This module is designed for prospective students in our Animal Science program. It contains short excerpts from a few of our core modules and will provide students with an ideal of the level of detail and assessment they can expect in the course.

Read the relevant notes and then trial any study questions or quizzes. Answers are generally not given in this booklet.

Please DO NOT submit any of the assessments for review or marking, they are for your use only.

Good luck with your studies
Zoonoses are infectious diseases that can be transmitted from animal to man, or from man to animal. Some of these diseases are life threatening. All animal care workers, especially in high risk areas, should be aware of these diseases, for many reasons;

- You do not want to catch a disease that is affecting an animal.
- You do not want to give an animal a disease that you have.
- You do not wish to expose other people with these diseases.

The diseases considered as zoonoses are infectious diseases. It means they are caused by contagious organisms, such as; bacteria, viruses, and parasites. You should always promptly seek professional advice when you are unsure of the health of an animal or human.

This does not mean that people should distance themselves from animals, and in fact, most people closely associated with animals will never suffer from any serious zoonotic disease.

**Spread of disease**

Zoonotic diseases may be spread in many ways;

- Direct contact (animal to animal, animal to human and vice versa)
- Fomite – inanimate objects that may transfer disease, such as blankets, food bowls
- Inhaling aerosols and airborne particles (bacteria, spores)

**High standard of hygiene and care**

There are some general measures that can be taken to avoid as far as possible the risk of contracting a disease from an animal.

- Keep premises clean and well ventilated
- Use disinfection when large numbers of animal are held closely together
- Wear PPE (gloves, boots and aprons) as needed
- Practice good personal hygiene and when handling animals, clean your hands afterwards
• Cover cuts and scratches with waterproof plasters
• Do not kiss your pet, ensure children are not handling the rear of pets or being licked in the face
• Dispose of all wastes, especially faeces in a careful manner (use gloves)
• Control vermin (rats) and insect pests such as flies and cockroaches
• Pregnant women should not handle cat faeces or litter trays
• Have yourself vaccinated for zoonotic diseases that can be prevented by vaccination (e.g. rabies)
• Practice safe work practices if working with animals. Seek advice on risks associated with abattoir or other industry occupations. Government agencies such as Worksafe provide such information.
• Avoid eating and drinking around animals

Prevention of disease in animals

• Keep the animals in a healthy, clean state
• Feed good quality food and water
• Regularly inspect and treat animals for internal and external parasites
• Vaccinate animals for contagious diseases
• Quarantine all new animals
• Isolate animals showing signs of disease

Hand washing

Personal hygiene is the first step in controlling the spread of infection, whether it is at home or working in an animal care industry. As mentioned above, zoonotic diseases may be passed on from direct contact or fomites. Research has shown that human contagious diseases are mostly passed on from hand to hand contact. Examples are; influenza, chicken pox and gastroenteritis (vomiting and diarrhoea). Unless people are working in the health industry, not many are aware the techniques to wash hands properly.

On the next page is a poster taken from the Government of Western Australia Department of Health, on the accepted standard in washing hands.

1. Define zoonoses
_________________________________________________________________
_________________________________________________________________

2. Discuss 6 methods of maintaining a high level of hygiene that will reduce the risk of contracting a disease.
_________________________________________________________________
_________________________________________________________________
_________________________________________________________________
_________________________________________________________________
_________________________________________________________________
_________________________________________________________________

3. List 3 ways we can prevent diseases in animals in general.
_________________________________________________________________
_________________________________________________________________
_________________________________________________________________

4. Using the guideline supplied by the Department of Health, how would you properly wash your hands?
_________________________________________________________________
_________________________________________________________________
_________________________________________________________________
_________________________________________________________________
_________________________________________________________________
_________________________________________________________________
This section is taken from our Animal Nutrition and Feeding Module. Try the questions for yourself at the end of the chapter.

WATER

An animal’s body will be made up of at least 60% water, more in younger animals.

Water is vital to life and its functions include:

- Acting as a solvent to dissolve and carry essential materials in and out of the cell.
- Forms the main part of blood, which carries gases and nutrients around the body.
- Is involved in regulating the body temperature
- Is vital for digestion, and the excretion (passing out) of wastes through the urine and faeces.

Water can be taken in and lost from the body in the following ways:

<table>
<thead>
<tr>
<th>Intake</th>
<th>Output</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water drunk</td>
<td>Urine, faeces</td>
</tr>
<tr>
<td>Water in food (meat is around 60% water)</td>
<td>Expired air, sweat, milk</td>
</tr>
<tr>
<td>Metabolic water (from the breakdown of</td>
<td>Illness such as diarrhoea, bleeding</td>
</tr>
<tr>
<td>nutrients in the body)</td>
<td></td>
</tr>
</tbody>
</table>

**Animals should ALWAYS have free access to clean water.**

Of course the demands for water vary with the individual, factors such as the type of food, environmental temperature, amount of exercise, and physiological state (for instance producing milk) will alter water requirements. If any animal has a reduced input or increased output of water, for whatever reason, their fluid intake must be supplemented.
WATER REQUIREMENTS FOR ANIMALS

Dogs and cats require approximately 50 ml / kg /day

*For example an 8 kg dog requires 400 ml / day (8 x 50)*

Horses require 50 - 60 litre /day, cows 30-40 litre / day. This will vary considerably with the type of pasture. Very green pasture will provide more water in the food as the grass has a higher water content.

If an animal is taking a dry diet (such as commercial cat food), most of the water intake must be drunk. If the animal is on a moist food diet, it reduces the drinking water requirements. Dry dog food for instance contains around 6 % water, whilst canned foods may have around 80 % water.

Some Thoughts

*Should an animal have a reduced intake or excess loss of water, it will become dehydrated, and may eventually die.*

*An excess of water in the body, for instance drinking and not being able to excrete (pass out) can cause serious damage to the brain resulting in an animals death!!*
These questions are intended to assist you with your studies.

You do not need to send these to your tutor, they are for you revision only.

Considering that approximately 60% of an animal’s body weight is water, complete the table below calculating the amount of water for each example. This first example is done for you. You need to assume that 1 litre of water weighs 1 kg.

<table>
<thead>
<tr>
<th>Animal</th>
<th>Calculation</th>
<th>Amount of Water</th>
</tr>
</thead>
<tbody>
<tr>
<td>Horse 200 kg</td>
<td>200 kg x 60% = 120 kg</td>
<td>120 litre</td>
</tr>
<tr>
<td>Horse 500 kg</td>
<td>(200 x 60/100)</td>
<td></td>
</tr>
<tr>
<td>Cat 8 kg</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dog 40 kg</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Calculate the expected water consumption for the following animals

<table>
<thead>
<tr>
<th>Animal</th>
<th>Calculation</th>
<th>Amount of Water</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dog 12 kg</td>
<td>12 kg x 50 ml = 600 ml</td>
<td>600 ml</td>
</tr>
<tr>
<td>Dog 60 kg</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cat 8 kg</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The solutions. Try to work out the solution before looking.

Solutions: 120 l, 300 l, 4.8 l, 24 l

600 ml, 3000 ml (or 3 litre), 400 ml
DISINFECTION

Disinfection is the removal or destruction of most disease causing (pathogenic) micro-organisms.

Not all organisms are killed by disinfection, and bacterial spores (the tough resistant forms of bacteria) may not be killed.

Disinfection is used when it is considered important to reduce the population of micro-organisms in the environment beyond cleaning. That is, most micro-organisms will be destroyed. There are many circumstances where disinfection is recommended. A few are shown on the table following:
<table>
<thead>
<tr>
<th>Situation</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Where an outbreak of a disease has occurred</td>
<td>cat flu in a cattery</td>
</tr>
<tr>
<td></td>
<td>strangles in horses</td>
</tr>
<tr>
<td></td>
<td>kennel cough in dogs</td>
</tr>
<tr>
<td>Many animals confined closely together</td>
<td>dogs in a boarding kennel or veterinary hospital</td>
</tr>
<tr>
<td></td>
<td>sheep in a shearing shed</td>
</tr>
<tr>
<td></td>
<td>cattle at sale yards</td>
</tr>
<tr>
<td></td>
<td>goats in a dairy</td>
</tr>
<tr>
<td>Equipment that will come in contact with several animals or close contact with an animal</td>
<td>brushes ,combs and clothing</td>
</tr>
<tr>
<td></td>
<td>milking machine</td>
</tr>
<tr>
<td></td>
<td>clippers</td>
</tr>
<tr>
<td></td>
<td>teeth cleaning equipment</td>
</tr>
<tr>
<td></td>
<td>feed and water bowls</td>
</tr>
<tr>
<td>Where an animal is unwell or has a reduced immunity to disease</td>
<td></td>
</tr>
</tbody>
</table>

Disinfection can be achieved in several ways; the method used depends on the situation. Chemical agents can be used, such as the use of bleach or other chemicals, or physical methods such as the use of boiling water may be used. These methods are discussed in detail shortly.

Disinfection is aimed at reducing the number of organisms to such an extent that the risk of disease is greatly reduced. It is aimed at minimising the risk of *contamination*. (introduction of micro-organisms to living tissues, materials or equipment)

There are many chemicals that may have an action on micro-organisms to reduce their numbers. Various chemical disinfectants will produce different results, depending on their action, strength and way in which they are used.

Disinfectants that are used on the skin or other surfaces of an animal (such as the mouth or in the vagina) are described as *antiseptics*. Often antiseptics are weak disinfectant solutions, but not all disinfectants can be used as antiseptics, some will cause serious damage to the skin if
used. Antiseptics will not achieve sterilisation, and act by reducing the population of microorganisms on the skin. (disinfection)

Some examples of disinfectants and their usage will now be discussed.

**ALCOHOL**

**Examples**  Ethyl alcohol and isopropyl alcohol are commonly used
Methylated spirits is widely used, as it is relatively inexpensive. It contains: 85 % ethyl alcohol, 10 % methyl alcohol, and 5 % napha (a foul tasting chemical used to discourage drinking of meths).

**Usage**

It will destroy most bacteria, but is not effective against bacterial spores. It will kill some viruses and has a weak action against fungi.

Alcohols should be used at a concentration of around 70 %, therefore Methylated spirits is best used by adding 25 % water. (That is for every 75 ml of meths add 25 ml of water)

**Application**

Alcohol is useful for general disinfection of benches, equipment, animal cages, feeding utensils and other general equipment. Thermometers are often kept in alcohol solutions.

It can be used safely on the skin to achieve antisepsis, but will irritate and cause pain if used on mucous membranes (such as the eye) or wounds.

It is sometimes combined with the disinfectant chlorhexidine to improve its effect.

**Considerations**

Alcohol does not penetrate organic material or other dirt very well (such as faeces, blood, hair etc.) Therefore micro-organisms that are found in organic material or dirt are not readily destroyed. *Thorough cleaning must be performed prior to use of this disinfectant.*
CHLORINE (HYPOCHLORITES)

Examples These chemicals are from the halogen group of chemicals.

Chlorine has a rapid bactericidal action. (this means that bacteria are killed) It usually comes in the hypochlorite form, which are often referred to as bleach.

Usage
It is effective against bacteria, spores, fungi and viruses. It is widely used in the treatment of water and as a surface disinfectant. There are many forms available commercially and they are fairly inexpensive.

Bleach is usually supplied as a 12.5 % solution of sodium hypochlorite and should be used in the following way.

General cleaning of clean surfaces Dilute 1 in 100 with water ( add 10 ml of concentrated solution for every litre of solution to be made )

Cleaning of contaminated surfaces Dilute 1 in 10 with water ( add 10 ml of concentrated solution for every 100 m1 of solution to be made)

For different strength solutions, adjust the dilution accordingly

Note Whenever making up solutions, whether solids or liquids, always add the chemical to the water, not water to the chemical. This is to avoid severe chemical reactions that may be harmful. Always follow safety directions on the labelling.
Application

Useful for general disinfectants for clean surfaces. Also useful as dunking solutions for glassware and plastic or rubber products (such as feeding bottles). Food and water bowls can be cleaned with bleach.

Considerations

Bleach should be made up freshly each day prior to use. Sunlight will cause the solution to lose its action fairly quickly.

Chlorine tends not to be active (is inactivated) in the presence of organic materials such as blood and dirt.

It is corrosive to metals (therefore metals should only be dunked for a short time) and may cause fabrics to deteriorate. At high concentrations it can irritate the skin.

**Thorough cleaning of surfaces must be performed prior to use of this disinfectant. It can be used without losing its performance after the use of detergents**

**Chloramines**

Acts similarly to hypochlorites, but has a longer duration of action. *Halamid* is a popular brand of chloramine that is less irritant to skin than bleach and may be used as an antiseptic. It is particularly useful in the environment for the killing of fungal spores, such as those that might be found with ringworm.

It is usually used at concentrations of 0.5% - 2.5%
IODINE ( & IODOPHORS )

Examples   Despite being a very effective disinfectant, pure iodine tends to be very irritant to skin and will stain most materials. It is not widely used. However so called iodophors described below are widely used.

Iodophors are a more complex form of iodine that results in solutions that are not irritating to the skin and are less staining. They are widely used. Povidone iodine (Betadine is one commercial product) is a common example.

Usage

Are used to destroy most bacteria, but is less effective against bacterial spores. It is effective against many viruses and is useful against fungi. It may be used as both a disinfectant and antiseptic.

Application

It is generally used as a hand and arm wash when a thorough antiseptic result is required. Handling diseased animals and materials, and prior to surgery are two such situations. Betadine is available as a scrub (ie betadine combined with a detergent) where it lathers and cleans as well as its antiseptic properties. This is used for scrubbing hands prior to surgery, and antiseptic properties on the skin. Betadine scrub should not be used in open wounds since the detergent may be irritating. Betadine solution (ie betadine without detergent) may be diluted and used in open wounds.

Betadine is widely used.
Considerations

Iodine loses much of its activity in the presence of organic material. It is not widely used for general disinfection of surfaces and materials due to its yellow coloration and ability to stain. It is also far more expensive than alcohols or bleach that can be used for that purpose.

QUATERNARY AMMONIUM COMPOUNDS

Examples  These chemicals are widely used in the community as disinfectants, but generally have a poor action. They usually contain cetrimide or benzalkonium chloride. Cetavlon, Zephiran, Pine-O-Cleen are some commercial examples. Many of these older types are not effective against viruses such as Canine Parvovirus.

Usage

These substances are actually detergents that are non-irritating. They are useful for cleaning of wounds, but have a low antiseptic activity. They are bacteriostatic (inhibit the growth of bacteria, without killing them) and have limited action against viruses and fungi.

Application

Useful for cleaning dirty and contaminated wounds. May be useful for cleaning drinking bottles.
Useful for cleaning very dirty areas such as drains and dirty floors.

Considerations

They need to be thoroughly rinsed if bleach is to be used. Soap will cause them to be inactive. They should not be used for general disinfection due to their poor action.
In combination with other chemicals they may have improved activity. An example is Savlon which is a commercial preparation of cetrimide with chlorhexidine.

There are a new generation of quaternary ammonium chlorides which are highly effective
**F10SC** is effective against Gram Positive and Gram Negative bacteria, Fungi, Yeast and Moulds, Fungal spores and Bacterial spores and Viruses including Canine Parvovirus, rabies, Newcastle disease and infectious bursal disease depending on the concentration it is made up at. It contains no hazardous ingredients, is non-irritant and has a zero hazard rating with biodegradability.

![F10SC disinfectant](image1)

**F10SC** a popular disinfectant with broad activity against microbes

**Trigene** is effective against bacteria, fungi, viruses (including Canine Parvovirus), mycobacteria and spores. At different dilutions (for economic general purpose use at 1:200) it can be effective in the presence of soilage and blood and at 1:20 can be used for laundry soaking for 30 mins. The product is non-corrosive and may be used on rubber, vinyl and most hard surfaces. It is biodegradable.

![Trigene disinfectant](image2)

**Trigene disinfectant**
CHLORHEXIDINE

Examples  These chemicals are popular commercially and include brands such as Hibitane and Chlorhex.

Usage

These substances have a good activity against bacteria, but a poor activity against spores. It has a limited effect against viruses. It is relatively non-toxic and non-irritating. It is particularly useful for treating wounds and has good antiseptic activity. For general antiseptic dilute 20 mL of CHLORHEX-'C' (a specific brand) in 1 litre of clean water (to produce a 0.1 % w/v aqueous solution).

For pre-operative skin preparation, instrument disinfection and disinfection of the surfaces of equipment, dilute 10 mL of 'CHLORHEX-'C' with 15 mL of clean water and make up to 100 mL with industrial methylated spirits (to produce 0.5% w/v in 70% w/v alcohol solution).

NOTE: Prepared aqueous solution should be used within one month and prepared alcohol solutions within 12 months

Application

It is widely used as a skin scrub when used with a detergent. This may be used for hand washing or on skin prior to surgical procedures. It may also be used to sterilise instruments when combined with alcohol

Considerations

It has good activity in the presence of organic material. Soap will cause it to be inactivated. Savlon is a commercial preparation of cetrimide with chlorhexidine.

Chlorhexidine in a pump dispenser
PHENOLS

Examples  Phenols are usually inexpensive but many have a strong odour and cause skin irritation. Coal tar derivatives are occasionally used, *lysol* is a commercial example.

Chlorinated phenols are good disinfectants and are often found mixed with fragrant solutions such as pine oil. Dettol is one well known commercial preparation.

Hexachlorophene is a more complex compound that is slower acting. *Phisohex* and *Gammaphen* are two commercial examples.

Usage

These substances have a good activity against bacteria. They have a selective effect against viruses. They are particularly active in the presence of organic material and do not damage metal.

They may also be used in combination with soaps as a general hand wash.

Application

They are widely used as an economical general surface cleaner and disinfectant. Regular use as a hand wash will result in a good effect. Some preparations are suitable for use as a general antiseptic when diluted.

Considerations

It has good activity in the presence of organic material. They have limited antifungal action. Cats may be harmed by phenolic compounds and they should not be used on or around cats.
**ALDEHYDES**

**Examples**  Glutaraldehyde is the main aldehyde seen. Wavicide and Parvocide are two such products. NB Rarely used nowadays

**Usage**

It has a good activity against bacteria. Glutaraldehyde is one of the best cold (used with cold water) disinfectants for use against viruses however it is rarely used nowadays due to toxic effects.

**Application**

It is a particularly effective environmental disinfectant however due to irritation of eyes, nose, throat and skin it is not commonly used in Australia anymore. It can also cause asthma and allergic reactions of the skin.

**Considerations**

Care must be taken to avoid contact with the skin as it can cause severe damage. Gloves should be worn when using this preparation.

It is expensive

**A MULTI COMPOSITION DISINFECTANT**

**Virkon**  A blend of an inorganic peroxxygen compound, inorganic salts, organic acid, anionic detergent, fragrance and a dye.  Virkon contains a surfactant and cleans and disinfects in one step, quickly and without harmful fumes. Supplied as a space saving powder, Virkon contains no aldehydes, phenols or quaternary ammonium compounds.  It is effective against bacteria, fungi, viruses and yeast.

As a powder it can cause serious eye damage, irritation to the respiratory system through dust release, irritating to the skin and is harmful to aquatic organisms (though it is not expected to display long term adverse effects in the aquatic environment) so wear protective clothing,
once in its liquid form (1% solution) it is considered non-irritating with no toxic vapour phase.

Virkon S is very effective but deteriorates quickly once made into a liquid. In its active form it is pink coloured, as its effectiveness reduces so does the pink colour, usually less than a week.

Some study questions

25. Outline the use of alcohol as a disinfectant

_________________________________________________________________________
_________________________________________________________________________

26. What major group of disinfectants is bleach classed in?

_________________________________________________________________________

27. List some disadvantages of using bleach as a disinfectant

_________________________________________________________________________
_________________________________________________________________________
_________________________________________________________________________

28. Why should chemicals be added to water and not vice versa?

_________________________________________________________________________
29. Provide the commercial name for a commonly used povidone-iodine antiseptic

30. Describe situations where the povidone-iodine product listed above is commonly used

31. List 2 new generation quaternary ammonium products which are highly effective disinfectants

32. List 2 common uses for chlorhexidine

33. Name the species of animal which are highly sensitive to phenols (i.e. phenols may be toxic to them)

34. What is the name of the highly effective disinfectant that comes as a powder and is made up into a pink liquid?

35. Outline some general principles for the effective use of disinfectants
This section is taken from our Structure and Function of Animals Module
Try the revision questions for yourself at the end of the chapter.

This module is considered by many to one of the most challenging of our modules and will give you an ideal of the level of learning in the more advanced modules

FUNCTIONS OF THE CARDIOVASCULAR SYSTEM

PARTS OF THE CARDIOVASCULAR SYSTEM

The cardiovascular system is comprised of the organs and vessels involved in circulating blood and lymph around the body. The lymphatic system is often considered part of the circulatory system and will be discussed later in this chapter.

Parts of the cardiovascular system include:

- heart
- blood vessels, and
- blood.

The lymphatic system is the composed of the:

- lymph nodes
- lymph vessels, and
- lymph

Purpose of the cardiovascular system

The main purpose of the cardiovascular system is to carry blood, and therefore nutrients and oxygen to the tissues, and to carry the waste products of metabolism to anatomical sites such as the lungs, liver and kidneys for elimination from the body.

The cardiovascular system also plays a role in thermoregulation, the immune system and in inflammation.
The Heart

The heart is the pump of the circulatory system and enables blood to be pumped through the blood vessels of the body. The heart is composed mainly of a special type of muscle tissue that is not under conscious control. (In other words it functions automatically)

The heart sits within the chest cavity between the fourth and seventh ribs depending on the species. It is divided into two sides, the left and right side and there is no mixing of blood from the left or right side within the heart.

A cross section of the heart wall would show a thin inner lining called the endocardium, a thick layer composed of heart muscle, i.e. the myocardium (virtually the entire thickness of the wall) and a thin outer layer called the epicardium. The heart sits within a tough fibrous sac called the pericardium. The pericardium contains a tiny amount of fluid and the heart is able to beat within this sac with minimal friction from nearby tissues such as the lung.

The heart is divided into four chambers as follows:
- left atrium
- left ventricle
- right atrium
- right ventricle

The atria (plural for atrium) collect blood from large veins returning from the body, while the ventricles empty into large arteries that supply blood to the body. Once blood has been delivered to the tissues and cells, it will give up its oxygen. It is then returned to the heart as deoxygenated (little oxygen) and pumped to the lungs to collect more oxygen.
The left side of the heart is thicker than the right side since it must pump blood to the majority of the body, whereas the right side only pumps blood to the lungs.

**Flow of blood through the heart**

Oxygenated blood flows from the lungs via the pulmonary veins into the left atrium, through the left atrio-ventricular valve (mitral valve) and into the left ventricle. The blood is then ejected from the heart through the aortic valve and into the large artery, the aorta, for distribution to the rest of the body. Deoxygenated blood returns from the rest of the body to the heart via the vena cava veins into the right atrium. It then flows through the right atrio-ventricular valves into the right ventricle. Blood is then ejected through the pulmonic valve and into the pulmonary artery to the lungs to be re-oxygenated, and then the circulation begins again.

**The heart valves**

As mentioned previously the heart possesses valves. These valves permit the blood to only flow in one direction, i.e unidirectional. There are four valves within the heart:

- Left atrio-ventricular valve (mitral valve)
- Right atrio-ventricular valve (tricuspid valve)
- Aortic valve (between the left ventricle and aorta)
- Pulmonic valve (between the right ventricle and the pulmonary artery)

The left and right atrio-ventricular valves are open when the heart is relaxed to allow blood to flow from the atria into the ventricles and snap shut when the heart beats to prevent backflow of blood back into the atria.

The aortic and pulmonic valves are shut when the heart is relaxed to prevent blood from flowing back into the ventricles but during contraction the valves are opened to allow blood to enter the aorta and pulmonic valves.
The valves are thin structures made of tough connective tissue. If they become diseased or damaged then blood may flow back against the normal flow and this abnormal turbulence may be heard as a heart murmur.

**The Heart Beat**

Each contraction of the heart forces blood to be ejected from the ventricles into the arteries. This sends a wave or pulse of blood through the arteries which may be palpated or felt by resting a finger on an artery.

The activity of the heart may be divided into:
- **Systole**: (the actual contraction of the heart when blood is ejected from the heart)
- **Diastole**: (the brief period of relaxation between each contraction when blood flows into the heart)

The heart beat is controlled by the nervous system of the body by the presence of a specialised structure in the right atrial wall called the pacemaker or sino-atrial node. This structure initiates an electrical impulse which travels through specialized nerve-like structures within the heart muscle to stimulate the heart muscle cells to contract. This conduction of electrical stimuli must occur in a coordinated fashion otherwise the contraction of heart muscles will not be coordinated. In-coordinated contraction of the heart muscle would mean that the blood would not be ejected properly from the heart.
The electrical activity of the heart may be measured on the surface of the skin by a machine called an **electrocardiogram (ECG)**. Abnormal traces seen on an ECG can provide an insight into diseases of the heart in animals.

![ECG](image)

**Figure 4.3.** The large spike in the ECG trace represents part of systole or contraction of the heart

### Heart Sounds

Listening to the heart contracting by using a stethoscope (auscultation) allows us to hear normal heart sounds. Typically we are to discern two heart sounds for each beat or contraction. The sounds may be described as ‘**lub-dup**’ sound.

The first sound or the lub part is due to blood turbulence associated with closure of the right and left atrio-ventricular valves closing, while the second heart sound, the ‘dup’ is due to turbulence of blood flow associated with closure of the aortic and pulmonic valves.

Abnormal heart sounds indicate an abnormal flow of blood in the heart, which may be caused by conditions such as holes between heart cavities or faulty heart valves.
The Circulatory System

The circulatory system consists of:

- **Heart**
- **Arteries**, blood vessels transporting blood from the heart
- **Arterioles**, smaller arteries
- **Capillaries**, microscopic blood vessels forming large beds or networks within tissues, where transfer of gases and nutrients may occur
- **Venules**, small veins running from capillaries to veins
- **Veins**, blood vessels transporting blood towards the heart

![Figure 4.4. Circulatory system](image-url)
On the diagram above it is possible to see that there are two main loops of the circulation system. That is:

- The **pulmonary circulation**: a loop through the lungs where blood is oxygenated, and carbon dioxide is removed.
- The **systemic circulation**: a loop through the remainder of the body to provide oxygen to tissues.

Blood flows in these loops in one direction. In arteries high blood pressure prevents any backflow, whereas in low blood pressure veins valves located on the inside of the vessel prevent backflow.

Arteries, arterioles, venules and veins can be seen as the transportation system of the blood while capillaries are the site of gas and nutrient exchange, and the site for white blood cells to enter tissues.

| Arteries: carry blood away from heart, thick walled, high blood pressure |
| Veins: carry blood toward heart, thin walled, low blood pressure, have valves |

Oxygenated blood is returned from the lungs and enters the left side of the heart to be pumped via the aorta to the remainder of the body. Arteries branch off the aorta to supply various tissues of the body.
The arteries subsequently branch into smaller and smaller vessels, becoming arterioles and finally branching into a bed of microscopic capillaries where exchange of oxygen and carbon dioxide and other nutrients occur.

On the other side of the capillary bed vessels start to form larger vessels called venules. These vessels continue to merge to form veins. Veins ultimately flow into the vena cavae to return deoxygenated blood to the right side of the heart.

From the right side of the heart, blood is pumped to the lungs where a large capillary bed exists for transfer of gases with the alveoli.

Figure 4.2. The circulatory system showing various organs with their capillary beds.
Blood pressure

Blood pressure is a measure of the pressure of blood within arteries. There are two blood pressure readings that may be made:

- **Systolic pressure**: blood pressure in the arteries when the heart contracts
- **Diastolic pressure**: blood pressure in the arteries when the heart is in diastole, or not contracting

Blood pressure is influenced by a number of factors including the amount of blood ejected by the heart, and the diameter of the blood vessels. Blood pressure receptors in major arteries may detect a drop in blood pressure and send signals to the brain. To return the blood pressure to normal the heart then contracts more forcefully or more rapidly, and blood vessel diameters are decreased by contraction of smooth muscle in the blood vessel walls. The body may also try to conserve water through the kidneys in an attempt to increase the blood volume.

Capillaries

Capillaries are the tiny vessels with a wall that is only one cell thick. Having such a thin wall assists in transfer of gases, nutrients and wastes between vessels and the cells of surrounding tissues. Cells must be located close to capillaries for efficient transfer of materials this is the reason for all tissues having a network of capillaries throughout.

Oxygen diffuses from the red blood cells in the capillary, through the capillary wall and into the adjacent tissue cells. Oxygen is moving by simple diffusion from an area of high oxygen, at the start of the capillary, to areas of lower levels in the tissues. The reverse is true for the waste carbon dioxide produced by cells. It diffuses from higher levels in the tissues to lower levels in the capillary. Nutrients also flow from high concentrations area in blood vessels to
lower levels in tissues. Some nutrients are transported across cell membranes by special transport mechanisms.

Small quantities of fluid leave the capillary due to the pressure of fluid in the vessels, but the opposing force to draw fluid back into the vessel is achieved by the osmotic pressure of the protein albumin within the capillary.

**Figure 4.4.** Fluid leaving and entering the capillary determines how much fluid is left in the interstitial tissue. Excess interstitial fluid is returned to the circulation by lymphatic vessels (see next section). Image: US Govt
Revision Questions
Cardiovascular System

These questions are designed to consolidate your learning of this chapter. They should not be sent for marking unless your tutor specifically requests them from you.

Complete the following questions:

What is the purpose of the cardiovascular system?

__________________________________________________________________________________
__________________________________________________________________________________
__________________________________________________________________________________

List the three main parts of the circulatory system

__________________________________________________________________________________
__________________________________________________________________________________
__________________________________________________________________________________

Label the following diagram of the heart
Name the veins that enter into the left atrium

__________________________________________________________________________________

Name the artery that leaves the left ventricle

__________________________________________________________________________________

Name the veins that enter the right atrium

__________________________________________________________________________________

Name the artery that leaves the right ventricle

__________________________________________________________________________________

Describe the function of the heart valves?

__________________________________________________________________________________

What do the two heart sounds represent?

__________________________________________________________________________________

__________________________________________________________________________________

Name the three layers of the heart

__________________________________________________________________________________

__________________________________________________________________________________

__________________________________________________________________________________

What is the pericardium?

__________________________________________________________________________________

Explain how is each heart beat initiated?

__________________________________________________________________________________

With what piece of equipment do we measure the electrical activity of the heart?

__________________________________________________________________________________
Define systole

__________________________________________

Define diastole

__________________________________________

What does the pulse represent?

__________________________________________

List 3 places where you could measure the pulse of an animal when it is under general anaesthesia

__________________________________________

__________________________________________

__________________________________________

Draw a typical ECG trace

On the diagram below indicate chambers of the heart with high oxygen levels or low levels (you could use red pen to shade areas of high oxygen and blue pen to shade areas of low oxygen).
Discuss why is the left side of the heart larger than the right?
__________________________________________________________________________________

List 3 differences between arteries and veins
__________________________________________________________________________________
__________________________________________________________________________________
__________________________________________________________________________________