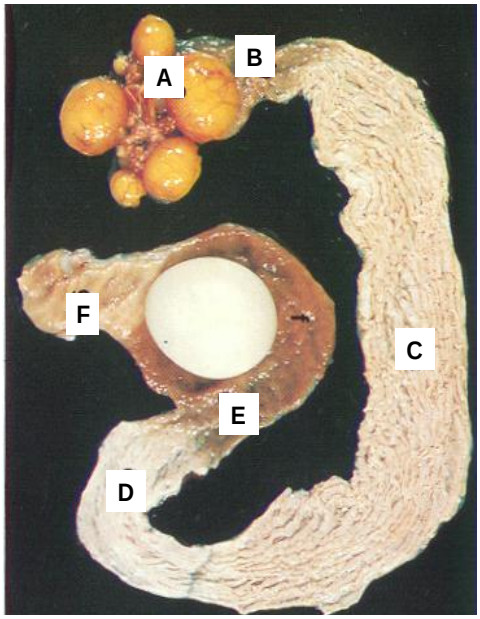
The ovary in the day-old hen (pullet) contains all the ova, the reproductive cells with the genetic material of the hen. Each ovum is enclosed by an inner and outer membrane. At about 16 weeks of age, the liver starts to form the yellow yolk

The ovary with small and mature ova

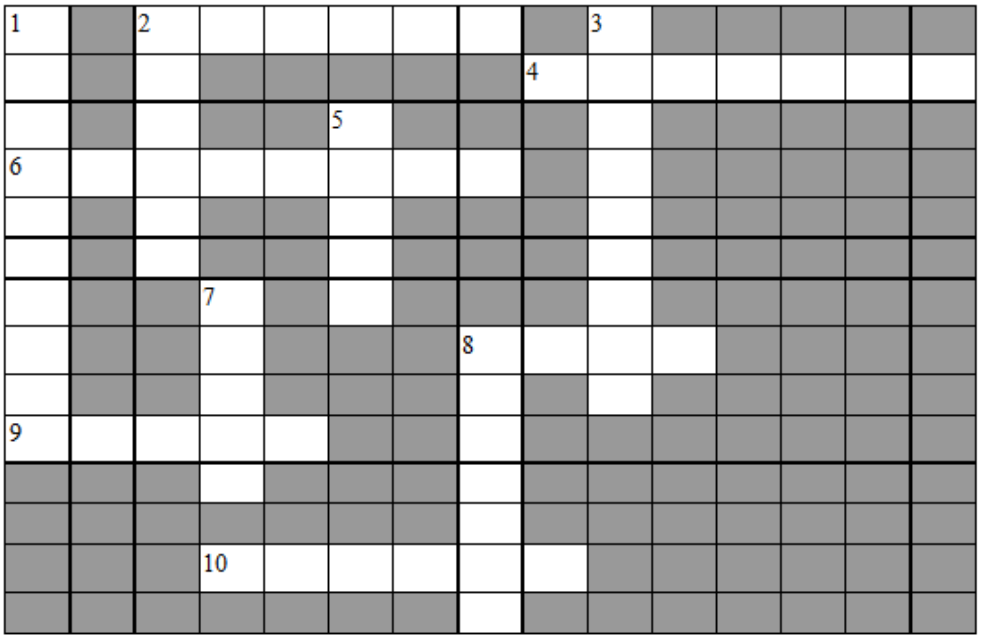
material, which is transported by the blood stream and deposited inside the inner membrane. The ovum thus becomes surrounded by yolk material and is in contact with a source of nutrients, fats, proteins and vitamins, for the embryo during incubation.
In a fully developed ovum the outer membrane will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



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	Fabricius	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