



# Grade 9 **Natural Sciences** 3-in-1 CAPS

## CLASS TEXT & STUDY GUIDE

This Grade 9 Natural Sciences handbook and study guide is a major newcomer to our Sciences range that will prove invaluable in unpacking a challenging curriculum.

### It includes:

- Comprehensive Skills Section
- Organised, easy-to-follow Notes
- Topic-based Questions
- Detailed Answers

### Key Features:

- Skills section:
  - step-by-step explanation of scientific investigation
  - illustrated summary of representing data (tables/graphs/diagrams)
  - worked example of a scientific investigation question
  - expanded Action Verbs list to identify the focal point of questions
- clear, self-explanatory diagrams with annotated labels
- enrichment snippets to stimulate discussion
- visual summary flow diagrams
- extensive range of questions with detailed answers
- tips and teacher-talk boxes to provide context and clarity

This study buddy establishes a solid groundwork for success in Life Sciences and Physical Sciences. It motivates independent learning, avoids rooting of common misconceptions and develops confidence in tackling scientific material.

GRADE

9

CAPS

3-in-1

# Natural Sciences

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Retha Louw, Norman Davies & Silvana Scarola

## THIS CLASS TEXT & STUDY GUIDE INCLUDES

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Notes

- Life and Living
- Matter and Materials
- Energy and Change
- Planet Earth and Beyond

2

Questions per Module

3

Detailed Answers (in separate booklet)

E-book  
available 



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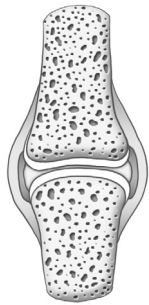
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## Arthritis

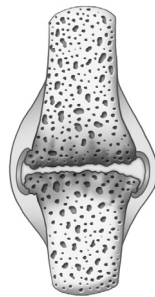
- Condition that occurs when the cartilage between two bones wears down and becomes thin.
- Friction between the two bones causes pain, swelling and inflammation.
- It causes deformity of joints and difficulty in movement.
- It affects mainly older people.



Normal joint



Normal hand



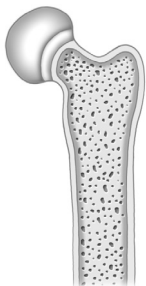
Arthritis joint



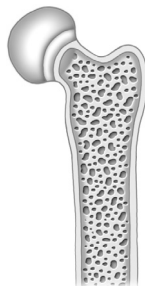
Arthritis hand

## Osteoporosis

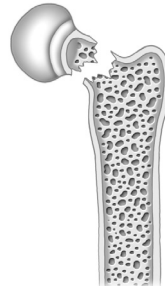
- This condition causes bones to become spongy and fragile, resulting in low bone density.
- These brittle bones increase the risk of fractures.
- It is caused by a lack of calcium and vitamin D in the diet.
- It occurs mainly in older people.



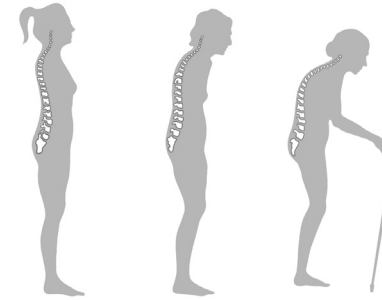
Normal bone



Osteoporosis bone



Broken osteoporosis bone



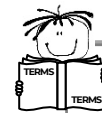
Posture changes due to osteoporosis and ageing

## UNIT

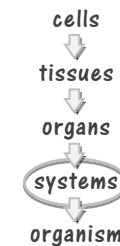
### 6

## EXCRETORY SYSTEM: OVERVIEW

- **Excretion** is a process that results in the removal of **metabolic waste** from an organism.



**metabolism:** all the chemical reactions in a cell, e.g. respiration, protein synthesis, etc.



**Excretory system**  
removes waste and regulates water and salts

- **Metabolic waste** is substances produced by cells that are harmful to the organism if they accumulate.
- The main waste products are CO<sub>2</sub>, excess water, salts and urea.
- CO<sub>2</sub> is removed by the lungs.
- Most of the other waste is excreted in urine via the kidneys.

### NOTE

Faeces contain some metabolic waste, but is mostly undigested waste. The removal of faeces is known as egestion.



## MAIN PROCESSES

There are three main processes involved in excretion:

- **filtration** of blood to form the filtrate
- **reabsorption** of useful substances back into the bloodstream
- **secretion** of additional waste in the blood into the filtrate

### Filtration

- Waste products are carried by the blood into the kidneys.
- The kidneys filter the blood and waste products, salts, certain nutrients and water from the blood move into the kidney tubules to form a liquid called the **filtrate**.
- This filtrate will eventually form **urine** after useful substances are reabsorbed back into the blood.

### Reabsorption

- Some of the substances filtered out of the blood into the kidney tubules are useful to the body.
- Useful substances, e.g. nutrients like glucose, vitamins and amino acids and also salts form part of the filtrate.
- Most useful substances (nutrients, necessary salts and water) are reabsorbed from the filtrate back into the blood by the process of **diffusion**.

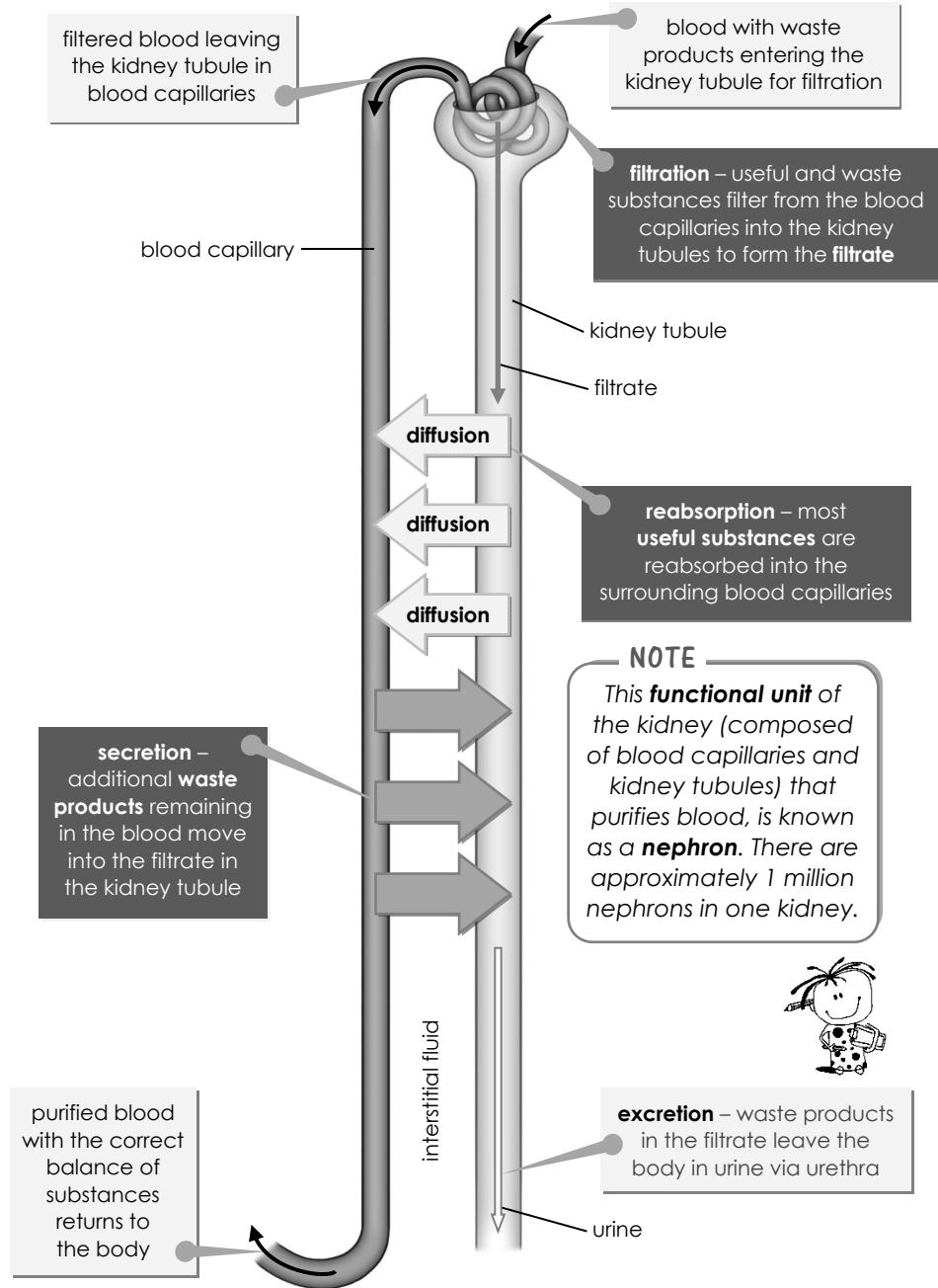
**diffusion:** a process where particles move from an area of **high concentration** to an area of **low concentration** until they are evenly distributed; no energy is required



- Hormones control the amount of water reabsorbed back into the blood from the filtrate. This controls the water balance of our bodies and is known as **osmoregulation**.

### Secretion

- Some waste products are still present in the blood after filtration.
- These waste products in the blood are added to the filtrate in the kidney tubules.



Simplified diagram to show processes of excretion in the kidney tubules

## Excretion

- The concentrated filtrate containing waste products eventually forms urine.
- Urine passes out of the kidney via the ureters to the bladder for storage.
- Once the urine reaches a certain level in the bladder, the increase in pressure triggers the urge to urinate.
- Metabolic waste leaves the body in urine via the urethra during urination. This is known as **excretion**.
- Urination is controlled by a ring muscle (sphincter) at the base of the bladder.

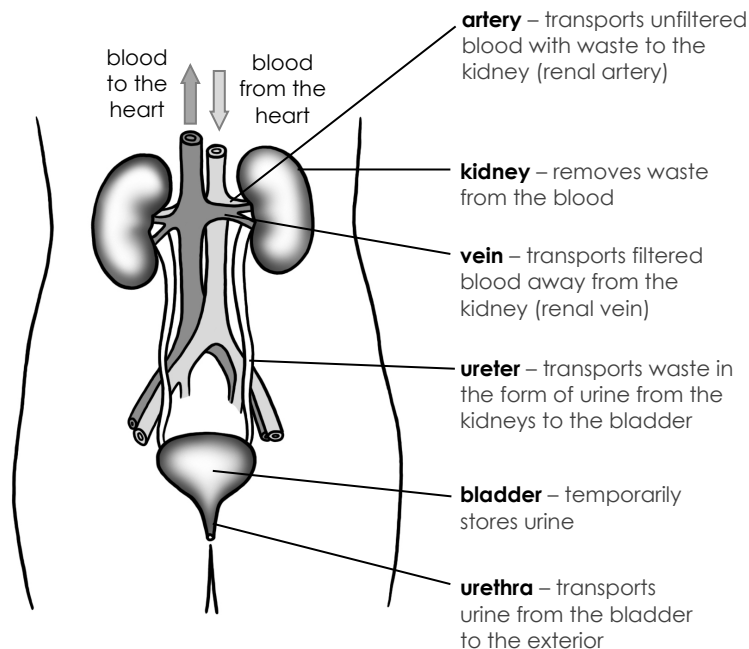
### NOTE

The filtered blood that leaves the kidneys is purified and has balanced levels of useful substances.



## MAIN COMPONENTS

The following **structures** play an important role in excretion: kidneys, ureters, bladder, urethra.



Excretory system in humans

## HEALTH ISSUES

The following **diseases** are associated with the excretory system:

### Kidney (Renal) Failure

- Renal failure is a state where the kidney is so damaged that it can no longer function.
- This can be due to an injury, complications after surgery, a drug overdose or the overuse of certain painkillers.
- Medical conditions like diabetes and high blood pressure can also cause kidney failure
- In renal failure, toxic waste products and excess water accumulate in the blood and may cause death.
- A person suffering from renal failure can be kept alive by dialysis or should otherwise undergo a kidney transplant.

**Dialysis** is a process whereby blood is artificially purified using a kidney machine.

The patient's blood is filtered through a dialysis machine (artificial kidney) and purified blood is returned to the patient's body.

Treatment varies from a few hours per week to daily dialysis.

### Bladder Infection (Cystitis)

- The urethra is open to the exterior, so it is easy for **bacteria** to enter and cause infection.
- The symptoms of bladder infections are lower abdominal pain, difficulty or burning urination, cloudy urine, and frequent urination.
- There may also be other symptoms of infection like **fever** and **nausea**.
- Bladder infections can be treated with **antibiotics**.
- Women are more likely to have bladder infections due to a shorter urethra which opens closer to the anus.

# 1 Kidney Stones

- Wastes and salts (calcium and uric acid) that form part of urine are dissolved in water.
- Solid crystals, known as kidney stones, form when these minerals do not dissolve properly due to insufficient water.
- Kidney stones occur more commonly in men and in people with obesity/high blood pressure/poor diet with low water intake.
- Large kidney stones can block the ureter, leading to severe pain in the side, lower abdomen and groin.
- Blood can occur in the urine due to damage to the urinary tubes.
- Other symptoms include: cloudy urine, difficulty urinating, nausea and vomiting.
- The kidney stones can be broken up by ultrasound waves and then excreted in the urine.
- Kidney stones that are too large are usually removed surgically.

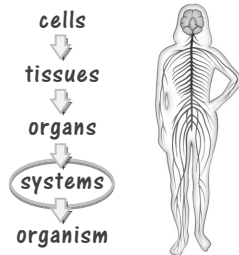
UNIT

7

## NERVOUS SYSTEM: OVERVIEW

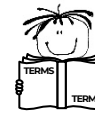
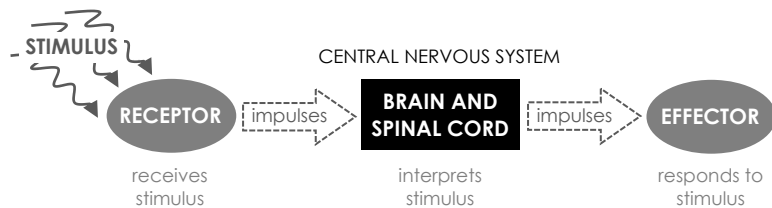
The nervous system enables survival by performing the following functions:

- **sensing** changes in our environment
- **interpreting** what these changes mean
- **responding** to the changes appropriately



**Nervous system**  
receives and responds to stimuli

### MAIN PROCESSES



**stimulus:** (plural: stimuli) a change in the environment that causes a response

**Senses** – receives stimuli and send impulses to the brain and spinal cord

The nervous system receives stimuli from the environment through our senses.

Sense	Organ	Stimulus
hearing	ear	sound
seeing	eye	light
touch	skin	mechanical
taste	taste bud	chemical
smell	olfactory organ in the nose	chemical

Although these are the main five senses, our nervous system senses many other stimuli, including balance and acceleration, temperature, pressure, pain and many chemical or physical changes that occur internally.

**NOTE**

Some animals have the ability to sense stimuli that humans cannot. Some fish and sharks can detect electric fields; many migratory birds can detect the Earth's magnetic field; certain snakes can detect an infra-red heat signature given off by nearby animals.

- Sense organs contain specialised cells to receive the stimuli called **receptors**.
- These receptors convert stimuli to **nerve impulses**.
- The nerve impulses are sent to the brain and/or spinal cord via **neurons** (nerve cells).



**Interpretation** – receives impulses from sense organs

- The brain makes sense of (interprets) the information received via impulses from the sense organs.
- It can associate meaning to the information received and provide understanding of the changes in the environment.

**Response** – sends impulses from the brain and spinal cord (central nervous system) to **effectors**

- The information received from the sense organs (**receptors**) via impulses may need a response.
- The brain or spinal cord sends impulses to the **effectors** (muscles or a gland).
- Some responses are automatic and very rapid, these are known as **reflexes**.

**effectors:** organs that respond to stimuli, e.g. muscles or glands



### EXAMPLE

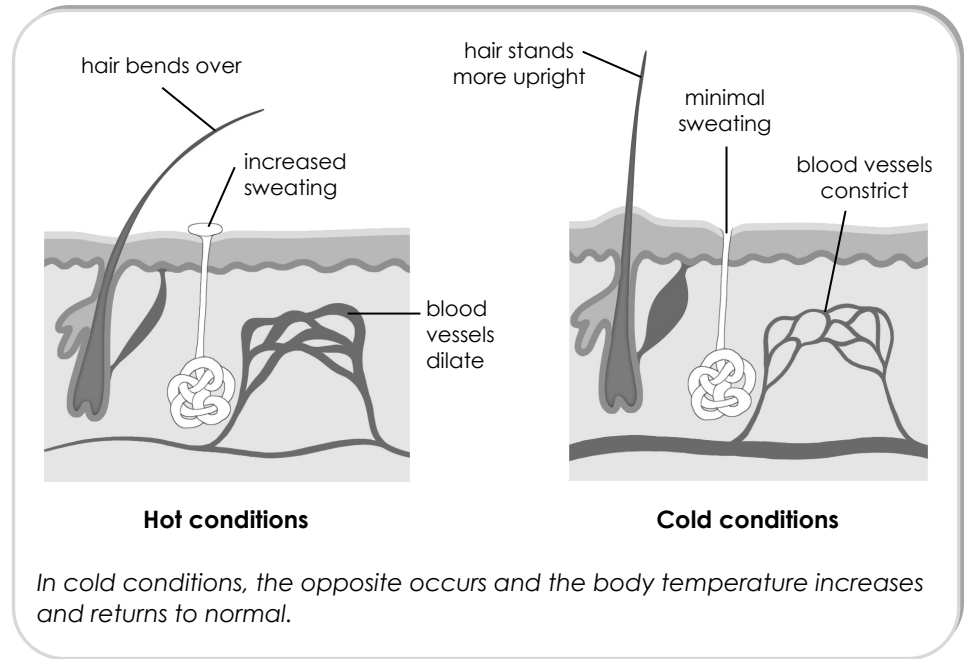
The nervous system controls the internal body temperature of animals that keep their temperature constant – known as **endotherms**.



**endotherms:** animals that are not affected by environmental temperature and maintain a constant body temperature, e.g. mammals

In hot conditions:

- The brain detects the temperature increase in the skin.
- The blood vessels in the skin dilate (widen) – heat is lost through radiation as more blood flows nearer to the surface of the skin.
- The sweat glands are stimulated to produce sweat and the body cools due to evaporation.
- The body temperature decreases and returns to normal.



## MAIN COMPONENTS

All parts of the nervous system consist of specialised nerve cells called **neurons**.

The main **structures** in the nervous system:

**Brain** – part of the central nervous system

- processes and **interprets** information from the sense organs
- co-ordinates the appropriate **response**

**Spinal Cord** – part of the central nervous system

- responsible for triggering **reflexes**
- transmits impulses from the **receptors** to the brain
- transmits impulses from the brain to the **effectors** (muscles/glands)



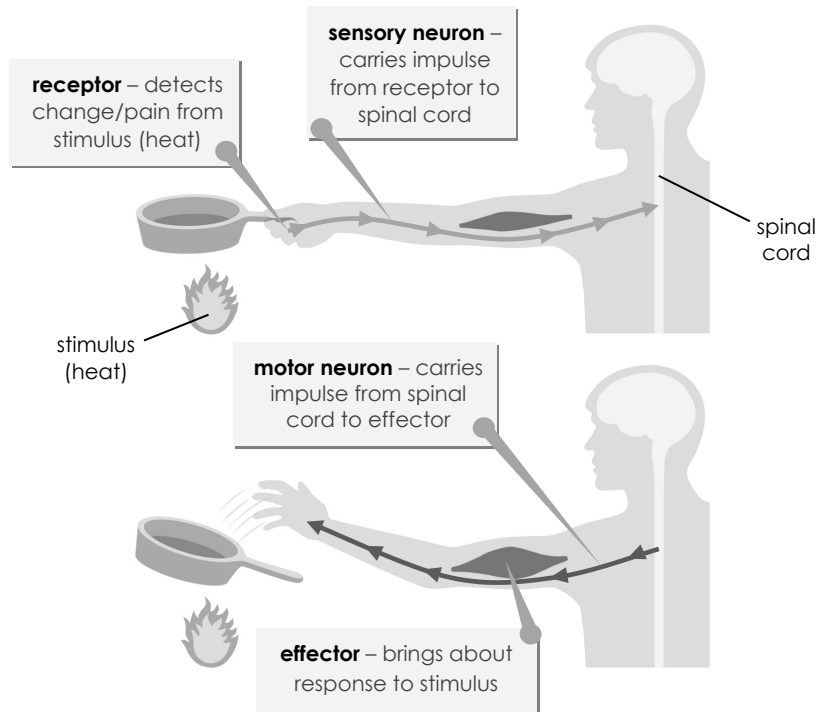
# 1 Nerve

- contains nerve cells/**neurons**
- transmits messages **via impulses** from the **receptors** in the sense organs to the spinal cord or brain
- transmits impulses from the spinal cord or brain to the appropriate **effectors** (muscles or glands)

## Sense Organs (Receptors)

- ear – hearing
- eye – sight
- skin – touch and temperature, pressure and pain
- tongue – taste
- nose – smell

The nerve impulse pathway is summarised in the diagram below showing a reflex action.



Pathway of nerve impulses in a reflex action

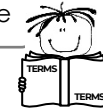
# HEALTH ISSUES

There are many **conditions** that affect different components of the nervous system. Some of these include:

## Deafness

- It includes partial or total loss of hearing.
- It is caused by damage or disease in the ear, brain or associated nerves.
- Treatment depends on the cause of deafness, but may include using hearing aids or cochlear implants.

**cochlea:** a part of the inner ear where sound is converted into a nerve impulse



## Blindness

- It involves the loss of sight.
- It is caused by damage or disease in the eye, brain or associated nerves.
- Treatment depends on the cause of blindness, but it would usually involve surgery, such as a cornea or lens transplant.

## Short-sightedness

- It is the inability to see distant objects clearly.
  - a person who is short sighted (has **myopia**) can only see nearby objects clearly
  - caused by an elongated eyeball or irregular shaped lens
- Treatment may include laser surgery, glasses or contact lenses.

**NOTE**

These conditions can also be genetic, i.e. passed from one generation to the next.



## MAIN PROCESSES

The terms involved in the main processes of reproduction are:

- **growth** – increase in size and number of cells
- **cell division** – multiplication of cells for growth
- **maturation** – development of male and female individuals to sexual maturity
- **copulation** – sexual intercourse
- **ejaculation** – release of liquid semen (containing sperm/male gametes) from penis



**semen:** the fluid released by various glands in the male reproductive system that contains sperm

- **ovulation** – release of female gamete (ovum/egg cell) from ovary
- **menstruation** – shedding of the uterus lining every 28 days
- **fertilisation** – fusion of gametes (ovum and sperm) to form a zygote (fertilised ovum)
- **implantation** – ball of cells sinks into lining of uterus (womb) in pregnancy

These terms are discussed in more detail in TOPIC 3, but are summarised in the flow diagram on the next page.



## Effects of Drugs and Alcohol on the Brain

- Drugs and alcohol affect the transmission of impulses from neuron (nerve cell) to neuron within the brain.
- **Stimulants** ('uppers') cause impulses to travel faster and excite the central nervous system.
  - increased alertness, heart rate and feelings of joy (a 'high')
  - highly addictive substances
  - e.g. nicotine, caffeine, cocaine, ecstasy
- **Depressants** ('downers') cause impulses to slow down.
  - causes sedation, decreased heart rate, relaxation and anaesthesia (numbness to pain)
  - highly addictive substances
  - e.g. alcohol, heroin, sleeping tablets

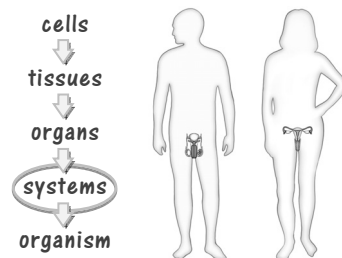
Most drugs create a false sense of well-being, and gradually destroy fragile nerve tissue which can cause permanent damage, e.g. memory loss, personality disorders or ultimately death over time.

### UNIT



## REPRODUCTIVE SYSTEM: OVERVIEW

The reproductive system produces sex cells (**gametes**) for fertilisation and to ensure the continuation of the species.



### Reproductive system

provides sex cells and support for offspring



### NOTE

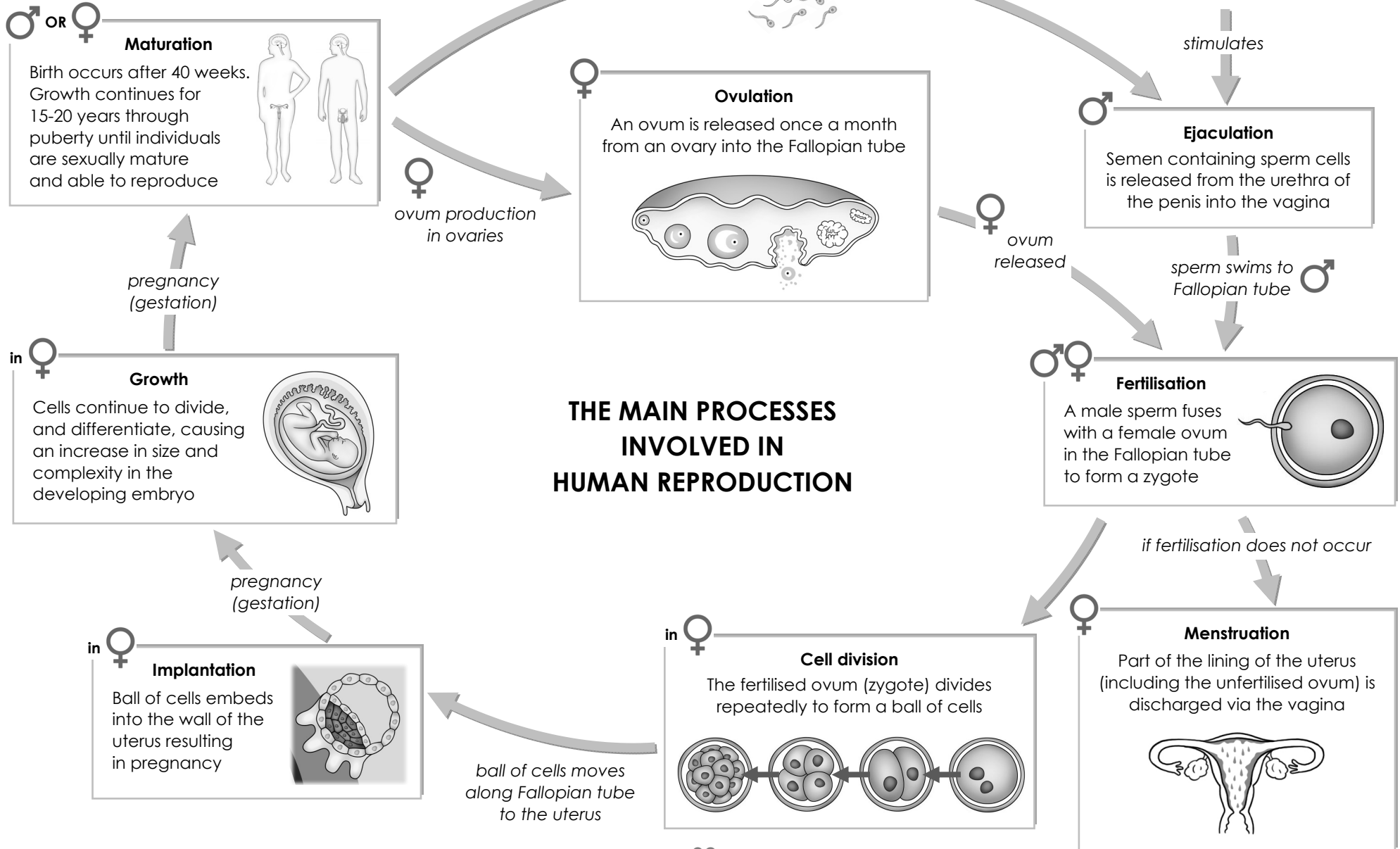
**Human Reproduction** is discussed in more detail in **TOPIC 3** on p. 35.



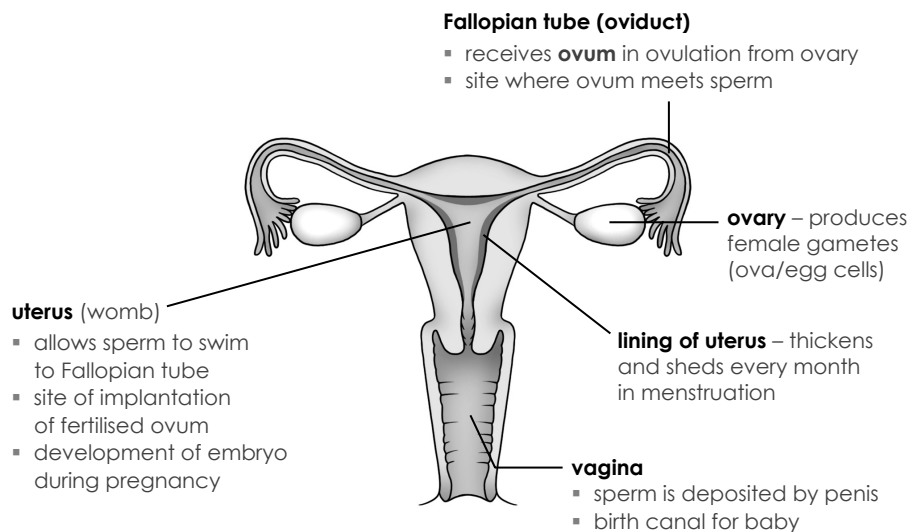
**NOTE**

Use the diagrams on p. 33 to understand the processes illustrated below. These processes will be discussed in more detail in TOPIC 3 on p. 35.

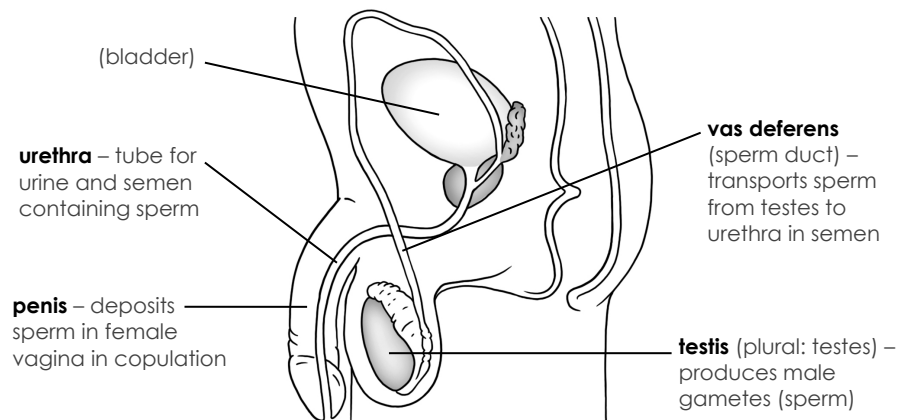
♂ = male    ♀ = female



## MAIN COMPONENTS



Front view of the female reproductive system



Side view of the male reproductive system

## HEALTH ISSUES

### Infertility

- It is the inability of a person to reproduce naturally.
- Infertility may be due to abnormalities in the male or in the female.

### Male infertility

- Males may be infertile due to a low sperm count, where there are too few healthy sperm cells.
- Some of the factors that decrease sperm counts in males include:
  - increased age
  - smoking
  - stress
  - poor diet
  - excessive exposure of testes to heat (e.g. bathing, sauna, using a laptop on the lap)
  - damage to the testes (e.g. diseases like mumps and malaria or activities like cycling)

### Female infertility

- Common causes of female infertility:
  - disruption to the menstrual cycle preventing ovulation or implantation
  - damage to the ovary, blocked Fallopian tubes or uterus (often caused by STDs)
  - hormonal imbalances during early pregnancy
- Treatment may include hormone supplements, medication and lifestyle changes.

**STDs:** sexually transmitted diseases that affect the reproductive system and other parts of the body

## 1 Foetal Alcohol Syndrome (FAS)

- Foetal alcohol syndrome is a condition that may occur in a baby when the mother drinks too much alcohol during pregnancy.
- Alcohol passes from the blood of the mother to the **foetus**, and affects development.
- Problems may include:
  - short stature
  - low birth weight
  - small head
  - poor coordination
  - low intelligence and learning disabilities
  - behavior problems
  - hearing or seeing difficulties



**foetus:** an embryo that has developed all the main tissues at about 8 weeks old

## Sexually Transmitted Diseases (STDs)

### NOTE

**STDs** are sometimes called **STIs** (sexually transmitted infections). An **STI** is a general term for all sexually transmitted infections that may or may not develop into a disease (**STD**).



- Sexually transmitted diseases (STDs) can affect the sex partners, foetus, and newborn infant.
- STDs are transmitted via semen/sperm, vaginal fluid, saliva or blood.
- STDs can be grouped into three categories according to their symptoms:

### Inflammatory diseases

STDs that produce inflammation of the **internal** parts of the sex organs.

- **Gonorrhoea** and **chlamydia** are the most common bacterial STDs that cause inflammation.



### NOTE

**Bacterial** infections are treated with **antibiotics**.  
**Viral** diseases may be treated with **antiviral drugs**.

- These diseases can be treated and cured with antibiotics, but they may not show symptoms.
- Women with these infections are often infertile due to damage to the reproductive organs.

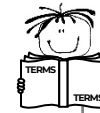
## Skin lesion causing diseases

STDs that produce lesions (growths) on the **external** sex organs (genitals).



**skin lesions:** abnormal growths on the skin, e.g. warts, blisters or open wounds

- **Herpes** is the most common viral disease in this category.
  - symptoms can be treated with antiviral drugs
  - these infections cannot be cured
- **Syphilis** is a bacterial infection and can lead to death.
  - it is curable with **antibiotics**
- **HPV** (human papilloma virus) is incurable and causes warts on the genitals.



**genitals:** the external structures of the sex organs

- it is the leading cause of cervical cancer in women

## Diseases that affect other organ systems

Viral diseases that affect organ systems other than those of the reproductive system.

- e.g. Hepatitis and HIV.
- Both diseases can be spread by the exchange of sexual fluids or blood.
- HIV may lead to AIDS.
- ARVs (anti-retroviral drugs) slow the progress of the disease, but do not cure it.
- Infectious individuals may appear symptom-free for years and thus pass on the disease unknowingly.

### NOTE

STDs are also discussed under **Contraception and Population Control** on p. 44.

