Animal science

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# Animal Science

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Chapter 1 - Body Systems

The Skeleton

The functions of the skeleton are:
- Protection of vital organs (e.g. brain, lungs, heart)
- Maintaining the shape or form of the body
- Allowing the animal to move
- Production of blood cells
- Storage of minerals

Structure of the skeleton

The basic structure of bones and joints are similar for most mammals, although they have specific adaptations to their environment.

Fig 1. Diagram of the skeleton of a cow

Bones

Bones are made up of living material and contain minerals (calcium, phosphorus and magnesium) to make them hard and strong. Long bones such as the femur contain bone marrow in the centre of the bone. Red bone marrow produce red blood cells therefore bones have a good blood supply.

Calcium is needed in the diet of young animals for growth to ensure their bones are strong and healthy. Lack of calcium can lead to rickets (a deficiency disease which will prevent correct bone development). Adult animals with a calcium deficiency in their diets may be able to move calcium from the bones into the blood stream e.g. lactating dairy cows. As animals become older they can find it harder to release the calcium and this can lead to milk fever (hypocalcaemia)
Joints

A joint exists where two bones meet. The structure of joints governs the directions and the amount of movement of the joint.

- **Fixed joints** – the bones interlock so that no movement can take place e.g. the skull
- **Cartilaginous joints** (slightly movable) - the bones are joined together by cartilage so there is a limited amount of movement. These joints occur in the spine, between the vertebrae.
- **Synovial joints** (freely movable) – these joints have a capsule of synovial fluid and cartilage at the ends of the bones. Examples of these types of joints include ball and socket joints (e.g. hips, and shoulders) and hinge joints (e.g. elbows).

![General diagram of a joint](image)

Fig 2. General diagram of a joint

A joint is made up of the following tissues:

- **Ligaments** – tough fibres that link bones together
- **Tendons** – fibres that attach muscles to bones
- **Cartilage** – a smooth slippery layer that covers the ends of the bones and reduces friction
- **Synovial fluid** – the liquid that lubricates the joint

Problems that may occur with joints include infections such as Joint-ill which occurs in young animals when bacteria enter the body and infect a joint. This can lead to damage and painful swelling.
Respiration and the Circulatory System

Respiration
Respiration occurs as a physical and a chemical process; physical inhalation to move gases from the air to the blood stream and expiration to remove waste gases and water, and cell respiration when a chemical reaction takes place to release energy. Cell respiration is the process that allows plants and animals to release energy for their own use. Energy in chemicals such as glucose is released when oxygen reacts with them to produce smaller molecules; the process is similar to the release of energy by burning fuel such as petrol.

Food + Oxygen → Carbon dioxide + Water + Energy

This reaction occurs inside the cells, but the respiratory process must also move oxygen to the cells and remove the waste products. If an animal is unable to move oxygen to the vital organs, it will rapidly die.

Functions of the circulatory system

The circulatory system has several functions:
- To take oxygen to muscles and other tissues
- To remove waste products e.g. carbon dioxide
- To take the products of digestion to the tissues that need them
- To carry chemical messages in the form of hormones
- To transport blood cells and antibodies to fight disease
- To help with temperature regulation

Structure

Gases are exchanged in the lungs. As an animal shortens the muscles in the rib cage and contracts the diaphragm the volume in the chest increases. This draws air into the lungs (the animal breathes in).
Air in the lungs contains more oxygen than tissues therefore oxygen dissolves and passes into the blood stream. The oxygen is carried by red blood cells.

The circulatory system moves oxygenated blood from the lungs to the tissues and deoxygenated blood back to the lungs. The heart pumps the blood through a series of blood vessels (pipes) to the tissues.
- **Arteries** (carry blood away from the heart). Usually the blood is under high pressure and contains a lot of oxygen.

- **Veins** (carry blood to the heart). Usually the blood is low in oxygen, but contains the carbon dioxide to be removed by the lungs.

- **Capillaries** these occur where the arteries become very narrow to allow the blood to bathe the tissues so that food and oxygen can go into the cells and waste products can be removed. Blood leaving the capillaries will enter veins so that it can be returned to the heart.

**Fig 5 Diagram of the heart**
Blood cells

Red blood cells — contain an iron based protein called haemoglobin which binds with oxygen and transports it in the blood. Red cells are made in the red bone marrow of long bones such as the femur and ribs. White blood cells are needed to protect animals from disease.

- Phagocytes are large cells which can attack and engulf bacteria
- Lymphocytes produce antibodies to fight specific diseases.

Platelets are required for blood clotting

Respiration rate and heart rates
In healthy resting animals the approximate rate of respiration and heart rate are shown in table 1:
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<th>Pulse rate (beats /minute)</th>
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<td>12-16</td>
<td>45-50</td>
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<tr>
<td>Sheep</td>
<td>12-20</td>
<td>70-80</td>
</tr>
<tr>
<td>Pigs</td>
<td>10-16</td>
<td>70-80</td>
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*Table 1. Respiration and pulse rates. Adapted from Black’s Veterinary Dictionary*

Stress or exercise will increase the heart and respiration rate. Generally young animals will have faster rates than adults.

**Conditions that may arise with respiration and the circulatory system include:**

- **Pneumonia** – an infection of the lungs. This may be a particular problem if livestock are kept in poorly ventilated housing.
- **Anaemia** – a shortage of haemoglobin which is the chemical in red blood cells that carries oxygen. This often arises if the animal is deficient in iron. It may be seen in young piglets whose diet is low in iron, and in ewes which have a heavy worm burden.
- **Asphyxiation** – animals not getting enough oxygen e.g. if large quantities of gases are released from under ground slurry store into livestock housing.
- **Cardiac failure** – the heart stops pumping the blood around the body
**The digestive system**

The digestive system breaks down feed into small molecules that can be absorbed by the digestive tract into the blood and lymphatic systems. The three main processes of digestion are:

- **Physical break down** – e.g. chewing the food
- **Chemical break down** – e.g. (1) hydrochloric acid released by the stomach wall; (2) Enzymes which are chemicals that speed up chemical reactions without getting changed themselves.
- **Microbial** - e.g. fermentation of food in the rumen (first stomach of a cow or sheep)

Digestive systems have evolved over time to suit the natural diet of the particular animal. The alimentary canal is the term used for the digestive tract.

**The digestive system of a single stomached animal (e.g. the pig)**

**The Mouth**

**Teeth** – these are used for collecting and chewing food. The types of teeth are:

- **Incisors** – for cutting food
- **Canines** – for tearing flesh
- **Molars and premolars** – for crushing and grinding foods.

The teeth are adapted to the diet for example pigs are omnivores (they eat a wide range of feeds from plant and animal sources) their teeth have smooth enamel and they have incisors on both the upper and lower jaw.

**Saliva** contains water, electrolytes, mucus and enzymes to break down starch. It moistens feed to make it easier to swallow.

**The tongue** is made up of muscles that manipulate feed into a bolus (ball) ready for swallowing. It contains taste buds that allow animals to taste the feed. The ability to taste feed allows animals to detect poisons which have a bitter or unpleasant taste and avoid eating them. The animal swallows food when it has been moved to the back of the mouth; a flap called the epiglottis closes off the wind pipe (trachea) to prevent choking.

**The Oesophagus**

This is the tube that connects the mouth to the stomach. Food is pushed along by muscular contractions- this is called peristalsis.

**The Stomach**

This is where the majority of protein breakdown occurs through the activity of an enzyme called pepsin. To make enzymes work effectively, hydrochloric acid is released by the stomach wall to make the contents of the stomach acidic. The muscles in the stomach wall mix the feed before it is gradually released to the next stage of digestion in the small intestine.

Young animals produce rennin in the stomach which clots milk protein into curds which are then broken down by pepsin enzyme.

**The Small Intestine**
Chemicals to complete the breakdown of food are released into the small intestine from:—

**The wall of the intestine**—which releases enzymes.

**The pancreas**—releases pancreatic juice which contains enzymes

**The gall bladder**—bile is produced by the liver, it is stored in the gall bladder and released into the duodenum (the 1st part of the small intestine).

<table>
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<tr>
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<td>- Neutralises the pH so that the enzymes can work better</td>
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<td>- Breaks down (emulsifies) the fats and oils into small droplets so that they have a larger surface area for the enzymes to work on</td>
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<tr>
<td>Amylase</td>
<td>Breaks down carbohydrates to sugar</td>
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<tr>
<td>Trypsin</td>
<td>Breaks down proteins to amino acids</td>
</tr>
<tr>
<td>Lipase</td>
<td>Breaks down fats to fatty acids and glycerol</td>
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When the food particles are of molecular size they are small enough to pass through the wall of the intestine into the blood or lymphatic system. To speed up this process the small intestine it is covered in villi which create a large surface area;

![Fig 7 Diagram of villus](image)

Once the absorbed feed particles have entered the circulatory system they will pass through the liver to remove toxic particles. The circulatory system will move the products of digestion around the body so the digested feed particles can be taken to where they are required e.g. sugar to muscles to provide energy.

**The large intestine**
This is where the process of digestion and absorption is completed and water is reabsorbed to the body from the digestive tract. The waste material is held in the rectum until it is passed out through the anus.
The Ruminant digestive system (e.g. sheep and cattle).
The digestive system of the ruminant is specially adapted to a diet which contains high levels of plant fibre that is difficult to break down. This has led to the development of a structure that has four stomachs; including a final chamber which works in the same way as the stomach of a pig.

The Mouth.
Teeth – these are used for collecting and chewing food. Cattle and sheep have no teeth on the upper jaw at the front of their mouth, rather they have a hard pad of bone and skin. As cattle and sheep get older they will change their first set of teeth (milk teeth) for their adult teeth in a set pattern.

Fig 8. Drawing of cattle incisors (age 2-2½years)

![Temporary incisors](image)

Sheep will tend to graze by biting grass with their incisors cutting up against the hard pad on the upper jaw, cattle tend to use their tongues to collect and pull at the pasture before biting. Ruminants will swallow the food before chewing it thoroughly as they can regurgitate and send it back to the mouth to finish chewing later. Ruminant molars and premolars on both upper and lower jaws at the back of the mouth have a rough surface to physically break down plant fibre.

Saliva – large amounts of saliva are produced by ruminants. The saliva is slightly alkaline to prevent rumen fluid from becoming too acidic.

The Oesophagus
This is the tube that connects the mouth to the rumen. The first three stomachs of the ruminant have developed from the oesophagus; they do not produce any digestive chemicals.

The stomachs.
The stomachs are;
- Rumen
- Reticulum
- Omasum
• Abomasum (or true stomach)

**Fig 9 Ruminant digestive system**

The **rumen** of a cow has a capacity of around 120 litres but varies according to body size and breed. The sheep rumen has a capacity of 15-20 litres. Feed in the rumen is broken down by microbes, mainly bacteria and protozoa.

- Bacteria use some of the food to reproduce and increase numbers. Bacteria are moved down the digestive system with the rest of the feed and get digested. This is referred to as microbial protein.
- Microbes also add nitrogen to molecules to produce protein.
- Microbes will release waste products, some of these can be used by the cow e.g. volatile fatty acids. Waste gases e.g. methane produced by microbes are removed by belching. Cattle and sheep must get rid of the waste gases to prevent bloat where trapped gases expand the rumen, cause discomfort and put pressure on internal organs. Severe cases can result in death.
- If too much highly fermentable feed (e.g. wheat) is given then too much acid will be produced; this will upset the digestive system and cause acidosis.

Rumen microbes are adapted for specific feed. Diet changes have to be gradually introduced to give the rumen population time to adjust. The muscles of the rumen move the food and gases; this helps to remove the gases and mix the food and bacteria. Some chemicals can be absorbed through the wall of the rumen.

The **reticulum** is much smaller than the rumen. Food passes into the reticulum from the rumen. Large food particles are sent back to the mouth so that they can be chewed again. When the particles in the reticulum are small enough they pass into the next stomach, the omasum.

The **omasum** is the third stomach. This stomach has folds of tough tissue which can grind fibrous material.
The abomasum is the fourth stomach. This stomach works in the same way as the single stomach of the pig where hydrochloric acid and pepsin break down feeds.

Rumen flora and fauna break down feeds to their constituent parts for absorption in the lower gut. Some feeds, particularly high quality fat and proteins, are already in a form that can be broken down and absorbed in the lower gut therefore it is a waste of energy for such compounds to be broken down in the rumen. Due to the cost of high quality fat and protein, it is usual that only highly productive animals have rations designed to contain ‘protected’ sources of fat and protein that should not be broken down by rumen microbes.

The small and large intestines
Digestion and absorption in the intestines is similar to the process in the single stomached animal (see earlier notes).

Development of the ruminant digestive system in young animals.
At birth, the first three stomachs are not well developed and young stock need to get milk into the abomasum for it to be digested. When young ruminants drinks milk a gathering of tissue called the oesophageal groove diverts milk through the rumen, reticulum and omasum directly to the abomasum.

Fig 10 Diagram of the young rumen

Poor feeding practice e.g. having the buckets at the wrong height, can prevent the oesophageal groove from forming properly and animals lose milk to the rumen, reticulum and omasum which results in digestive problems such as scouring. As the animal eats more feed, especially feed which is high in fibre, the first three stomachs will develop. It is important that the young animal is eating enough solid feed before it is weaned (no longer fed on milk).

During the first six hours of life lambs and calves are able to absorb large compounds through the wall of the digestive tract. This allows them to absorb antibodies from colostrum (the first milk). The digestive system alters very
rapidly thereafter and the ability to absorb antibodies is lost after about six
hours. The antibodies provide passive immunity from disease.
The Nervous System

Functions of the nervous system
The nervous system in an animal coordinates body movement, sends and receives messages that allow reaction to stimuli e.g. pain, noise, smells, and monitors organ activity.

Structure of the nervous system
The nervous system is made up of 2 parts:
The central nervous system – the brain and the spinal cord.
The peripheral nervous system – the rest of the animal’s nerves.

Stimuli travel along the peripheral nervous system to the central nervous system. This can invoke a voluntary response after the stimuli are processed by the brain or a more rapid involuntary response when the stimuli are processed in the spinal chord and brain.

Problems may be seen in farm animals when the nervous system is damaged or not functioning properly. Examples of this include:
Physical damage
- Gid occurs when tape worm cysts develop and cause pressure on the brain.
- Brain damage due to fighting
Nutritional causes
- Swayback in young lambs where copper deficiency in the ewe during pregnancy has prevented the complete formation of the spinal cord
- Metabolic disorders such as magnesium deficiency (grass staggers) where the lack of magnesium upsets the transmission of messages
Infections
- BSE and scrapie where brain damage has occurred
- Tetanus and botulism where toxins are produced which damage the nervous system
**The excretory system and the removal of waste.**

**Functions of the excretory system**

This system removes waste products from the animal. The gut removes the indigestible waste products of digestion directly from the digestive tract through the anus. Other waste passes from the tissues into the blood stream and is removed from the blood by the liver and kidneys.

**The lungs**

The lungs enable the body to remove the waste products of respiration, namely carbon dioxide and water, by expiration.

**The liver**

The liver has many functions, these include:
- Making bile from damaged red blood cells
- Breakdown excess amino acids into urea which is released into the blood stream to be removed by the kidneys
- The removal of toxic substances from the blood e.g. alcohol
- Breakdown of body fat reserves to release energy (this can occasionally cause the release toxic chemicals (ketones) and result in ill health e.g. twin lamb disease in pregnant ewes

Conditions of the liver include liver fluke where parasites damage the tissues, and infections such as hepatitis.

**The kidneys**

The body has two kidneys and these filter the blood.

![Diagram showing the kidney](image)

Fig 11 Diagram showing the kidney

They remove excess salts, water and urea from the blood and collect the resulting urine which is then passed to the bladder through the ureter. The
urine is stored in the bladder before being passed out of the body through the urethra.

**Problems** that can occur with the removal of waste include:
Urinary calculi – crystals forming in the urine due to the mineral content. These may block the urethra so that the animal is unable to urinate (it is most common in castrated lambs fed on concentrates).
Reproductive systems
The male reproductive system

Functions of the male reproductive system
The male reproductive system produces sperm which fertilise the ova (eggs) in the female so that embryos are produced. Hormones are produced which affect the animals' behaviour and lead to the development of secondary sexual characteristics (such as the development of strong shoulders, head and neck).

Structure of the male reproductive system

![Diagram of male reproductive organs](image)

The reproductive tract of the bull

Fig 12 Diagram of male reproductive organs

A table showing the main functions of the male reproductive organs

<table>
<thead>
<tr>
<th>Testes/testicles</th>
<th>Produce immature sperm</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Produce male hormones</td>
</tr>
<tr>
<td>Scrotal sac</td>
<td>This is the skin surrounding the testes</td>
</tr>
<tr>
<td>Epididymis</td>
<td>Very long narrow tubes in which the sperm develop and mature</td>
</tr>
<tr>
<td>Spermatic cord</td>
<td>This is the blood and nerve supply to the testicles</td>
</tr>
<tr>
<td>Vas deferens</td>
<td>This transports the sperm from the epididymis to the</td>
</tr>
</tbody>
</table>
urethra. Fluid from accessory sex glands is added to the sperm and this produces semen.

**Accessory glands**

Produce fluid to transport and provide nutrients for the sperm.

**Penis**

This is the male organ used for mating; it is used to deposit the semen into the female’s vagina.

**Castration**

Male calves and lambs that are kept for meat may be castrated when they are young to prevent them from developing secondary sexual characteristics. Castration can also make management easier as they will not be able to mate with female livestock on the farm, may be less aggressive, safer and easier to handle. However growth rate may be reduced. Piglets may also be castrated, however, the practice is less common than in the past. Castration can prevent boar taint (meat from entire males having an unpleasant taste), but many pigs are slaughtered at a sufficiently early age for it not to be a problem. There are strict regulations concerning the castration of livestock – see the appropriate livestock welfare codes.

**Vasectomies**

Entire males produce pheromones (chemicals) that send messages to females which can stimulate female hormone production. Rams which have been vasectomised are called teasers; that is they have had the vas deferens cut so that the sperm which is produced will not be able to reach the penis. Teasers will produce pheromones and behave like entires, however they will be infertile. They are used to synchronise the breeding season of female livestock.

**Fertility**

Fertile bulls and rams will produce semen which contains large amounts of healthy active sperm. For the animals to be fertile the sperm produced must be mature. Testicles are placed in the scrotal sac outside the body cavity to produce and store sperm a a lower temperature. Sperm is easily damaged if it is too warm.

Rams are usually given a physical inspection well before the breeding season to check for any abnormalities which could reduce their fertility. There is an infertility rate of approximately 10% in mature rams. Infections in the body e.g lameness can reduce fertility by increasing body temperature and reducing the viability of sperm. Infections also reduce physical activity and even though not directly affecting the reproductive system, it creates a reduced willingness to serve females which will reduce flock fertility.
Samples of sperm can be collected and studied under a microscope to assess sperm quality. Common faults include lack of movement, deformities and damaged tails.

**The female reproductive system**

**Functions of the female reproductive system**

This will produce the ova (eggs) that can be fertilized to produce embryos. The embryos will be nourished in the uterus until parturition (birth). The female reproductive system will produce a range of hormones that will control the maturing and release of ova; they will also make the female receptive to the male so that she will stand to be mated.

**The structure of the female reproductive system**

![Diagram of the female reproductive tract](image)

**Ovary**  
These contain ova that develop inside follicles. The ova only develop a few at a time (the number varies with the species of animal and its condition)  
Female hormones are produced

**Fallopian tubes**  
These collect the ova when they are released (ovulation) and carry them to the uterus. Fertilization takes place between the ovum and the sperm in the Fallopian tubes. The fertilized egg travels to the uterus.
**Uterus**

The uterus or womb is where the embryo develops. During pregnancy the embryos will attach to the uterus and nourishment will be transferred from the mother through the placenta.

**Cervix**

A thick band of muscle that closes the neck of the uterus. It allows semen to enter when the animal is on heat and opens for her to give birth. It prevents infections entering the uterus and keeps the developing foetus inside the uterus.

**Vagina**

Holds the penis during mating so that the sperm will be deposited in the right place.

**Vulva**

The external opening of the female reproductive tract

---

**Puberty**

Puberty is the stage in an animal’s life when it becomes sexually active and is capable of reproducing. The age will vary between individuals and the factors listed below will influence the timing of puberty:

- Breed
- Body weight and nutrition (this may be far more important than age, particularly for females)
- Effect of changing day length (decreasing day length will trigger breeding activity in sheep and an increasing day length will trigger breeding activity in horses and birds)
- Environmental factors e.g. the presence of males

**The reproductive cycles**

The stage during the reproductive cycle when a female will stand to be mated is known as oestrus. During the breeding season mature females that are not pregnant will have an oestrus cycle at regular intervals.
<table>
<thead>
<tr>
<th>Animal</th>
<th>Length of oestrous cycle</th>
<th>Duration of oestrus</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Usual</td>
<td>Range</td>
</tr>
<tr>
<td>Cow</td>
<td>20 days</td>
<td>16-24 days</td>
</tr>
<tr>
<td>Ewe</td>
<td>16-17 days</td>
<td>10-20 days</td>
</tr>
<tr>
<td>Sow</td>
<td>21 days</td>
<td>15-30 days</td>
</tr>
</tbody>
</table>

Table 2. Length and duration of oestrus in cattle, sheep and pigs. Adapted from Black’s Veterinary Dictionary.

Cattle and pigs kept in agricultural systems breed throughout the year. Sheep are seasonal breeders; the breeding season will start in the autumn, in general the lowland breeds will start to cycle earlier in the year than the hill and upland breeds.

The oestrous cycle is controlled by female hormones. These will coordinate the maturing and release of the ova with the animals’ reproductive behaviour. If the ova is fertilized the hormones will maintain the pregnancy.

- **Follicle Stimulating Hormone (FSH)** – this is produced by the pituitary gland and it stimulates the ova to mature in the follicle.
- **Luteinising hormone (LH)** - makes the follicle burst and release the ovum.
- **Oestrogen** – makes the animal show the signs of heat
- **Progesterone** – blocks FSH and stops the animal ovulating, if an ovum (egg) is fertilized then the progesterone level will stay high throughout pregnancy.
- **Prostaglandins** - if the egg is not fertilized then the uterus will produce prostaglandins and the cycle will be repeated.
Fig. 14 Diagram of the levels of females hormones

**Pregnancy**
If the ova are fertilized the cell will rapidly divide and multiply. The embryo will implant into the wall of the uterus to gain nourishment from the dam. If the dam is under stress e.g. not getting enough feed, then the embryo may fail to implant.

The average gestation periods (length of pregnancy) for classes of stock are shown in table 3:

<table>
<thead>
<tr>
<th>Animals</th>
<th>Gestation (months)</th>
<th>Gestation (days)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cattle</td>
<td>9</td>
<td>279-290</td>
</tr>
<tr>
<td>Sheep</td>
<td>5</td>
<td>144-150</td>
</tr>
<tr>
<td>Pigs</td>
<td>3 months, 3 weeks &amp; 3 days</td>
<td>112-115</td>
</tr>
</tbody>
</table>
Table 3. The average gestation periods for cattle, sheep and pigs (adapted from Merck's Veterinary Manual).

The length of the gestation period is affected by the number of offspring, breed and sex of embryo. In general twins have a shorter gestation length than singles, beef breeds longer than dairy breeds and male feti have a longer gestation length than females.

**Mammary system**

**Function of the udder**
Milk is the feed of young animals and is produced and stored in the udder. Cells capable of producing milk develop in the udder as a female animal matures. During pregnancy hormones prepare the cells for milk production and in the final hours of gestation produce milk available to the young animal immediately after parturition.

The first milk produced is colostrums and has a high fat content making it rich in energy. It also provides antibodies for newborn animals. Gradually the dam will produce milk used for rearing the young stock or for sale e.g. dairy cows.

**Structure of the udder**

The number of sections and teat will vary according to the type of livestock:
- **Cows** – four sections in the udder, each is known as a quarter
- **Ewes** – have two parts to the udder and two teats
- **Sows** – have a large number of independent teats 14-16 (the number and positioning of the teats will be one of the criteria used for selecting replacement gilts)

The quarter of a cow has a large blood supply. There is a large amount of spongy tissue which contains millions of milk producing cells that are arranged to form small spheres of cells (alveoli).
Small tubes lead from the alveoli leading to the lower part of the udder where they join together to form the milk duct (or cistern) above the teat. A narrow duct or tube runs through the teat. A band of muscle closes the opening at the end of the teat.

**Milk let-down**

For the young to drink the milk or for the cow or ewe to be milked, there must be milk let-down. Milk is released from the cells where it has been produced and it is moved from the alveoli to the lower part of the udder. Stimuli, such as the calf pushing the udder and sucking the teat or cleaning the teats as part of the pre-milking routine, make the cow release a hormone called oxytocin. The oxytocin is carried in the blood stream to the udder for the milk let down to occur.

If the animal is frightened or upset, adrenalin will be released, this will block the oxytocin so the milk will not be let down properly. Milk let-down does not occur instantly so the parlour milking routines must allow time for the hormone to work (60 -90 seconds); therefore five cows may be prepared for milking before returning to the first cow to attach the units.

**The endocrine system**

The function of the endocrine system

The endocrine system produces chemicals known as hormones which are secreted into the blood stream. These hormones carry messages to other parts of the body and produce specific responses.
Examples of endocrine glands and hormones:

<table>
<thead>
<tr>
<th>Hormone</th>
<th>Action</th>
<th>Where it is produced</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thyroxine</td>
<td>Controls the metabolic rate; how fast the body systems work</td>
<td>Thyroid gland</td>
</tr>
<tr>
<td>Adrenalin</td>
<td>Prepares the body to respond to danger:</td>
<td>Adrenal gland near the kidneys</td>
</tr>
<tr>
<td></td>
<td>• increases the pulse rate and breathing,</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• gets the animal ready to fight or run away.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• interferes with milk let down</td>
<td></td>
</tr>
<tr>
<td>Insulin</td>
<td>Controls sugar levels in the blood</td>
<td>Pancreas</td>
</tr>
<tr>
<td>Oxytocin</td>
<td>• Causes milk let down</td>
<td>Pituitary gland</td>
</tr>
<tr>
<td></td>
<td>• Produces uterine contractions at calving or lambing (parturition)</td>
<td></td>
</tr>
<tr>
<td>Oestrogen</td>
<td>• Development of female secondary sexual characteristics</td>
<td>Ovaries</td>
</tr>
<tr>
<td></td>
<td>• Heat (oestrus)</td>
<td></td>
</tr>
<tr>
<td>Progesterone</td>
<td>Maintains pregnancy and prevents the maturing and release of ova</td>
<td>Ovaries</td>
</tr>
<tr>
<td>Testosterone</td>
<td>Male sex hormone that governs secondary sexual characteristics</td>
<td>Testicles</td>
</tr>
</tbody>
</table>

**Growth.**

When young stock such as lambs or calves grow they develop in a set pattern. The carcase is made up of bones, muscle and fat and the proportion of these tissues will change as the animal matures, the animals' body shape will also change.

A typical growth pattern shows a rapid increase in weight a first, slowing down as the animal reaches puberty.

Initially there is a high proportion of bone growth followed by an increase in the proportion of muscle, then fat will be deposited. The rate of fat deposition will vary between breeds and this will be considered in the selection of finishing system for stock.

The rate of growth will vary according to:
- genetics
- the environment (including the amount and type of feed available, health)
- sex (and whether the males are entire or castrated)

An animal’s growth rate can be calculated by dividing the weight increase by the number of days of growth; this is the daily live weight gain (d.l.w.g.). The d.l.w.g. is usually expressed in kg or grams per day. The formula is
Daily live weight gain = Weight gain ÷ the number of days of growth

**Example**

A lamb weighed 5.5kg at birth; it weighed 8.5kg twenty days later. What is the daily liveweight gain?

Second weight – birth weight = 8.5kg - 5.5kg = 3.0kg weight increase.
Days of growth = 20 days.

\[
\frac{Weight\ gain}{Days\ of\ growth} = \frac{3.0\ kg}{20\ days} = 0.15\ kg/day \ daily\ liveweight\ gain
\]

**Temperature control**

Cattle, sheep and pigs are mammals. They are warm blooded animals so they have body systems which can regulate their temperature.

Average body temperatures are:

- Cattle: 38.9°C
- Sheep: 40.0°C
- Pigs: 39.7°C

**Heat loss**

Animals lose heat by panting or sweating, both of these actions will increase their water requirement. They will also take action to cool down if possible e.g. seeking shade, standing in streams. Sweating is an active process that requires heat to evaporate water, taking heat from the skin to evaporate water cools the animal. To increase the amount of heat loss, animals can increase the blood flow to the skin.

If the environment is too hot then feed intake decreases and production will be reduced e.g. reduced milk yield in dairy cows.

Temperatures can vary widely over a 24 hour period, so animals which have been too hot and sweated during the day may then be damp and cold later if the sweat has not evaporated.

**Maintaining and producing heat.**

Adult sheep and cattle with full coats or fleeces can maintain their temperature as long as they have sufficient feed and shelter. Young animals have a relatively large surface area (a large amount of skin surface compared to their volume) and lower fat reserves so they are more at risk from hypothermia (being too cold). Animals can generate heat by breaking down fat; very young animals only have a small fat reserve so they need colostrum (and later milk) to provide them with the energy to keep warm. If animals become wet through they will lose heat more rapidly because of the energy taken from their skin to evaporate the water.
The amount and type of birth coat will also affect the young animal’s ability to keep warm. Hill lambs are born with thick birth coats that will protect them from the weather. Piglets only have very fine hair, so they need protection from the elements; outdoor systems have bedded arcs for sows and piglets, many indoors systems have heated creep areas. In older animals the coat varies according to the breed and the level of feeding that the animal receives.

Other mechanisms used to keep warm are shivering, making hairs erect and reducing blood flow to the skin. The rapid movement of muscle when shivering will produce body heat; however animals can be suffering from hypothermia but not shivering. Making the hairs erect will trap more air close to the skin to insulate the animal. Constricting the blood vessels near the skin will reduce the skin temperature and the amount of heat lost.

References and further reading


Teagasc (1994). Introduction to Farm Animals. Teagasc


Chapter 2 - Health and Welfare

Animal welfare is important because

- people who look after livestock have a moral responsibility to ensure that the animals are properly cared for
- there is legislation in place to safeguard animal welfare (the law states that stock are looked after properly)
- stock need to be fit and healthy to be profitable

Aspects of animal welfare are now part of the cross compliance for the Single Payment Scheme. (For details see the Welsh Assembly website www.wales.gov.uk, www.cefngwlad.cymru.gov.uk or the DEFRA website www.defra.gov.uk for the requirements in England)

Livestock welfare codes

Background to the codes

There are specific guidelines relating to farm animal welfare in England and Wales. Welfare codes are available for different classes of stock (e.g. sheep, cattle and pigs) and for specific circumstances such as livestock auctions. Welfare codes give information about the current animal welfare legislation, and they also give explanations that show how the law may be interpreted for given situations e.g. space requirements for animals.

Everyone who owns or is responsible for keeping livestock should ensure that the standards laid down in the codes are met. Copies of the standards are available from DEFRA on their website (www.defra.gov.uk) or as hard copies. The codes are regularly updated. The codes cover all aspects of livestock production and stockmanship e.g. health, management, feeding, breeding, housing and emergency precautions.

The five freedoms

Animals must be kept in a way that meets the requirements of the five freedoms.

The five freedoms as stated in the front of the welfare codes are:

1. **Freedom from hunger and thirst** by ready access to fresh water and a diet to maintain full vigour
2. **Freedom from discomfort** by providing an appropriate environment including shelter and a comfortable resting area
3. **Freedom from pain, injury and disease** by prevention or rapid diagnosis and treatment
4. **Freedom to express normal behaviour** by providing sufficient space, proper facilities and company of the animals’ own kind
5. **Freedom from fear and distress** by ensuring conditions and treatment to avoid mental suffering

To ensure that livestock are kept to these standards, the codes also state that those who have the care of livestock should practise:

- Caring and responsible planning and management
- Skilled, knowledgeable and conscientious stockmanship
- Appropriate environmental design
- Considerate handling and transport
- Humane slaughter

**Causes of ill health**

Ill health in animals can be caused by:

- Viruses
- Bacteria
- Fungi
- Parasites
- Metabolic disorder
- Poisons

It is possible that animals may have several of these factors affecting them at the same time.

For diseases to be prevented or treated it is important that the cause of ill health is known; for example a change in feeding system could prevent metabolic disorders, whereas improved hygiene or vaccination may be appropriate actions to take to prevent some viral or bacterial diseases.

<table>
<thead>
<tr>
<th>Cause of ill health</th>
<th>Information</th>
<th>Examples of disease/problems caused</th>
</tr>
</thead>
<tbody>
<tr>
<td>Viruses</td>
<td>Very small disease causing organism</td>
<td>Foot and mouth disease</td>
</tr>
<tr>
<td></td>
<td>Can only multiply inside other living cells</td>
<td>Orf</td>
</tr>
<tr>
<td></td>
<td>Often very contagious</td>
<td></td>
</tr>
<tr>
<td></td>
<td>May be killed by disinfectants when outside the body</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Can’t be seen with an ordinary microscope</td>
<td></td>
</tr>
<tr>
<td>Bacteria</td>
<td>Small disease causing organisms</td>
<td>Foot rot (<em>Fusobacterium necrophorum</em> and <em>Dichelobacter nodosus</em>)</td>
</tr>
<tr>
<td></td>
<td>Range of types, shapes and sizes (round, rod shaped, spiral)</td>
<td>Anthrax (<em>Bacillus anthracis</em>)</td>
</tr>
<tr>
<td></td>
<td>Can grow and multiply outside host cells</td>
<td>Joint ill</td>
</tr>
<tr>
<td></td>
<td>Can live as spores for many years (these may be hard to kill with disinfectants)</td>
<td>Clostridial diseases such as Tetanus (<em>Clostridi um tetani</em>), Braxy (<em>Clostridi um septicum</em>), and Pulpy kidney (<em>Clostridi um welchii</em>)</td>
</tr>
<tr>
<td></td>
<td>Can be seen with a light microscope</td>
<td>Black disease (<em>Clostridi um oedematiens</em>).</td>
</tr>
<tr>
<td></td>
<td>Sometimes a disease will be described by using the scientific name of the bacteria e.g. Escherichia coli which is shortened to E. coli</td>
<td>Ringworm (<em>Trichophyton verrucosum</em>)</td>
</tr>
<tr>
<td>Fungi</td>
<td>These include moulds and yeasts</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Larger than bacteria</td>
<td></td>
</tr>
</tbody>
</table>
**Cause of ill health**

<table>
<thead>
<tr>
<th>Information</th>
<th>Examples of disease/problems caused</th>
</tr>
</thead>
<tbody>
<tr>
<td>Multiply rapidly under warm moist conditions</td>
<td>Round worms (&lt;code&gt;Nematoda&lt;/code&gt;)</td>
</tr>
<tr>
<td>Quite resistant to disinfection</td>
<td>Tapeworms (&lt;code&gt;Cestoda&lt;/code&gt; e.g. Pork tapeworm &lt;i&gt;Taenia solium&lt;/i&gt;, Beef tapeworm &lt;i&gt;Taenia saginata&lt;/i&gt;)</td>
</tr>
<tr>
<td>These are larger organisms that live at the expense of the host (the animal they live on)</td>
<td>Fluke (&lt;code&gt;Trematoda&lt;/code&gt; e.g. &lt;i&gt;Fasicola&lt;/i&gt;)</td>
</tr>
<tr>
<td>Internal parasite live inside the host (e.g. in the intestine, liver, lungs)</td>
<td>Lice (&lt;code&gt;Linognathus&lt;/code&gt;)</td>
</tr>
<tr>
<td>External parasites live on the outside of the animal</td>
<td>Blowfly (&lt;i&gt;Lucilia sericata&lt;/i&gt;)</td>
</tr>
<tr>
<td>Some parasites only spend a short part of their life cycle with the host (e.g. ticks)</td>
<td>Ticks (&lt;i&gt;Ixodes ricinus&lt;/i&gt;)</td>
</tr>
<tr>
<td>Parasites such as tapeworms carry out most of their life cycle inside the host</td>
<td>Sheep scab mites (&lt;i&gt;Psoroptes communis ovis&lt;/i&gt;)</td>
</tr>
<tr>
<td>Metabolic disorders occur when there is an imbalance of energy or minerals in the body tissues</td>
<td>Lack of calcium (&lt;code&gt;Hypocalcaemia&lt;/code&gt;)</td>
</tr>
<tr>
<td>May be due to a lack of a mineral in the feed e.g. grass staggers (hypomagnesaemia) in stock on spring grass</td>
<td>Milk fever</td>
</tr>
<tr>
<td>May be brought on by stress (e.g. sheep handled just before lambing may be prone to twin lamb disease)</td>
<td>Lack of magnesium (&lt;code&gt;Hypomagnesaemia&lt;/code&gt;)</td>
</tr>
<tr>
<td>If one animal is showing signs of metabolic disorder others in the flock or herd may also be on the verge of suffering from the disorder.</td>
<td>Grass staggers</td>
</tr>
<tr>
<td>May be due to animals eating poisonous plants</td>
<td>Lack of blood sugar (&lt;code&gt;Hypoglycemia&lt;/code&gt;) Twin lamb</td>
</tr>
<tr>
<td>Accidental overdosing e.g. giving sheep too much copper</td>
<td>Swayback (lack of copper)</td>
</tr>
<tr>
<td>From farm chemicals</td>
<td>Plants include bracken (&lt;i&gt;Pteridium aquilinum&lt;/i&gt;), Yew (&lt;i&gt;Taxus baccata&lt;/i&gt;) and Ragwort (&lt;i&gt;Senecio jacobea&lt;/i&gt;)</td>
</tr>
<tr>
<td>Poisons</td>
<td>Lead, anti-freeze, slug pellets, rat poison</td>
</tr>
</tbody>
</table>

**Principles of immunity.**

Livestock have two mechanisms which protect them from disease:
- White blood cells engulf foreign bodies such as bacteria; these are not specific to any particular disease causing organism.
- Antibodies in the blood are produced to fight specific diseases. If an animal is infected by a disease, then it will produce antibodies to fight that disease, however antibodies arise in the blood stream from other sources, therefore immunity may be categorised in several ways.

**Active immunity**

Active immunity occurs when the animal produces antibodies either in response to natural challenges from disease, or as a result of vaccination. Once an animal has produced a specific antibody, it can produce more antibodies of the same type rapidly in response to infection. This is why there are some diseases that tend only to be caught once in a lifetime.

**Passive immunity**

This occurs when an animal receives antibodies from another source rather than producing its own. The protection from passive immunity doesn't last long (a few weeks) because the antibodies are gradually used or broken down by the animal.

Pregnant animals produce antibodies which are moved from the bloodstream to the colostrum (first milk). It is very important that newborn animals are given colostrum as their first feed because they can absorb antibodies from the gut into the blood stream. The colostrum will only contain antibodies to the diseases that the dam has been exposed. It is possible for specific antibodies to be collected from blood and given to animals that are suffering from diseases. This treatment may be effective when the animal would not have sufficient time to produce its own antibodies.

**Vaccines**

Vaccines contain weakened strains of a disease causing organism (live vaccines), or attenuated (killed) disease causing organisms. Vaccines are given so that the animal can develop an active immunity to a disease without suffering from the disease. Animals are given vaccines in several ways (e.g. Clostridial diseases by injection, orf by scratching the skin, lung worm as an oral dose).

The vaccinated animal will produce antibodies in response to the vaccine. Many vaccine contain an adjuvant, this is a chemical (e.g. oil) that stimulates the animal to produce more reaction to the vaccine. Vaccines must always be handled with care as the organisms and adjuvants can cause serious reactions in people if vaccinated by accident.

For the vaccines to work they must be correctly stored and administered. Vaccines can be easily damaged or destroyed e.g. by heat or by killing live vaccines by using sterilizing chemicals on the vaccination equipment. The levels of antibodies will rise gradually after vaccination; many vaccines have a programme that need to be followed to ensure the best level of protection.
Example: Clostridial vaccines the primary course consists of an initial vaccination then a booster after six weeks, this is followed by an annual booster to maintain protection and stimulate antibody production for the colostrum so that that lamb gains passive immunity for the first few weeks of life.

Fig 16 Diagram of clostridial immunity

Vaccination will only work well if the treated animals are healthy and receiving sufficient food. Care must be taken not to give too many treatments at once as this may hamper the development of immunity e.g. if a lung worm vaccine has been given, dosing the animals with anthelmintics (wormers) will kill the live lung worm in the vaccine and the animal will not be stimulated to develop its own immunity.

**Signs of health and disease in livestock**

When looking after livestock it is important that animals are checked regularly, and any signs of ill health are recognised, and that action is taken quickly. The routines for checking livestock will vary, for example there is an opportunity to closely inspect the udder of dairy cows twice a day during milking, whereas sheep may be checked routinely in the field.

The following table suggests some signs which will indicate health/ ill health in livestock; the table is intended to give indicators, and is not exhaustive.
<table>
<thead>
<tr>
<th>Points to check</th>
<th>Signs of health</th>
<th>Signs of ill health</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Behaviour</strong></td>
<td>• Interested in surroundings and alert</td>
<td>• Dull, listless</td>
</tr>
<tr>
<td></td>
<td>• With the flock/ herd (cows/ ewes may go off on their own at calving/lambing)</td>
<td>• On its own, not with flock or herd</td>
</tr>
<tr>
<td><strong>Posture</strong> (how the animal stands/lies)</td>
<td>Weight evenly spread between all four legs</td>
<td>• Hunched up e.g. lambs with hypothermia</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Head low with neck outstretched with breathing difficulties</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Weight not evenly spread, or kneeling; foot or leg problems</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Unable to rise, or lying flat out</td>
</tr>
<tr>
<td><strong>Posture</strong></td>
<td>Weight evenly spread between all four legs</td>
<td></td>
</tr>
<tr>
<td><strong>Movement</strong></td>
<td>Co-ordinated, normal movements (speed and type) for the species and surroundings</td>
<td>Stiff, lame or uncoordinated.</td>
</tr>
<tr>
<td><strong>Legs and feet</strong></td>
<td>Animal moves soundly (weight on all four legs)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Swelling</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Hooves overgrown or misshapen</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Lameness</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Strong unpleasant smell</td>
</tr>
<tr>
<td><strong>Appetite</strong></td>
<td>Feeding and drinking behaviour, e.g. attracted to feed, calves drinking their milk</td>
<td>Not attracted to feed, young stock not drinking their milk</td>
</tr>
<tr>
<td><strong>Condition of fleece/ coat and skin</strong></td>
<td>• Glossy coat, with lick marks (cattle)</td>
<td>• Loss of fleece or hair</td>
</tr>
<tr>
<td></td>
<td>• Clean fleece</td>
<td>• Scratching</td>
</tr>
<tr>
<td></td>
<td>• Skin flexible, not damaged</td>
<td>• Soiling (dirt/ muck)</td>
</tr>
<tr>
<td></td>
<td>• Pink mucus membranes e.g. by eyes and gums</td>
<td>• Skin red, scaly, scabby or broken</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Lumps /abscesses</td>
</tr>
<tr>
<td><strong>Condition</strong></td>
<td>Compare with the rest of the group: often looking for condition score 2-3 but varies with the production cycle( difficult to assess accurately without handling the animals)</td>
<td>Thin; consider the condition of the whole group of animals, and individuals within the group.</td>
</tr>
<tr>
<td><strong>Condition of dung / urine</strong></td>
<td>Colour and consistency for the type of stock No difficulties in passing faeces or urine; passed regularly.</td>
<td>• Scouring</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Strong unpleasant smell</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Bloody</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Animal having difficulty in passing faeces/urine</td>
</tr>
<tr>
<td>Points to check</td>
<td>Signs of health</td>
<td>Signs of ill health</td>
</tr>
<tr>
<td>-----------------</td>
<td>-----------------</td>
<td>--------------------</td>
</tr>
<tr>
<td>Breathing</td>
<td>Quiet, unhurried</td>
<td>• Panting, breathing rapidly or very slowly</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Coughing</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Noisy breathing</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Runny nose</td>
</tr>
<tr>
<td>Eyes</td>
<td>Clear, bright</td>
<td>Cloudy, runny</td>
</tr>
<tr>
<td>Ears</td>
<td>Moving to follow sounds</td>
<td>Drooping, cold</td>
</tr>
<tr>
<td>Jaw/teeth</td>
<td>Incisors meet with upper pad. Correct number of teeth for the age of the animal</td>
<td>• Signs of food being dropped from the mouth</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Teeth missing, loose</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Swollen jaw</td>
</tr>
<tr>
<td>Navel (young animals)</td>
<td>The umbilical cord will be wet straight after birth but will rapidly dry</td>
<td>Swollen, hard, wet, bleeding</td>
</tr>
<tr>
<td>Udder</td>
<td>Soft, warm.</td>
<td>• Lumps, hot or cold, swollen,</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Producing abnormal discharge</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Painful</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Teats cracked, bleeding</td>
</tr>
</tbody>
</table>

The average temperatures for different types of livestock are:
- Cattle: 38.9 °C
- Sheep: 40.0 °C
- Pigs: 39.7 °C

(Figures from Black’s Veterinary Dictionary.)

Temperature can vary between individuals, so recording the changes of temperature for an individual animal may be more useful than comparing a reading to a standard table.

**Notifiable diseases**

Certain livestock diseases are classed as notifiable. The diseases have at least one of the characteristics:
- Potentially dangerous to people e.g. anthrax
- Likely to cause suffering to livestock and a large amount of economic loss e.g. foot and mouth
- Have the potential to be controlled, or reduced if reported

If anyone (who owns, or is in charge of livestock) suspects the livestock are suffering from a notifiable disease they should inform the authorities immediately. That is, contact the police or the DEFRA Divisional Veterinary Manager. DEFRA and not NAWAD (National Assembly for Wales Agricultural Department) retain responsibility for animal health in Wales.
A full, up to date, list of notifiable diseases is available from [www.defra.gov.uk](http://www.defra.gov.uk) website this list will also indicate when the disease was last seen in the UK (if ever).

<table>
<thead>
<tr>
<th>Diseases</th>
<th>Animals affected</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anthrax</td>
<td>Cattle, sheep, and other mammals</td>
</tr>
<tr>
<td>Bovine Spongiform</td>
<td>Cattle</td>
</tr>
<tr>
<td>Encephalopathy (BSE)</td>
<td>Sheep and goats</td>
</tr>
<tr>
<td>Blue Tongue</td>
<td>Sheep and goats</td>
</tr>
<tr>
<td>Brucellosis (two types)</td>
<td>Sheep and goats</td>
</tr>
<tr>
<td>Brucella abortus</td>
<td>Cattle</td>
</tr>
<tr>
<td>Brucella melitensis</td>
<td>Sheep and goats</td>
</tr>
<tr>
<td>Enzootic Bovine Leukosis</td>
<td>Cattle</td>
</tr>
<tr>
<td>Foot and Mouth Disease</td>
<td>Cattle, sheep, pigs and other clovenhoofed animals</td>
</tr>
<tr>
<td>Rabies</td>
<td>Dogs and other mammals</td>
</tr>
<tr>
<td>Scrapie</td>
<td>Sheep and goats</td>
</tr>
<tr>
<td>Tuberculosis (bovine TB)</td>
<td>Cattle and deer</td>
</tr>
<tr>
<td>Warble fly</td>
<td>Cattle, deer and horses</td>
</tr>
</tbody>
</table>

**Table 1. Examples of notifiable diseases of farm animals.** *(Note the full list includes a significant number of other diseases that affect pigs, goats and horses.)*

Once the disease has been reported actions are taken to prevent the disease from spreading, for example the animals may be isolated and livestock movements in the area may be stopped. The exact restrictions will depend on which disease is found; compulsory slaughter may be required to stop the spread of disease e.g. for Foot and Mouth and Bovine Tuberculosis.

**Anthrax**

Caused by anthrax bacteria which can live in the soil for extremely long periods of time (there are reports of the bacteria surviving for centuries) The spores can survive for extended period in building infrastructure. Animals will be come ill and die very quickly, and often the animals are found dead. Sick animals have a very high temperature, and there is bleeding from external openings e.g. the mouth and nose. The blood will be full of anthrax bacteria and is extremely contagious. If anthrax is suspected the animals or carcases should be isolated, and the State Veterinary Officer informed. They will decide how to deal with the stock and dispose of the carcases.

**Bovine Spongiform Encephalopathy (BSE)**

This may be suspected when older cattle change their behaviour or temperament or show signs of poor coordination. When a case of BSE is reported a vet will check the animal and if they suspect the disease the animal will be sent for compulsory slaughter. The brain will be checked by State Veterinarians to confirm a diagnosis. The presence of BSE changes the
consistency of brain tissue to give it a spongy appearance when examined by microscope.

**Foot and Mouth disease**
This is a highly infectious disease caused by a virus. Animals will rapidly show signs of ill health, going off their feed, having a high temperature and appearing listless. They will also develop blisters in their mouths and between the cleats. These will be very painful for the animal. Only approximately 5% of infected animals die naturally from the disease, but there are large economic losses due to lower productivity. It is for economic and animal welfare reasons that there is a compulsory slaughter policy with foot and mouth disease. When foot and mouth disease is suspected then isolation, disinfection and movement restrictions will be rapidly put in place, and if the disease is confirmed all of the stock on the farm will be slaughtered. On the continent vaccination is used to reduce transmission. The last major outbreaks of the disease in the UK were in 1967 and 2001.

**Bovine Tuberculosis**
This is caused by the bacteria *Mycobacterium bovis* the natural host of the disease is cattle, however it can infect humans and a wide range of animals (e.g. deer, pigs, dogs, cats, and badgers). The disease leads to the gradual development of tubercles (growths) in the organs. The rate of development of the disease and the signs will vary according to which organ is affected. Signs include weakness, loss of appetite, swelling of lymph nodes, coughing, and in the case of udder infections hardening and swelling in the affected quarter. If the disease infects the udder this can be detected in milk samples. To control bovine TB there are routine tests so clinical cases are rarely seen in cattle. There are two main elements in the bovine TB control programme:
- Routine free skin testing of cattle carried out every one to four years. There is a compulsory slaughter policy for reactors and direct contacts.
- Routine inspection of carcases by the Meat Hygiene Service (looking for signs of TB lesions)
The level of TB varies widely in the UK; currently there are on going trials relating to control measures including the culling and control of badgers. A government compensation scheme is in operation.

**Safe use and storage of veterinary medicine**
Medicines must be used and stored correctly:
- to comply with legislation (COSHH and welfare legislation),
- to protect the operator and the consumer, and
- to ensure that the treatment is effective

**Medicines code of practice**
There is a code of practice that should be followed – “The code of practice on the responsible use of animal medicines on the farm”. Full copies are
available from the Veterinary Medicines Directorate (www.vmd.gov.uk). The main points are summarised below.

Planning and purchasing

- Plan ahead; there should be a clear animal health plan for the farm, this should cover the prevention and treatment of diseases. Risk assessments should be made to ensure that the work is done safely. Work with the vet; this will help to ensure that the correct medicines and treatments are provided.
- Buy the correct amount of medicine. Medicines must be used before their expiry date. It may be illegal to sell or pass on medicines to other people. Only buy, and use, authorised medicines.
- Keep proper records (see below for more details)

Administration of medicines

- One person should be responsible for recording and giving medicines, and ensuring that withdrawal periods are observed
- Only experienced and trained people should handle and administer medicines
- Don’t give medicines unnecessarily as this can lead to resistance
- Always read and follow the instructions carefully
- Check the expiry date to ensure that the medicine will be active
- Unless directed otherwise by your vet, only use medicines in the way that they have been authorised (species, dosage). Prescription medicines should only be used on the animals that they were prescribed.
- Always complete the programme of treatment
- If in doubt, consult a vet

Safety

- Always follow all of the operator precautions on the label e.g. use of protective clothing. Risk assessments must be followed.
- Keep a list of emergency phone numbers at hand (local doctor, hospital, vet and pharmacist)
- Strictly observe all withdrawal periods (between the end of treatment and the slaughter of the animal, or the taking of eggs or milk for human consumption). This is to prevent any of the medicines entering the human food chain.

Storage

Medicines must be stored according to the instructions on the label. They should not be left in direct sunlight, nor should they be allowed to get too warm or freeze. If they are stored in a fridge the temperature should be between 2 C and 8 C. If medicated feeds are used, feed bins should be clearly labelled with the description of the feed and the expiry date. Medicines should be kept in their original containers, and kept out of the reach of children and animals. If possible medicines should be kept under lock and key. Store medicines separately from non-medicines.
Disposal of unwanted medicines and needles
Used needles must be disposed of safely, for example by using a sharps container. Always follow the manufacturer's advice regarding disposal; never put unused medicines down the drain or toilet, or throw them away with the domestic rubbish. Chemicals such as sheep dip are potentially very hazardous to the environment; their disposal should be planned before purchase.

Reporting of harmful, unexpected side effects
If treated animals show any unintended reactions to the medicines, it must be reported to your vet or to the Suspected Adverse Reactions Surveillance Scheme at the Veterinary Medicines Directorate. Any adverse reactions experienced by people exposed to the medicines should also be reported.

Medicines records

Records of medicines used on farms must be kept for at least three years. If prescription medicines have been used, the records must be kept for five years. Records must show;

- The name of the animal medicine used
- The name and address of the supplier
- The date of purchase
- The date of administration
- The total quantity of medicine used
- The identity of the animal or group treated
- The number of animals treated
To ensure that you have complete records, and to prevent residues entering the food chain, records should also include;

- The dates on which any withdrawal period for slaughter, milk or other animal products
- The date that treatment finished
- The name of the person who administered the medicine
- The batch number of the product used.

The records do not have to be kept in a set format; however standard animal medicines record books are available from the National Office of Animal Health (NOAH). Records will be required for farm assurance schemes, and for some production systems (e.g. organic systems, the withdrawal periods may be far longer than for conventional farming systems).

Types of medicines

Medicines used for livestock are classified in several groups; the classification governs where the medicine can be purchased. There is a gradual transfer from the old classification system to the new system; the new system will be fully in place in 2008.

<table>
<thead>
<tr>
<th>Old classification</th>
<th>New classification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prescription- only Medicines (POM)</td>
<td>Prescription only medicines-</td>
</tr>
</tbody>
</table>
—these can only be supplied by vets for animals under their care, or dispensed from a pharmacy with a written prescription from a vet.

**Animal Medicines (P)** – can only be supplied by vets for animals under their care, or over the counter from a pharmacy. If the medicine is on the [Pharmacy and Merchants List (PMS)](https://www.gov.uk/government/publications/pharmacy-and-mERCHANTS-list-pms) it can be sold to livestock farmers by registered agricultural merchants.

**Prescription only medicines—veterinarian, pharmacist, suitably qualified person (POM-VPS)**

Must be prescribed by a vet, pharmacist or qualified person and can be dispensed by any of those persons (e.g. wormers, vaccines)

**Non-food animal medicines - veterinarian, pharmacist, suitably qualified person**

Must be prescribed by a vet, pharmacist or qualified person (e.g. pet wormers)

**General Sales List (GSL) medicines**

Can be sold in ordinary shops.

**Authorised veterinary medicines (AVM-GSL)**

Can be supplied by anyone (e.g. flea treatments)

**Medicated feeding stuffs (MFS)** are medicines which are added to the feed following a prescription from a veterinary surgeon.

**Common terms on medicines instructions**

When reading the manufacturer’s instructions it is very important that the terms are understood. Some of terms and their meanings are given below.

**Contra indications.** There may be a section on the instructions with the heading “Contra indications”. In this section there will be information relating to the medicine and times when it may not be appropriate to use it. Some labels will have a heading of ‘Contra indications and warnings’

**Subcutaneous** - ‘under the skin’. Administration by injection of a product e.g. vaccine, under the skin. This is a common method of administering medicines and vaccines to livestock. It releases the product at a slower rate into the blood stream.

**Intravenous.** - ‘into the vein’. Few products administered by farmers or stockmen are given this way, it is mainly done by a vet. It releases the product very rapidly into the blood stream.

**Intramuscular** – ‘into the muscle’. Administration by injection of a product e.g. antibiotic, into the muscle. Care needs to be taken that such injection sites do not damage carcasses of animals destined for meat production.
**Intramammary** – ‘into the udder’. Dry cow tubes or antibiotics to treat mastitis are administered by this route through the teat canal into the cistern.

**Oral.** This term is used for medicines that are given to the animal through the mouth.

**Bolus.** A bolus is an object that will stay in a ruminant’s stomach. Boluses are used for medicines and minerals which will be released slowly over a several weeks e.g. magnesium boluses may be given to sheep in the spring so that the sheep get a constant supply of magnesium when the levels of magnesium in the pasture are low.

**References and further reading**


Teagasc (1994). Introduction to Farm Animals. Teagasc


HSE. Veterinary Medicines, safe use by farmers and other animal handlers. (see the HSE website [www.hse.gov.uk](http://www.hse.gov.uk))

Veterinary Medicines Directorate. (2000). Code of Practice on the responsible use of animal medicines on the farm. (see also the website [www.vmd.gov.uk](http://www.vmd.gov.uk))
Chapter 3 - Feeds and feeding

Feeding livestock correctly ensures they are healthy and productive and contribute to farm profitability.

**Feed classification**

Feeds can be grouped together according to the moisture content.

![Feed classification diagram]

**Succulents**

Succulents contain a high percentage of water e.g. fresh grass has a dry matter content of 20% with 80% being water. Livestock like to eat them and find them palatable. Succulents include conserved feeds such as silage as well as fresh plant material. These feeds are suitable for ruminants; some may be fed on a ration made up entirely from succulents e.g. suckler cows on a winter ration of silage or weaned lambs on grass. Succulents can be split into two categories;

- **Green leaf crops** such as grass, clover, rape and kale. The fibre content and feed value will depend on their type of plant and the stage of growth. Younger plants tend to contain less fibre and have a higher feed value.
- **Root crops** such as turnips and swedes. These tend to be high in carbohydrate but low in protein. Some root crops have very low dry matter content e.g. swedes have a typical dry matter of 11%.

**Dry feeds**

Dry feeds have dry matter content of 86% to 90%. It is important that these feeds are stored in a dry area as the dryness prevents the growth of fungi and
moulds that would cause the feeds to deteriorate (wet hay tends to go mouldy).

They are split into two main groups;
- **Roughages** e.g. hay and straw
  These feeds are bulky and contain relatively high levels of fibre.
- **Concentrates** e.g. such as dairy nuts, sheep nuts, barley, wheat and soya.
  These feeds usually contain high densities of energy and protein and are not as bulky as roughages.
  Concentrates which are bought and then mixed into a ration on the farm (e.g. wheat or maize gluten) are often referred to as ‘straights’; those which have been mixed by the manufacturer (e.g. coarse mix or pellets) are referred to as compounds.

The feeds selected for a ration on a particular farm will depend on factors that include;
- Which feeds available on the farm e.g. grass, straw, hay, silage
- The relative price of feeds
- The feeding system, scale of the enterprise and machinery available
- The level of productivity of the animal
- Restrictions relating to farm assurance or organic standards

**Components of feed**

Feeds are made up of six main components:

![Diagram](46)

Fig 18. Diagram to show the components of feeds. (The proportion of water and dry matter will vary between feeds.)
**Water (H₂O)**

The water content of common feeds can range from 10% - 90%.

<table>
<thead>
<tr>
<th>Feed</th>
<th>Dry matter %</th>
<th>Water %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Turnips</td>
<td>10.5</td>
<td>89.5</td>
</tr>
<tr>
<td>Barley</td>
<td>86.0</td>
<td>14.0</td>
</tr>
<tr>
<td>Brewers grains</td>
<td>23.0</td>
<td>77.0</td>
</tr>
<tr>
<td>Soya Bean Meal (Hipro)</td>
<td>90.0</td>
<td>10.0</td>
</tr>
<tr>
<td>Fresh grass</td>
<td>20.0</td>
<td>80.0</td>
</tr>
<tr>
<td>Silage - clamp</td>
<td>25.0</td>
<td>75.0</td>
</tr>
<tr>
<td>Silage – big bale</td>
<td>35.0</td>
<td>65.0</td>
</tr>
<tr>
<td>Hay</td>
<td>85.0</td>
<td>15.0</td>
</tr>
</tbody>
</table>

Table 1. *The % of dry mater and water in a selection of livestock feeds.*

Water is needed by the body for all chemical reactions to take place so it is essential that livestock have a good supply of water. The requirement for drinking water will increase if:
- Animals are fed on rations with high levels of dry matter
- The conditions are hot
- Livestock are lactating (producing milk)

**Carbohydrates (CHO)**

These are made of carbon, oxygen and hydrogen. Carbohydrates are a source of energy for animals; they are the main source of energy in most ruminant rations.

The smallest units of carbohydrates are single sugars (monosaccharides) such as glucose. For carbohydrates to be absorbed in the gut they need to be broken down from complex sugars to simple sugars.

<table>
<thead>
<tr>
<th>Type of carbohydrate</th>
<th>Characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Simple sugars</td>
<td>Taste sweet&lt;br&gt;Dissolve in water&lt;br&gt;Rapid uptake because they are very small molecules</td>
</tr>
<tr>
<td>e.g. glucose and dextrose</td>
<td></td>
</tr>
<tr>
<td>Starch</td>
<td>Made of long chains of sugar units&lt;br&gt;Not sweet to taste&lt;br&gt;Does not dissolve in water&lt;br&gt;Found in feeds such as wheat and barley (in the endosperm)&lt;br&gt;Ferments in rumen, needs to be broken down before it can be absorbed by the animal</td>
</tr>
<tr>
<td>Fibre</td>
<td>Made of long chains of sugar which are bonded together so they are difficult to break down&lt;br&gt;Does not dissolve in water&lt;br&gt;Broken down by the ruminant digestive system, but not by single stomached animals</td>
</tr>
</tbody>
</table>
Protein

Proteins contain carbon, oxygen, hydrogen and nitrogen. Proteins are made of units called amino acids. There are twenty five amino acids that make up proteins and all contain nitrogen. There are two main types of amino acids:

- Essential amino acids have to be included in an animal’s diet. Single stomached animals such as pigs need amino acids such as lysine, methionine and tryptophan in their diets.
- Non essential amino acids can be produced by the animal from other amino acids in the feed; they do not have to be provided in the diet. Ruminants need protein but their rations do not need to contain set levels of particular amino acids.

Protein is needed for muscle growth, tissue repair, milk production, metabolic activity, enzyme production, reproduction and the production of blood. Feeds such as soya are high in plant proteins and are added to diets to increase the protein level.

Ruminants are able to use nitrogen in their diets even if it is not fed to them in the form of protein, this is known as non-protein nitrogen (NPN). Urea is an example of non-protein nitrogen that may be found in ruminant feeds.

Fats and oils (lipids)

Lipid is the term that describes both fats and oils. These are made of carbon, oxygen and hydrogen. Fats and oils are not water soluble. Lipids are a source of energy for animals; weight for weight they contain about twice as much energy as carbohydrates, however, only a limited amount can be included in livestock rations without causing digestive upsets.

- Fats are solid at room temperature
- Oils are liquid at room temperature

Many lipids are made up of two types of chemical; fatty acids and glycerol.

![Diagram of lipids](image)

Fig.19. Diagram to show the structure of lipids.

For fats to be absorbed by the animal the links between the fatty acids and the glycerol must be broken by enzymes.
Some rations for highly productive stock such as dairy cows may include ‘protected’ fats as a source of energy which can be digested in the small intestine.

**Vitamins**

These are complex molecules that the animal requires to remain healthy. These molecules are based on carbon, hydrogen and oxygen but also contain a range of other elements. Vitamins are only needed in very small amounts in the diet. Vitamins can break down over time, so feed labels will indicate the levels of vitamins in the feed and the date by which the feed should be used.

<table>
<thead>
<tr>
<th>Vitamin</th>
<th>Needed for:</th>
<th>Deficiency symptoms</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vitamin A</td>
<td>• Production of protein</td>
<td>Reduced production and fertility, poor coat and hooves</td>
</tr>
<tr>
<td></td>
<td>• Development of bones and skin.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Night vision</td>
<td></td>
</tr>
<tr>
<td>Vitamin B group</td>
<td>• Many body processes including energy release</td>
<td>Poor growth, anaemia and other problems</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Microbes in the rumen can make vitamin B as long as there is enough cobalt in the diet</td>
</tr>
<tr>
<td>Vitamin C</td>
<td>• Growth and protection from disease</td>
<td>Not often deficient in ruminant as it is found in many plants</td>
</tr>
<tr>
<td>Vitamin D</td>
<td>• Bones development</td>
<td>Milk fever</td>
</tr>
<tr>
<td></td>
<td>• Balancing calcium and phosphorus in the body</td>
<td>Bone weakness</td>
</tr>
<tr>
<td>Vitamin E</td>
<td>• Use of fats</td>
<td>Reduced fertility, more still births and retained placentas. Closely linked to selenium</td>
</tr>
<tr>
<td></td>
<td>• Strong body membranes</td>
<td>Poor muscle structure and function</td>
</tr>
<tr>
<td></td>
<td>• Muscles</td>
<td></td>
</tr>
</tbody>
</table>

**Minerals**

These are mineral elements in addition to carbon, hydrogen, oxygen and nitrogen that are vital to life. Minerals can be divided into two groups according to the amounts needed by animals to stay healthy.
**Major elements:**
Major elements are required in relatively large amounts e.g. calcium and phosphorus.

<table>
<thead>
<tr>
<th>Mineral</th>
<th>Symbol</th>
<th>Required for</th>
<th>Deficiency symptoms</th>
</tr>
</thead>
<tbody>
<tr>
<td>Calcium</td>
<td>Ca</td>
<td>Bones, teeth, milk production, muscle function</td>
<td>Milk fever/hypocalcaemia. Reduced available calcium in the blood, lack of appetite and muscle function.</td>
</tr>
<tr>
<td>Phosphorus</td>
<td>P</td>
<td>Bones, fertility, milk production</td>
<td>Reduced fertility and production</td>
</tr>
<tr>
<td>Magnesium</td>
<td>Mg</td>
<td>Proper working of nervous system</td>
<td>Grass staggers/grass tetany; excitability, coma and death.</td>
</tr>
<tr>
<td>Potassium</td>
<td>K</td>
<td>Water balance, Use of energy</td>
<td>Reduced fertility and production</td>
</tr>
<tr>
<td>Iron</td>
<td>Fe</td>
<td>Red blood cells to carry oxygen</td>
<td>Anaemia</td>
</tr>
</tbody>
</table>

**Minor (or trace) elements**
Minor elements are required in smaller amounts e.g. copper, cobalt and selenium.
For certain minerals such as copper (in sheep) there is only a small difference between the amount required to prevent deficiency and the toxic dose.

<table>
<thead>
<tr>
<th>Mineral</th>
<th>Symbol</th>
<th>Required for</th>
<th>Deficiency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sodium</td>
<td>Na</td>
<td>Water balance</td>
<td>Reduced appetite, dehydration</td>
</tr>
<tr>
<td>Chlorine</td>
<td>Cl</td>
<td>Water balance</td>
<td>Reduced appetite, dehydration</td>
</tr>
<tr>
<td>Sulphur</td>
<td>S</td>
<td>Needed for proteins</td>
<td>Poor production (protein deficiency)</td>
</tr>
<tr>
<td>Copper</td>
<td>Cu</td>
<td>Blood cells, nerves, fertility</td>
<td>Sway back in lambs –poor coordination of the hind legs</td>
</tr>
<tr>
<td>Cobalt</td>
<td>Co</td>
<td>Formation of vitamin B\textsubscript{12}</td>
<td>Pine - poor performance</td>
</tr>
<tr>
<td>Selenium</td>
<td>Se</td>
<td>Healthy membranes</td>
<td>Reduced fertility, white muscle disease</td>
</tr>
<tr>
<td>Zinc</td>
<td>Zn</td>
<td>Healthy skin fertility</td>
<td>Poor growth and skin</td>
</tr>
<tr>
<td>Iodine</td>
<td>I</td>
<td>To produce the hormone thyroxine</td>
<td>Infertility and poor performance. Goitre</td>
</tr>
</tbody>
</table>
Measures of feed components and quality

Dry matter (DM)

As feeds vary so much in water content they are compared on a dry matter basis.

- At a dry matter content of 25%, 10kg of fresh silage would contain 7.5kg of water
- At a dry matter content of 86%, 10kg of wheat would only contain 1.4 kg of water

![Diagram comparing water and dry matter in wheat and silage](image)

10 kg of wheat

10 kg of silage

Fig 20. A diagram to compare the relative amounts of water and dry matter in 10kg fresh weight of wheat and grass silage.

It is important not to confuse fresh and dry matter analyses. Rations calculated on a dry matter basis must be converted to fresh weight to know how much actual feed to give to livestock. If feed quantities are converted from dry matter to fresh weight the answer must be larger than the amount started with.

**Example:** if a ration has 1 Kg of dry matter of a 25% dry matter silage the fresh weight needed could be worked out like this:

\[
\text{Quantity of silage dry matter (Kg) } \times 100 = \text{Fresh weight of feed}
\]

\[
\text{Dry matter % of the silage}
\]

\[
\frac{1 \text{ Kg of silage}}{25} \times 100 = 4 \text{kg of fresh silage}
\]

To calculate the amount of dry matter in a given amount of fresh feed, the formula below can be used:

Fresh weight of feed (Kg) \times Dry matter % = Dry matter of the feed in Kg

**Example:** How much dry matter is there in 8 kg of 25% dry matter silage?
8 kg of silage \times \frac{25}{100} \text{ dry matter} = 2 \text{ kg of dry matter in the silage}
Voluntary feed intake

It is possible to estimate the amount of dry matter that livestock can consume; this figure is used as the basis for ration calculations. Voluntary food intake (or appetite) for dry matter will be approximately 2-3 % of the animals liveweight. It is influenced by:

- How quickly the food is digested and moved through the gut
- The level of productivity of the animal
- The palatability of the food
- The stage of pregnancy

If the ration has a low dry matter content (wet), this may limit the amount of dry matter that can be eaten. Single stomached animals are unable to digest fibre. Ruminants can digest fibre through the action of rumen microbes, however it is a relatively slow process compared to the digestion of other carbohydrates such as starch. Fibre is needed in ruminant rations to stimulate them to chew the cud.

D value and digestibility

D- value is the percentage of the digestible organic matter in the dry matter of a feed.

\[
\text{Weight of digestible organic matter in the feed (kg)} \times 100 = \text{D-value}
\]

Weight of dry matter (kg)

The higher the D- value the more digestible the feed. For example young grass will contain less fibre than grass that has gone to seed, so it will be more digestible and have a higher D-value.

Energy

Often feeds are compared according to the amount of energy they contain in the dry matter. The units used to measure energy are megajoule (MJ)

There are different measures of energy; for example gross energy is all of the energy in the feed, (this can be measured by burning the feed), however, not all of the energy is available to the animal.

Metabolisable energy (ME) gives an indication of the amount of useful energy content in the feed. ME is generally used to compare the energy value of livestock feeds.
Fig 21 Energy utilization and metabolism

**Maintenance and production**

**Feed for maintenance** (a maintenance ration) is the food needed by an animal to stay alive without any change in condition. This will vary according to the size of the animal. The food is used for essential body functions such as breathing.

**Food for production** is the extra feed that is needed by animals to do things other than stay alive and maintain their condition. There are several categories of production:

- **Growth** – for young animals to increase in size and produce bone, muscle, fat, and other tissues.
- **Reproduction** – for the growth of the lambs/calves inside the ewes/cows and the production of sperm.
- **Lactation** – to produce milk and udder tissue.
- **Wool** – to produce the fleece.
- **Work** – some animals will need additional feed because of a high level of activity e.g. sheepdogs.

Energy requirements can be calculated and rationing tables are available to indicate the amount of energy needed for maintenance and production in different sizes and types of livestock.
If animals receive less energy than they require they will lose condition; if animals have a ration that provides more energy than they use they can store the energy as fat.

**Feeding protein to livestock**

When feeding pigs it is important to have the correct amount of essential amino acids in the feeds. Feed labels will indicate the levels of certain important amino acids such as lysine and tryptophan. If the diet is short of particular (limiting) amino acids the pigs will not grow well even if the diet contains enough protein in total.

Microbes in the ruminant digestive system can break down protein: they can also form protein if there is enough nitrogen and energy available in the rumen. There are several measures related to protein:

- **Crude protein** – an estimate the amount of protein in the feed if all of the nitrogen was in protein molecules
- **Non protein nitrogen** – the amount of nitrogen in chemicals other than protein (ruminants may be able to use this instead of protein, so chemicals such as urea may be used as a source of nitrogen in feed blocks)
- **Rumen degradable protein (RDP)** – can be broken down and used by the rumen microbes. If high levels are fed, it may be wasted.
- **Protected proteins** – these are not broken down in the rumen but can be digested further along the digestive system. They may be included in rations for high yielding animals.

The amount of protein in the dry matter may be shown in two ways:

- Grams of protein per kilogram of dry matter g/kg
- As a percentage

**Rationing**

Rations for livestock have to be designed to provide the animals with all of the energy and nutrients to be healthy and productive at an affordable price. The energy and protein requirements of livestock will vary with the stage in the production cycle for example:

There will be times when stock can be fed on grass, or conserved grass, such as silage with no requirement for concentrate feed e.g. dry ewes and suckler cows. Ewes in late pregnancy carrying twins or triplets and high yielding dairy cows will need rations which contain concentrate feeds to ensure that they can consume enough protein and energy. Rations will contain higher or lower energy densities or protein contents to reflect the balance between animal requirement and feed availability.

**Selection of feeds**

The feeds selected for a ration on a particular farm will depend on the following factors;
1. Which feeds are available on the farm.
This will vary with the time of year. Many farms in Wales will base their rations on fresh grass during the summer, and conserved grass as silage or hay during the winter. Crops may be grown specifically for livestock feed e.g. swedes, turnips, maize for silage. In some areas by-products from crops may be available e.g. straw.

2. The relative price of feeds
Prices of feeds will change for many reasons including the balance between supply and demand. Generally organic feeds are dearer to buy than a similar product that is from a conventional farm. The cost of delivery and the feed value will be factors that are considered when evaluating the price. For example, a wet feed may appear cheap when the fresh weight per tonne is considered, but the price per unit of protein or energy may not be as good. Market reports will allow farmers to compare the cost of energy (pence/MJ) and the cost of protein (pence/gram of digestible crude protein).

3. The feeding system, scale of the enterprise and machinery available
Feeds purchased in bags or in small amounts tend to be more expensive than a similar product purchased in bulk. Not all farms will require large amounts of feed, and they may not have the storage facilities or the machinery to handle the feeds easily. Many large farms have considerable amounts of money invested in feeding machinery and storage facilities; this may enable them to save time when feeding the stock, save money when purchasing the feeds, and provide a consistent ration.

4. The level of productivity of the animal
If animals are more productive they need more nutrients, and more money may be spent on feeds.
   • As ewes approach lambing time their requirement for energy and protein increases, but their appetite goes down, therefore concentrates are often fed at this time. If the ewes have been scanned they may be split into groups and fed according to the expected time of lambing and the number of lambs.
   • Dairy cows may be fed according to their level of production, and the stage of the lactation.
   • Lambs and growing cattle may be fed according to how fast the farmer wants them to grow e.g. early lambs may be given creep to get them to grow fast so that the can be sold when the prices are high in the spring.

5. Rules relating to farm assurance or organic standards
There may be particular rules governing the type of feeds that can be used e.g. there are limits to the amount of conventional feed that can be fed on an organic farm.
Formulating a ration

To calculate a ration you need to know:
- The size of the animal
- The level of production

From this information you can determine:
- The appetite (how much dry matter it will eat)
- Energy (ME) requirement and the protein requirement

Silage analysis or feed analysis tables can be used to determine the amount of ME, protein and minerals available in the feeds and to calculate a ration.

Rations are now calculated using computer programs as these allow factors such as feed price to be included in the calculations and allow a large number of feeds to be considered for a mix; however it is possible to calculate simple rations fairly quickly. The cheapest ration is described as the least cost ration.

Ration calculation

Simple rations using a balance of a roughage and a concentrate feed can be calculated using Pearson’s square. For the calculated ration to work the animal must be able to eat to appetite.

Task
Calculate a ration to feed a 70Kg ewe, carrying twins at lambing. The ewe is housed, and the main bulk feed available on the farm is silage.

1. Look up the sheep’s daily requirements for protein and Metabolisable Energy (ME).
   - Energy required (ME) 16.5 MJ
   - Digestible crude protein (DCP) 132g

2. Look up the amount of dry matter the ewe can eat in a day (appetite).
   - Appetite 1.33 Kg per day of dry matter

3. Calculate the average amount of energy needed in each kilogram of dry matter.
   - Energy needed by the ewe = \( \frac{\text{Amount of energy needed per kg of DM}}{\text{Appetite}} \)
   - Energy 16.5MJ = 12.4 MJ/Kg of dry matter
   - 1.33 Kg

4. Select suitable feeds for the ration. For the calculation to work there must be one with an energy value above the average that has been calculated in step three, and one with an energy value below the average.
   - Two possible feeds are shown below; the information was taken from a table of feed values.

   **Silage**
   - ME (energy) 12.0 MJ/kg DM
   - DCP (protein) 125 g/kg DM
   - Dry matter 25%

   **Compound**
   - ME (energy) 12.9 MJ/kg DM
DCP (protein) 140 g/kg DM
Dry matter 86%

5. Balance the amount of each feed to be used, using Pearson’s square.

Difference between silage and the average = 0.4 MJ
Difference between compound and the average = 0.5 MJ

Total = 0.4 + 0.5
= 0.9

These figures can be used to calculate the ratio of the two feeds in the ration.

**Silage**

\[
\text{Figure opposite} \times \text{Appetite} = 0.5 \times 1.33 \text{kg} = 0.73 \text{kg silage DM} \\
\text{Total} = 0.9
\]

**Compound**

\[
\text{Figure opposite} \times \text{Appetite} = 0.4 \times 1.33 \text{kg} = 0.6 \text{kg compound DM} \\
\text{Total} = 0.9
\]

This would give a total of 0.73 kg + 0.6 kg = 1.33 kg of dry matter in the ration (this matches the sheep’s appetite).

6. The figures should be checked to ensure the energy and protein levels are correct.

**Energy level**

\[
\text{Silage} \quad \text{dry matter} \times \text{energy per Kg} = \text{amount of energy from the silage} \\
0.73 \text{kg} \times 12.0 \text{MJ/Kg} = 8.8 \text{MJ} \\
\text{Compound} \quad \text{dry matter} \times \text{energy per Kg} = \text{amount of energy from the compound} \\
0.6 \text{kg} \times 12.9 \text{MJ/Kg} = 7.7 \text{MJ}
\]

Therefore the total ME of the ration is 8.8 MJ + 7.7 MJ = 16.5 MJ

**Protein level**

\[
\text{Silage} \quad \text{dry matter} \times \text{protein per Kg} = \text{amount of protein from the silage}
\]
0.73kg \times 125\text{g/Kg} = 91\text{g} \\
\text{Compound}
\text{dry matter} \times \text{protein per Kg} = \text{amount of protein in the compound} \\
0.6kg \times 140\text{g/Kg} = 84 \text{g}

Therefore the total digestible crude protein content of the ration is 175\text{g}; this is above the requirement of 132 \text{g per day.}

In circumstances when, using the Pearson’s Square method, the calculated energy content of the ration is equal to the requirement but calculated ration protein is above animal requirement, the ration may be recalculated with a concentrate containing less protein.

7. Convert the amounts of feed to fresh weight.

\text{Quantity of feed} \times 100 = \text{Fresh weight (Kg)} \\
\text{Dry matter percentage} \\
\text{Silage} \\
\frac{0.73\text{Kg}}{25} \times 100 = 2.9\text{kg of fresh silage} \\
\text{Compound} \\
\frac{0.6\text{Kg}}{86} \times 100 = 0.7\text{Kg of compound feed}

A spread sheet can be set up to carry out the calculations explained above.

More complex calculations can be carried out to balance more than two feeds, and to take account of the effect of changing feed quality on the animals’ appetite and production (e.g. dairy rations). Most of these calculations are performed using specialist computer programmes.

\text{Extracts from rationing tables;}

\text{1. Ewe requirements before lambing}

\text{Ewe weight} \hspace{1cm} \text{Dietary component} \hspace{1cm} \text{Weeks before lambing} \\
\text{6} \hspace{1cm} \text{4} \hspace{1cm} \text{2} \hspace{1cm} \text{0} \hspace{1cm} \text{6} \hspace{1cm} \text{4} \hspace{1cm} \text{2} \hspace{1cm} \text{0} \\
50\text{Kg} \\
\text{DM\%} \hspace{1cm} 1.30 \hspace{1cm} 1.25 \hspace{1cm} 1.15 \hspace{1cm} 1.05 \hspace{1cm} 1.30 \hspace{1cm} 1.23 \hspace{1cm} 1.10 \hspace{1cm} 0.95 \\
\text{ME (MJ)} \hspace{1cm} 7.8 \hspace{1cm} 8.6 \hspace{1cm} 9.5 \hspace{1cm} 10.5 \hspace{1cm} 8.3 \hspace{1cm} 9.6 \hspace{1cm} 11.1 \hspace{1cm} 12.8 \\
\text{DCP (g)} \hspace{1cm} 62 \hspace{1cm} 66 \hspace{1cm} 74 \hspace{1cm} 92 \hspace{1cm} 69 \hspace{1cm} 77 \hspace{1cm} 88 \hspace{1cm} 105 \\
60\text{ Kg} \\
\text{DM\%} \hspace{1cm} 1.56 \hspace{1cm} 1.50 \hspace{1cm} 1.38 \hspace{1cm} 1.26 \hspace{1cm} 1.56 \hspace{1cm} 1.47 \hspace{1cm} 1.32 \hspace{1cm} 1.14 \\
\text{ME (MJ)} \hspace{1cm} 8.8 \hspace{1cm} 9.8 \hspace{1cm} 10.8 \hspace{1cm} 11.9 \hspace{1cm} 9.4 \hspace{1cm} 10.9 \hspace{1cm} 12.7 \hspace{1cm} 14.7 \\
\text{DCP (g)} \hspace{1cm} 70 \hspace{1cm} 74 \hspace{1cm} 84 \hspace{1cm} 104 \hspace{1cm} 78 \hspace{1cm} 87 \hspace{1cm} 90 \hspace{1cm} 119 \\
70\text{Kg} \\
\text{DM\%} \hspace{1cm} 1.82 \hspace{1cm} 1.75 \hspace{1cm} 1.61 \hspace{1cm} 1.47 \hspace{1cm} 1.82 \hspace{1cm} 1.71 \hspace{1cm} 1.54 \hspace{1cm} 1.33 \\
\text{ME (MJ)} \hspace{1cm} 9.9 \hspace{1cm} 10.9 \hspace{1cm} 12.1 \hspace{1cm} 13.4 \hspace{1cm} 10.6 \hspace{1cm} 12.3 \hspace{1cm} 14.2 \hspace{1cm} 16.5 \\
\text{DCP (g)} \hspace{1cm} 76 \hspace{1cm} 82 \hspace{1cm} 92 \hspace{1cm} 115 \hspace{1cm} 86 \hspace{1cm} 96 \hspace{1cm} 110 \hspace{1cm} 132
2. Examples from feed analysis tables

<table>
<thead>
<tr>
<th>Feed name</th>
<th>Dry matter (%)</th>
<th>Metabolizable energy (MJ/Kg DM)</th>
<th>Digestible crude protein (g/Kg DM)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grass - good</td>
<td>20</td>
<td>13.1</td>
<td>125</td>
</tr>
<tr>
<td>Grass - poor</td>
<td>23</td>
<td>9.8</td>
<td>60</td>
</tr>
<tr>
<td>Barley</td>
<td>86</td>
<td>12.8</td>
<td>90</td>
</tr>
<tr>
<td>Wheat</td>
<td>86</td>
<td>13.6</td>
<td>118</td>
</tr>
<tr>
<td>Oats</td>
<td>86</td>
<td>12.0</td>
<td>8.5</td>
</tr>
<tr>
<td>Swedes</td>
<td>11</td>
<td>14.0</td>
<td>65</td>
</tr>
<tr>
<td>Turnips</td>
<td>10</td>
<td>12.7</td>
<td>70</td>
</tr>
<tr>
<td>Wheat straw</td>
<td>86</td>
<td>6.1</td>
<td>10</td>
</tr>
<tr>
<td>Dried molassed</td>
<td>86</td>
<td>12.5</td>
<td>80</td>
</tr>
<tr>
<td>sugar beet pulp</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Extracted soya</td>
<td>90</td>
<td>13.4</td>
<td>445</td>
</tr>
<tr>
<td>bean meal</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table to give examples of feed values (from The Modern Shepherd)

<table>
<thead>
<tr>
<th>Feed name</th>
<th>Dry matter (%)</th>
<th>Metabolizable energy (MJ/Kg DM)</th>
<th>Digestible crude protein (g/Kg DM)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Silage</td>
<td>25</td>
<td>12.0</td>
<td>125</td>
</tr>
<tr>
<td>Home mix</td>
<td>86</td>
<td>12.9</td>
<td>140</td>
</tr>
</tbody>
</table>

Examples of other feeds found on the farm- note the quality of silage and the composition of home mix will vary greatly

Points to remember when calculating rations

- Always check that the answer is sensible
- Feed quality varies e.g. not all of the silage made on the farm will have exactly the same analysis
- Rations are calculated using dry matter figures; they must be converted to fresh weight before the actual amount to feed is known
- There can be significant variation with in a group of livestock (e.g. size, level of production)
- Other characteristics of the feeds such as the type of protein supplied, the levels of sugar, starch and fibre, and mineral levels will need to be considered.
**References and further reading**

J. F. D. Greenhalgh, C.A. Morgan, R. Edwards, Peter McDonald  
Longman


Teagasc (1994). Introduction to Farm Animals. Teagasc


Longman Scientific and Technical


Chapter 4 - Livestock housing

Reasons for housing livestock

- To prevent poaching of the land in winter (to prevent damage to pastures and to fulfil cross compliance requirements)
- To make it easier to feed and check the livestock
- To provide shelter to the animals
- To provide better working conditions for the stockman
- To increase the numbers of livestock that can be kept on the farm

Most adult farm animals do not require extra heating when housed, however young stock such as piglets may have additional heating in the creep area.

Requirements of livestock housing.

Each welfare code gives outlines of the housing requirements for different classes of livestock. There are important factors that must be considered for all types of housing e.g. ventilation, drainage, lying areas, and feeding arrangements.

When livestock are housed they have less control over their environment e.g. less space to avoid bullying animals or move away from dirty bedding, so it is extremely important that they are checked frequently to ensure their welfare.

Ventilation

Livestock need sufficient fresh air in their accommodation to maintain a healthy environment. A good flow of air through a building will reduce air moisture content (lower levels of humidity) and reduce condensation. Good ventilation also reduces outbreaks of respiratory disease by eliminating the environment in which disease causing organisms thrive. The aim is to have a good air flow without draughts and maintain a comfortable temperature (avoiding overheating).
Fig 22 Ridge line ventilation of livestock housing

Cattle and sheep housing systems in the UK rely on natural ventilation, with air drawn in through the sides of the building (e.g. through Yorkshire boarding) and leaving via vents in the roof (e.g. open ridges). Forced ventilation may be installed where air is blown into a building. Such systems operate to increase the air flow when certain environmental conditions occur e.g. on still, humid days.

Fig 23 Powered ventilation in beef housing
Livestock need ventilation to ensure that the air is relatively dust free and that there is no build-up of toxic gases. Gases from slurry or litter can build up to levels that are dangerous to both livestock and farm workers. When slurry is agitated or stirred it releases more gas; many buildings will have hazard warning signs to remind people of the dangers, but if slurry has to be agitated or stirred in a store under a building, livestock should be moved out of the housing to prevent problems. The main gases produced will be carbon dioxide (CO$_2$), methane (CH$_4$), ammonia (NH$_3$) and hydrogen sulphide (H$_2$S).

**Stocking rates**

The numbers of animals that can be kept in a given area is referred to as the stocking rate or when indoors, the housing density. This will vary between systems, types of housing and the age and type of livestock.

Table 1 Space allowances for sheep loose housed on straw;

<table>
<thead>
<tr>
<th>Description</th>
<th>Space allowances</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lowland ewes (60-90kg live weight)</td>
<td>1.2-1.4 m$^2$ ewe</td>
</tr>
<tr>
<td>livestock during pregnancy</td>
<td>floor space per ewe</td>
</tr>
<tr>
<td>Lowland ewes with lambs at foot (up to 6 weeks of age)</td>
<td>2.0-2.2 m$^2$ ewe and</td>
</tr>
<tr>
<td>Lambs and sheep 12 weeks to 12 months old</td>
<td>lambs</td>
</tr>
<tr>
<td>Rams</td>
<td>0.75-0.9 m$^2$ lamb</td>
</tr>
<tr>
<td></td>
<td>1.5-2.0 m$^2$ floor</td>
</tr>
<tr>
<td>space each</td>
<td></td>
</tr>
</tbody>
</table>

(The above is an extract from the space allowances table in the Sheep Welfare Code [www.cefngwlad.cymru.gov.uk](http://www.cefngwlad.cymru.gov.uk)).

Where possible, pregnant ewes should be kept in groups of less than 50 as this makes it easier to give individual attention at lambing time. If cattle are housed in cubicles it is recommended that there should be 5% more cubicles than the number of cows in the housed group. Cubicles must be large enough for the stock being housed, cubicles that were designed for Friesian cows are too small for the larger Holstein cows. Generally cubicles are used for housing female cattle; male animals are not as well suited to the accommodation as they will foul the bedding when they urinate. Straw yards must be large enough to for all of the cattle to be able to lie down and move around freely.

Table 2. Space allowances for beef cattle in bedded yards

<table>
<thead>
<tr>
<th>Liveweight of animal (kg)</th>
<th>Bedded area (m$^2$/head)</th>
<th>Loafing / feeding area (m$^2$/head)</th>
<th>Total area (m$^2$/head)</th>
</tr>
</thead>
<tbody>
<tr>
<td>200</td>
<td>2.0</td>
<td>1.0</td>
<td>3.0</td>
</tr>
<tr>
<td>300</td>
<td>2.4</td>
<td>1.0</td>
<td>3.4</td>
</tr>
<tr>
<td>400</td>
<td>2.6</td>
<td>1.2</td>
<td>3.8</td>
</tr>
<tr>
<td>500</td>
<td>3.0</td>
<td>1.2</td>
<td>4.2</td>
</tr>
<tr>
<td>600</td>
<td>3.4</td>
<td>1.2</td>
<td>4.6</td>
</tr>
</tbody>
</table>
When housing cattle, the size of the animals, the type of animal, the type of bedding, the production system and whether the animals have horns must all be taken into consideration.

If cattle are housed on fully slatted floors then different space allowances apply.

Table 3. Space allowances for and trough space requirements for cattle on fully slated floors.

<table>
<thead>
<tr>
<th>Liveweight of animal (kg)</th>
<th>Area (excluding troughs) (m²/head)</th>
<th>Trough space for restricted feeding (mm/head)</th>
<th>Trough space for ad lib feeding (mm/head)</th>
</tr>
</thead>
<tbody>
<tr>
<td>200</td>
<td>1.1</td>
<td>400</td>
<td>100</td>
</tr>
<tr>
<td>300</td>
<td>1.5</td>
<td>500</td>
<td>125</td>
</tr>
<tr>
<td>400</td>
<td>1.8</td>
<td>600</td>
<td>150</td>
</tr>
<tr>
<td>500</td>
<td>2.1</td>
<td>600</td>
<td>150</td>
</tr>
<tr>
<td>600</td>
<td>2.3</td>
<td>600</td>
<td>150</td>
</tr>
</tbody>
</table>

Tables from ‘Clean beef cattle for slaughter. A guide for producers’.

Floors and bedding

Stock should have a dry, comfortable lying area, with dry, clean conditions under foot. This means that stock must be regularly cleaned out and bedded down. Many farms do not grow cereals and have sought cheaper alternatives to straw bedding e.g. cubicles and slats. If the floors and lying areas are not dry and clean, this will be an animal welfare issue and will also lead to increased incidence of disease.

If slats are use they must be of the correct size for the type of livestock. Ewes and young lambs should not be put on slatted floors unless there is additional, suitable bedding. Fully slatted floors should not be used for breeding cows, however partially slatted buildings (e.g. cubicle housing with a slatted passage way) may be appropriate. The advantage of slats is that they allow muck and urine to drain from the building, so helping to keep the environment clean. Slats must be regularly inspected and maintained, otherwise livestock may suffer from foot injuries e.g. claws becoming trapped between the slats.

Cubicles need to have enough clean bedding to keep the cows comfortable otherwise cows may suffer from contact or pressure sores. Bedding may be a mixture of materials, e.g. rubber mats with wood shavings on top. To ensure the bedding stays clean the passage ways should be regularly scraped out (at least twice per day for non slatted passage ways).

Few animals are tethered when housed, it is no longer legal to tether sows or calves. If cows are tethered in cow sheds, they must be untethered at least once a day for exercise. When tethered they must be able to groom themselves.
Floors (in passageways and other areas) must be well maintained. If the floors are too rough they may damage the livestocks’ feet, if they are too smooth they become slippery which is dangerous for both the stock and the handler.

Bedding must be kept clean. It is recommended in welfare codes that dairy cows kept on straw yards are have their bedding mucked out completely every 4-6 weeks to help prevent environmental mastitis, although some individual farm health plans suggest mucking out every two weeks.

Feed and water

Clean fresh water must be provided for housed livestock. Systems will vary e.g. buckets for calves in individual pens, automatic drinking bowls or water troughs.

The facilities must be checked, cleaned and maintained regularly. It is important that the water system is suitable for the type and number of animals housed, and that water bowls and troughs are sited to minimise the risk of freezing or contamination.

When animals are fed on limited quantities of concentrates there must be enough space at the troughs for them all to be able to feed at once without stress and bullying. Suggested trough space for sheep is 30cm for hill ewes and 45 cm for lowland ewes. (See table 3 for examples of cattle feed space).

If the animals are going to be fed on an ad lib basis (taking turns at the feeder) then the space allowance per animal can be reduced; sheep require 10-12 cm per head of trough length for hay or silage feeding ad lib.

Lighting

The requirements are similar for both sheep and cattle; there must be enough lighting available (portable or fixed) for the housed stock to be inspected at any time. During daylight hours, there must be enough light in the buildings (either natural or artificial) for the stock to be seen clearly.

Emergencies

There should be plans in place to deal with emergencies such as fires. Plans should address issues such as how to release livestock quickly and safely.

Consideration must also be given to loss of water or power supply, in intensive systems which rely on power for ventilation and temperature control even a short break in the power supply can lead to a rapid worsening of the animals’ environment. Generators may be installed to cope with loss of power, and frost protection systems can reduce the problem of frozen water supplies in the winter.

Routines
Livestock must be checked regularly to ensure:
- They have access to sufficient food
- They have access to clean water
- They are healthy
- They are the correct temperature
- They have a clean dry lying area
- They have sufficient ventilation (but not a draughty environment)
- There are no problems with other animals e.g. tail biting in pigs, mismothering of young lambs.
- There is no damage/wear to the building or equipment which could pose a risk (e.g. sharp edges on worn metal fixtures)

The routines will vary according to the type of stock. At peak lambing times a shepherd may be in the lambing shed for almost all of the time, but other stock may be checked as part of the routine when they are being fed, mucked out or bedded.

**References and further reading**

[www.defra.gov.uk/animalh/welfare/farmed/index](http://www.defra.gov.uk/animalh/welfare/farmed/index) this leads to the section of the DEFRA website where the animal welfare codes and publications can be accessed.

Code of Recommendations for the Welfare of Livestock - Sheep

Code of Recommendations for the Welfare of Livestock – Cattle

Emergencies on Livestock Farms
