Unit 4: Maintaining The Internal Environment

Year 12 Biology ATAR // Mark Weldon

HOMEOSTASIS

▪ Organisms have structural features, behavioural responses and physiological mechanisms to help maintain a constant internal state.
▪ Organisms communicate constantly with their environment (external and internal).

DETECTING STIMULI

▪ The principles of communication include:
→ the production of a signal that contains information to be transferred;
→ the detection of the signal;
→ the transfer of the signal to the target;
→ a response to the signal by the target;
→ the 'switch off' of a signal once it has been responded to.
▪ Stimuli may be physical (e.g. light, heat) or chemical (e.g. hormones).
▪ External and internal receptors allow organisms to respond to stimuli.
▪ There are five main types of receptor: **chemoreceptors, mechanoreceptors, photoreceptors, thermoreceptors** and **pain receptors.**

EXTERORECEPTORS

exteroreceptors: receptors that are highly specialised to receive signals from the external environment
▪ Exteroreceptors work by receiving information and converting it to chemical signals that can be relayed between body cells.
▪ Exteroreceptors can be distributed:
→ evenly over the body (e.g. pain receptors);
→ in specialised areas (e.g. taste buds);
→ concentrated in organs (e.g. the eye).

INTERORECEPTORS

▪ Interoreceptors receive from within the body's internal environment.
→ An internal signal could be the increase in CO_2 levels or pH.
▪ The internal environment is created by interstitial fluid (bathes cells) and blood plasma.
▪ The internal environment is maintained within narrow limits for maximum cellular efficiency.

EXAMPLES OF EXTERORECEPTORS AND INTERORECEPTORS

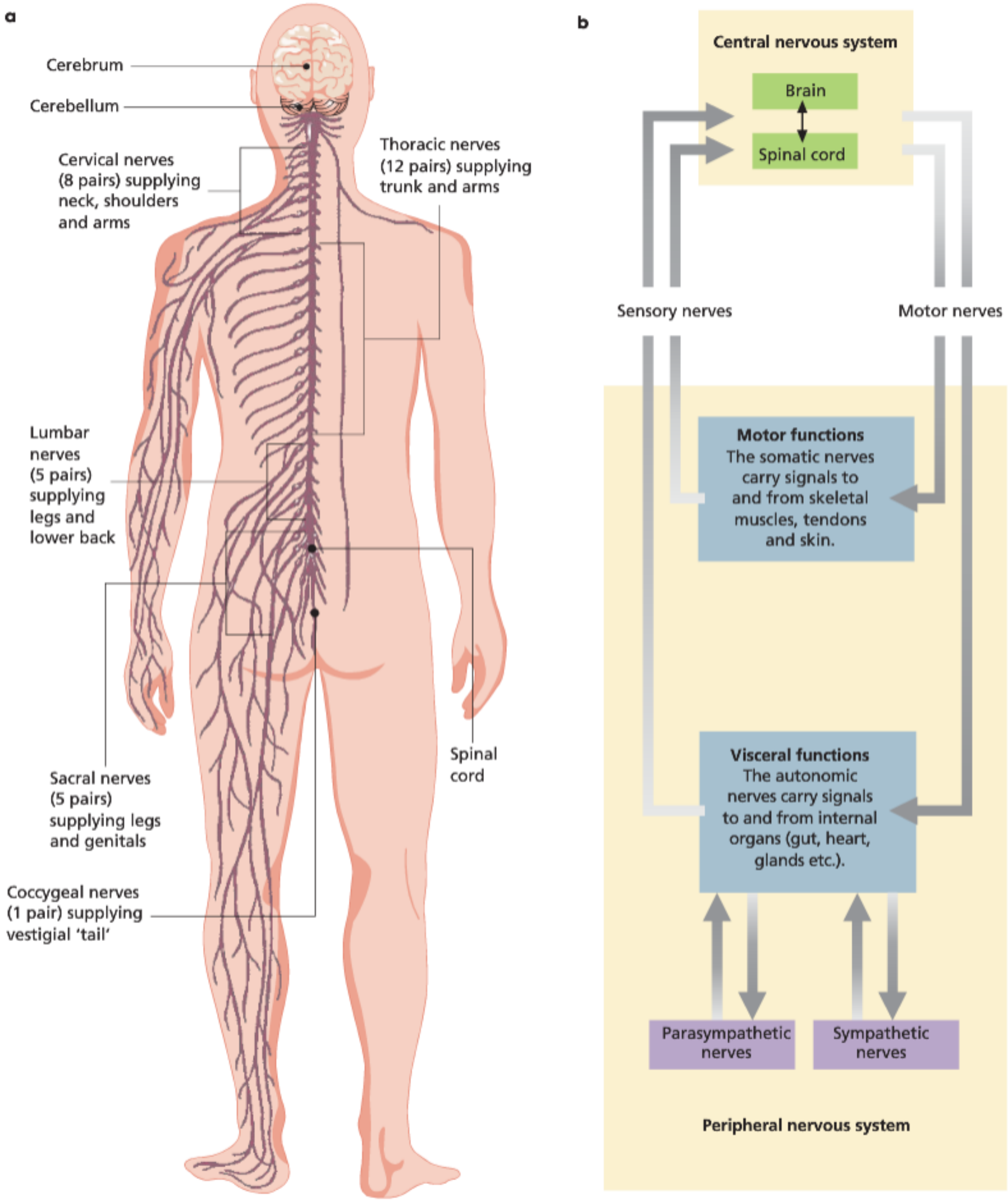
Receptor	Stimuli	Location
chemoreceptors	**exteroreceptors:** smell (olfactory receptors) or taste. **interoreceptors**: detection of oxygen and ion levels	nose, mouth aorta, carotid arteries.
mechanoreceptors	**exteroreceptors and interoreceptors:** pressure, touch, tension and sound vibrations.	ear, skin
photoreceptors	**exteroreceptors:** light	eyes and light-sensitive cells
thermoreceptors	**exteroreceptors:** external temperature variations **interoreceptors:** internal temperature variation	skin hypothalamus
pain receptors	**exteroreceptors and interoreceptors:** pain	free nerve endings in the skin

HOMEOSTASIS SYSTEMS

▪ The nervous and endocrine systems are responsible for monitoring changes and co-ordinating responses in complex organism.

NERVOUS SYSTEM

▪ The nervous system is comprised of the central nervous system (CNS) and the peripheral nervous system (PNS).
▪ The CNS is formed by the brain and spinal cord.
→ The CNS is responsible for processing, storing and co-ordinating information.
▪ The PNS is made up of all other neurons.
→ The PNS transmits information to and from the CNS.



NEURAL PATHWAYS

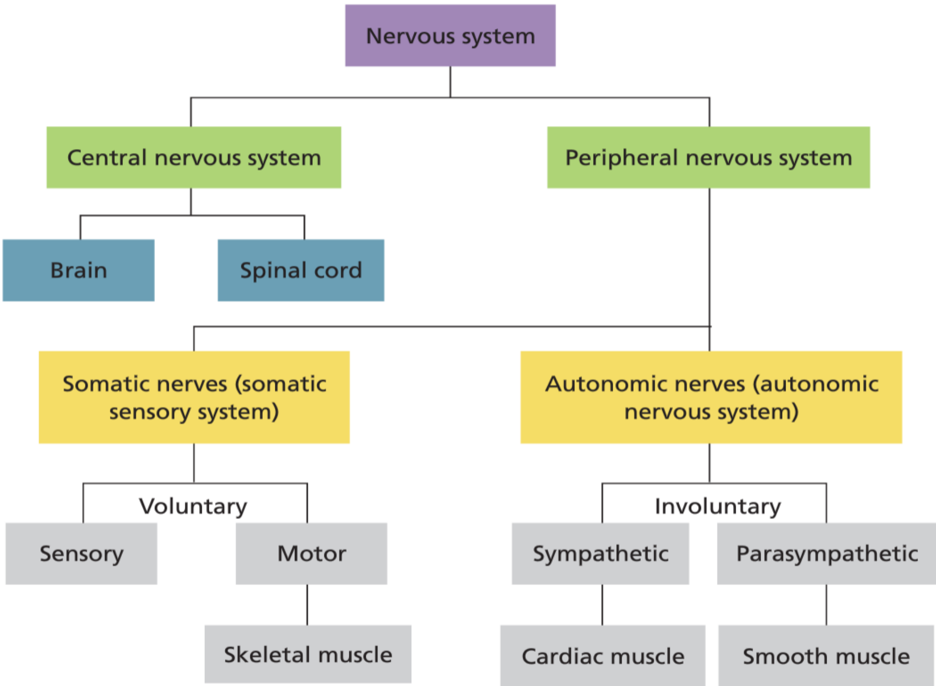
▪ Impulses follow sensory neurons from the source of stimulation via the PNS to the CNS.
▪ Impulses are then relayed (from sensory neurons) via interconnecting neurons to the appropriate motor neurons.
▪ Motor neurons relay the signal via the PNS to effectors (muscles/glands that respond to the stimuli).

NEURONS

▪ Neurons are the basic units of the nervous system.
▪ Neurons consist of fibres which contain a tubular extension called the **axon**.
→ The axon is enclosed in a fatty material called the **myelin sheath**.
▪ Myelin is composed of Schwann cells.
→ Schwann cells wrap around the fibre, leaving small nodes along the axon.
→ This assists in transmission; more myelin means faster conduction.
→ Oligodendrocytes create protecting nodes around the interconnecting tissues.

VOLUNTARY/INVOLUNTARY RESPONSES

▪ The nervous system is responsible for rapid responses to changes in the environment.
▪ Some responses are voluntary, others are involuntary.
→ Nerves involved in voluntary responses make up the **somatic system.**
→ Nerves involved in involuntary responses make up the **autonomic system.**
▪ Involuntary responses are only recognised when something goes wrong.



ENDOCRINE SYSTEM

▪ Some changes are slow and under control of hormones.
→ Not all stimuli require immediate response.
▪ **Hormones** are chemical substances (proteins, fatty and amino acids etc.) from the endocrine system.
▪ In vertebrates, they are secreted through **ductless glands** directly into the bloodstream.
▪ Hormones target and activate certain cells and organs, causing a response.
→ Cells must have specific receptors.

HORMONE EFFECTS

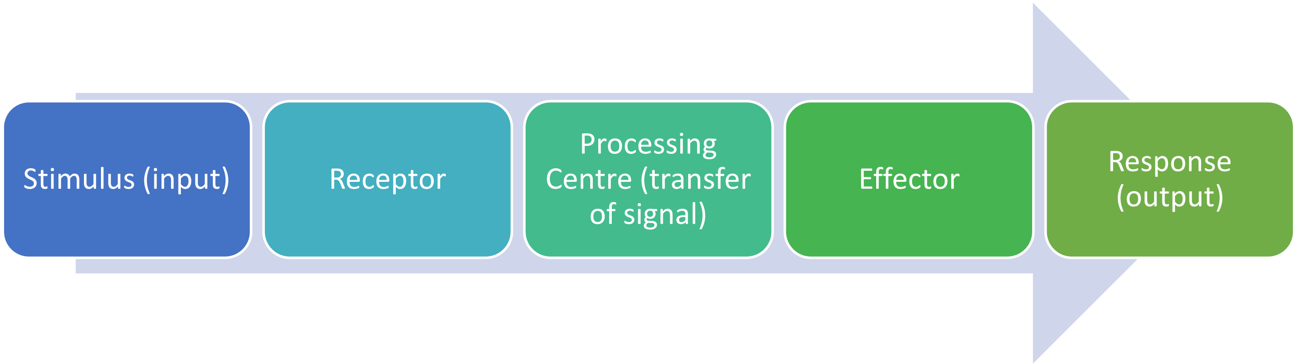
▪ Some are temporary (e.g. adrenaline), some are longer (e.g. development of a foetus).
▪ The co-ordination of activities is often connected to pituitary gland.
→ This produces many hormones that affect hormone production by other glands.
▪ In other animals:
→ Female ring doves coo to release hormones for egg development.
→ Light sensitive hormones called auxin is responsible for plant growth towards light to maximise their photosynthesis abilities.

IMPORTANCE OF RESPONSE

▪ Responding to signals is essential for the developmental processes, growth and reproduction of organisms and cells.
→ Failure in signalling pathways can lead to uncontrolled cell growth.
→ Failure to respond to apoptosis can lead to malformations.
→ Differentiation of stem cells during reproduction occurs from internal and external responses.
▪ Homeostasis requires the response of signals.
▪ The ability to keep substance concentrations equal, the movement of materials and the activities of enzymes require responses to correct these changes back to normal.
→ This is essential as biochemical process can be disrupted or cells can be killed.
▪ Responding to signals is essential to surviving challenges in the external environment.
→ Avoiding injury and death (e.g. predation or falling objects) is crucial to an organism's survival.

THE PRINCIPLE OF FEEDBACK

▪ Organisms have narrow ranges for internal temperature and fluid concentrations.
→ Minor fluctuations always occur (e.g. disease, trauma).
→ Disturbances must be controlled quickly for cells to function effectively.
▪ Signals about disturbances are fed to a control centre.
→ The centre interprets and co-ordinates specific responses that counteract or reinforce disturbances.
→ These processes are called feedback mechanisms.
▪ Feedback mechanisms are triggered when a stimulus is detected by a receptor, which is then processes and conveyed to an effector, carrying a response.



CONTROLLING RESPONSE

▪ Once signals are responded to, it must be switched off (otherwise it wastes energy/cells are damaged).
▪ To control a response, a cell or organism can:
→ disrupt the signal pathway;
→ remove the original stimulus, or;
→ respond in a way that alters the original signal (ie. feedback).

TYPES OF FEEDBACK

▪ Negative feedback refer to mechanisms that counteract a stimulus.
→ Negative feedback is important to restore the internal environment to a constant set of conditions.
EX: Eating chocolate leads to increase blood glucose, the body responds by removing the glucose from the blood and converting it to glycogen.
▪ Positive feedback refers to mechanisms that reinforce the original stimulus.
EX: As thyroxin rises in tadpoles, positive feedback allows for a rise in thyroxin concentration allowing metamorphosis from tadpole to frog.
▪ Positive feedback can be harmful.
EX: Increased temperature during fever can lead to a higher set point for temperature which can lead to heatstroke.

TOLERANCE RANGE

▪ A **tolerance range** is a set range in which difference levels of materials, pressure and temperature can be tolerated.
▪ Homeostasis maintains levels within an optimum range.
▪ If homeostasis fails, organisms can fall into a state of psychological stress.

METABOLIC ACTIVITY

▪ **Metabolism** is the sum of chemical reactions that occur in an organism to maintain life.
→ Most reactions require enzymes (which function at particular pH/temperatures).
▪ Metabolic activity creates internal body heat; increased activity results in increased temperature.
▪ These aspects are all connected: an increase in CO_2 → decrease in pH → decrease in enzyme function → decrease in metabolism → decrease in internal body temperature.
▪ Physiological processes aid in the regulation the body during exercise.
→ Increase in breathing rate to remove CO_2.
→ Thermoreceptors signal for sweat glands to operate to lower body temperatures.
▪ Structural features and behaviour also regulate the body during exercise.
→ Removing clothing or moving into shade are behaviours seen when individuals notice an increase in body temperature.

THERMOREGULATION

▪ Different animals have different internal temperatures.
▪ These temperatures are where their enzymes work most efficiently (ie. optimum temperature).
→ If internal temperatures rise too much, enzymes denature and metabolic processes fail causing **hyperthermia**.
→ If internal temperatures fall, enzyme function slows significantly causing **hypothermia**.

ENDOTHERMS

▪ Endotherms retain heat generated by metabolic activity in their bodies.
→ As they are usually **homoeothermic**, endotherms usually can maintain a relatively constant body temperature.
→ Exceptions include fast-swimming fish (such as the yellow-finned tuna) and butterflies – these species are **poikilothermic endotherms**.

ECTOTHERMS

▪ Ectotherms depend on absorbing heat from the external environment.
→ As they are usually **poikilothermic**, ectotherms cannot control their internal temperature which fluctuated with their surroundings.
→ Exceptions exist, much like endotherms, which include desert lizards and tropical marine invertebrates (such as the blood lobster) – these species are **homoeothermic ectotherms**.

	Homoeothermic	**Poikilothermic**
Endotherms	Koalas, emus, humans, wombats and kookaburras.	Yellow-finned tuna, bees, butterflies and hibernating animals.
Ectotherms	Desert lizards and tropical marine invertebrates (cleaner shrimp etc.)	Snakes, lizards, frogs and toads, invertebrates and fish.

STRATEGIES AND ADAPTATIONS FOR THERMOREGULATION

▪ Heat transfer depends on the temperature gradient between the internal and the external environment.
▪ The purpose of thermoregulation is to find heat balance (balance between heat loss and heat gain).
▪ This usually involves the interaction of an organism's physiology and their behaviour.

HEAT LOSS AND HEAT GAIN

▪ An organism may gain or lose heat in a combination of four ways:

→ **conduction**: the transfer of heat from a hotter object to cooler object by direct contact.

→ **convection**: the transfer of heat when hot air/water rises and is replaced by cooler aid/water.

→ **evaporation**: when water/sweat turn to vapour, cooling the skin.

→ **radiation**: when heat is transferred from object by infrared waves.

STAYING COOL IN THE HEAT

▪ Endothermic homeotherms (those that maintain internal body temperatures and retain heat from metabolic activity) need to be able to reduce heat gain and increase heat loss.

ADAPTATIONS FOR HEAT LOSS

Adaptation	Response	Effect
physiological	vasodilation	arterioles widen to increase blood flow to the skin where heat can evaporate
	sweating	water evaporation increases cooling from the skin
	metabolic processes stay steady until body's cooling mechanisms fail.	metabolism produces internal body heat
behavioural	shelter from high temperatures	reduced contact with higher temperatures can reduce temperature gain
	lick wrists where blood vessels are dense	increases evaporation from the surface and cools the surface, cooling the blood
	submerge in water	reduces body temperature by direct contact with cooler water
	lay/spread out	increased surface area increases heat loss
	moulting	reduced hair reduces the ability to hold heat, reducing heat gain
structural	smaller animals live in warmer climates	increased surface area to volume ratio for heat loss.
	larger ears	increases surface area
	light colour hair/fur	reflects light to reduce heat gain

ADAPTATIONS FOR HEAT GAIN

Adaptation	Response	Effect
physiological	vasoconstriction	arterioles constrict to limit blood flow to extremities (ie. hands and feet)
	piloerection	arrector pili muscles contract, raising hair in order to trap layer of air to act as insulator
	counter-current heat exchange	blood in arteries to foot/fins, warms blood returning in veins (penguins)
behavioural	huddling	decreases overall surface area exposed to elements (penguins)
	nests not usually made	young must huddle against parents which decreased SA:V ratio for heat loss
	migration	movement to different climates that are adequate for survival
structural	feathers, fur and fat	acts as an insulating layer
	larger animals in cool environments	decreases SA:V ratio for heat loss
	small ears	minimise SA for heat loss

HIBERATION AND AESTIVATION

▪ In very cold conditions, an increase in metabolic rate may be insufficient to maintain body temperature within tolerance limits.
▪ During hibernation, the metabolic rate falls to a level that just sustains life.
▪ In very dry conditions, **aestivation** occurs much like hibernation.
EX: Snails retreat into their shell and seal off.

UPPER AND LOWER CRITICAL LIMITS

▪ A lower critical limit is a temperature where metabolic rate rises, increasing heat output.
▪ An upper critical limit is a temperature where a body's cooling mechanisms fail and metabolic rate increases with external temperature.

WATER

▪ Water is a universal solvent and is essential to life.
▪ Most salts and minerals are broken into ions by water, creating aqueous solutions.
▪ Metabolic reactions occur in solutions composed of water.

OSMOREGULATION

▪ Water balance requires continuous homeostatic control, or **osmoregulation**.
▪ When supply does not meet demand, the concentration of solute versus the concentration of solvent is tissue fluids becomes difficult to regulate.
▪ Physiological functions are then affected:
→ A loss in blood volume leads to pressure drops.
→ Wastes are not excreted efficiently.
→ Enzyme function is affect.
→ Dehydration can lead to death or the collapse of shoot systems (plants).

KIDNEYS

▪ Kidneys are important for homeostasis and osmoregulation.
▪ Their osmoregulatory function includes:
→ the removal of nitrogenous wastes;
→ the regulation of water concentration in the blood;
→ the maintaining of ion levels in the blood.

NITROGENOUS WASTES

▪ Nitrogenous wastes are forms via deamination (the removal of an amino group from an amino acid).
▪ Ammonia (and its conversion, **urea**) are toxic and affects cell pH.

freshwater fish	lots of dilute urine with ammonia is excreted quickly and continuously to prevent build up.
marine fish and terrestrial animals	convert ammonia to urea and is released as urine (small amount)
reptiles and birds	produce uric acid, the least toxic form of nitrogenous waste with very little water.

KIDNEY OSMOREGULATION

▪ Kidney osmoregulation is controlled by an antidiuretic hormone (**vasopressin**).
→ Vasopressin is secreted from neurosensory cells in hypothalamus when osmoregulators detect increase in blood solutes.
▪ Osmoregulation increases the permeability of **distal tubule** (kidney).

→ As water concentration increases in blood plasma, negative feedback decreases release of vasopressin.

OSMOREGULATORS AND OSMOCONFORMERS
▪ Different organisms have various ways to maintain water balance.
▪ Osmoregulators regulate osmotic concentration to be **higher or lower than the external environment**.
▪ Osmoconformers allow osmotic concentration to be **equal to external environments**.

STRUCTURAL FEATURES OF OSMOREGULATORS
▪ Osmoregulators have a waterproof/impermeable outer layer to reduce water loss.
→ Scales, hair, feathers and the epidermis are examples of this outer layer.
→ Longer loops of Henle.
▪ Animals are osmoregulators and have adaptations to aid in osmoregulation.
EX: High densities of sweat pores in highly exposed areas.
▪ Plants are also osmoregulators, however water is constantly lost through the stomata. Therefore, structural adaptations include:
→ thick waxy cuticle on the leaf surface;
→ reduced numbers of stomata on the top of the leaf and increased numbers on the bottom of the leaf;
→ sunken stomata;
→ hairs on leaves;
→ cylindrical or rolled leaves.

PHYSIOLOGICAL PROCESSES OF OSMOREGULATORS
▪ **Osmoregulators** have highly specialised mechanisms for regulating internal water and solute concentrations, despite concentration changes in the external environment.
▪ These are some examples of physiological processes that help in osmoregulation:
→ reabsorption of water from kidney;
→ excretion of nitrogenous wastes as urea or uric acid;
→ slower production of urine;
→ antidiuretic hormone (vasopressin);
→ metabolising fat to produce water.

BEHAVOURAL ADAPTATIONS OF OSMOREGULATORS
▪ Examples of behaviours of osmoregulators include:
→ burrowing;
→ hibernating;
→ **aestivation** (the prolonged dormancy of an insect, fish or amphibian during dry periods).

AQUATIC ORGANISMS
▪ Marine organisms have body fluids that tend to be **hypotonic**.
→ Body fluids have **lower** solute concentration than the external environment.
▪ Freshwater organisms have body fluids that tend to be **hypertonic**.
→ Body fluids have **higher** solute concentration than the external environment.

OSMOCONFORMERS
▪ Osmoconformers include most marine invertebrates.
▪ Interstitial fluid concentration fluctuates to match the external environment.
▪ Fluids are said to be **isotonic** (ie. the same concentration).
▪ Organisms, known as **euryhaline species**, can tolerate fluctuations in salinity, (found in **estuaries**).

DISEASES
▪ A **disease** is any condition that interferes with how an organism functions.
▪ **Infectious** diseases are caused by invasion by a pathogen and can be transmitted.
▪ **Endemic** diseases are common in populations, but in low levels.
▪ **Epidemics** occur when there is a considerable increase in cases; **pandemics** occur when epidemics spread across multiple continents.
▪ An **outbreak** occurs when there is a sudden increase in incidence.
▪ An infected organism is known as the **host**.
▪ An infectious agent/organism that causes disease is called a **pathogen**.
→ Pathogens include: viruses, bacteria, fungi, protists and **parasites**.
▪ **Transmission** refers to the passing of disease from an infected host to another individual.
▪ Pathogens have a variety of adaptations that enable transmission from host to host.
▪ Easily transmitted diseases are **contagious**.

NON-INFECTIOUS DISEASES
▪ Non-infectious diseases are not caused by pathogens.
▪ Non-infectious diseases are not communicable (transmissible).
EX: Nutritional diseases (such as obesity), genetic diseases (such as haemophilia) and autoimmune disease (such as multiple sclerosis).

THE NATURE OF DISEASE
▪ Most microorganisms are not pathogenic.
▪ Microorganisms are pathogenic if:
→ they stick to or invade the cell;
→ produce toxins;
→ copes with or avoids the immune system.

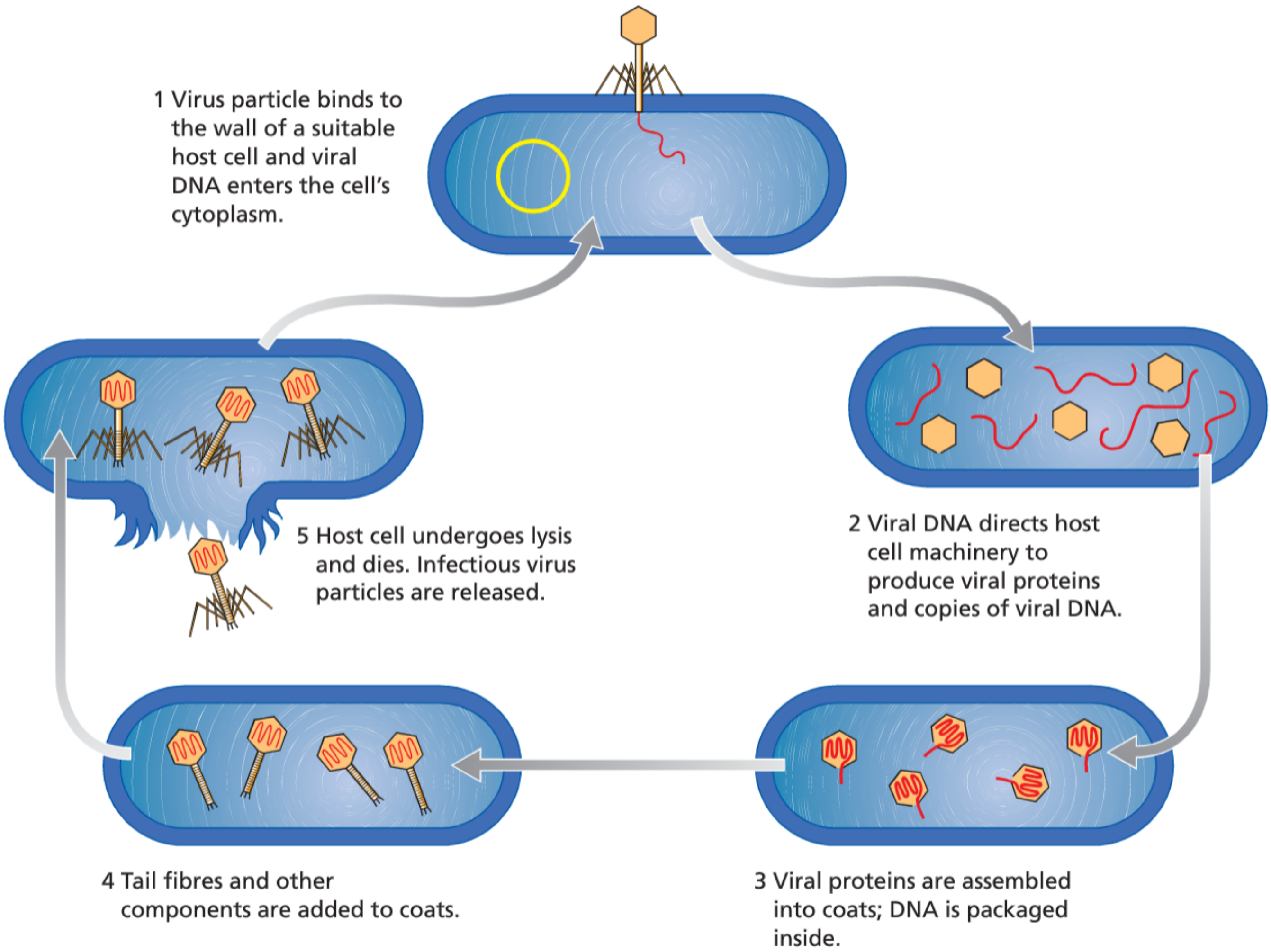
VARIATIONS IN PATHOGENS
▪ Pathogens differ in their **pathogenicity** (disease-causing ability).
▪ The intensity of a pathogen's effect is called it **virulence**.

SYMPTOMS
▪ Symptoms are the effects of a pathogen on the host.
▪ Symptoms are usually characteristics of the disease.
→ They can be used to diagnose the pathogen.

INCUBATION PERIOD
▪ Symptoms do not appear immediately.
▪ An incubation period refers to the time between infection and the onset of symptoms.
▪ This 'time lag' occurs for a number of reasons:
→ pathogens may need to divide;
→ may take time to reach target tissue;
→ toxins take time to accumulate.
▪ Disease is often contagious before symptoms occur.
→ incubation periods may be an adaptation by the pathogen (before symptoms occur).

VIRUSES
▪ A **virus** is a non-cellular agent composed of a protein coat and nucleic acid (DNA/RNA, not both).
▪ A virus infects an organism when it injects its nucleic acid into a host cell.
→ Viral nucleic acids then direct the host cell machinery to produce viral proteins and viral DNA copies.

→ These are then assembled into new viruses and are emitted during cell **lysis** (process of cell bursting).



VIRAL DISEASES

▪ All viruses cause disease.
▪ Viruses rely of the host cell to complete its life cycle.
▪ A virus cannot function outside of the host cell and is, therefore, called an **obligate** parasite.
→ This trait poses limitations in viral research.

VIRAL PHASES

▪ Some viruses do not cause host cells to make copies immediately.
▪ Instead they enter two phases, the **lysogenic phase** and the **lytic phase**.
▪ During the lysogenic phase:
→ viral nucleic acid is integrated with the host's chromosome;
→ viruses replicate with the host cell, remaining dormant (avoiding detection by defence mechanisms);
▪ The only way to remove the virus is to kill the host cell.
▪ The lytic phase is usually entered due to environmental factors.
→ The virus exits the host's genome and carries on with assembling new viruses.

VIRUS SPECIFICITY AND SUSCEPTABILITY

▪ Each virus is highly specific to the host cell/organism it can infect.
▪ Virus specificity is usually defined by the receptors in the host cell.
EX: An adenovirus specifically infects lung epithelial cells (causing the common cold) because it is able to recognise and bind to receptors only expressed on lung epithelium.
▪ All organisms are susceptible to viruses.

BACTERIA

▪ Bacteria are a cellular agent, only a small number cause disease (ie. most are not pathogenic).

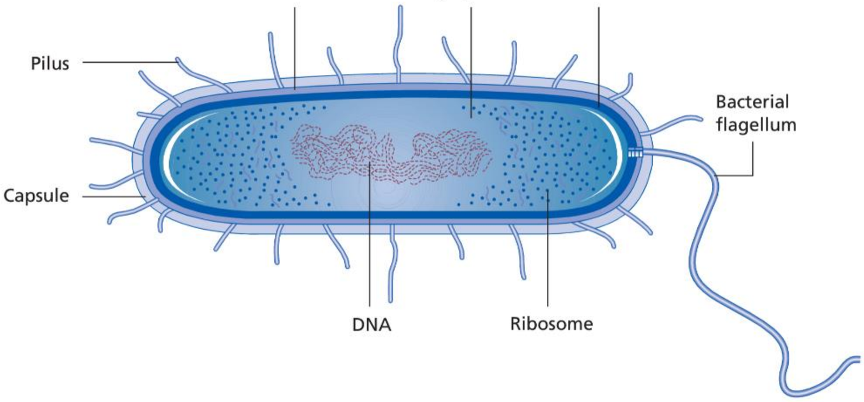
▪ Bacteria, as they are prokaryotes, have no-membrane bound organelles or nucleus, but do possess ribosomes and a single circular chromosome.

▪ Bacteria can survive in a tougher, dormant form called an endospore which are resistant to extreme temperatures and chemicals.

→ This adaptation helps in dispersal and resistance.

▪ A slimy **bacterial capsule** is an adaptation helpful in sticking to surfaces.

▪ Some bacteria possess flagellum which help movement.



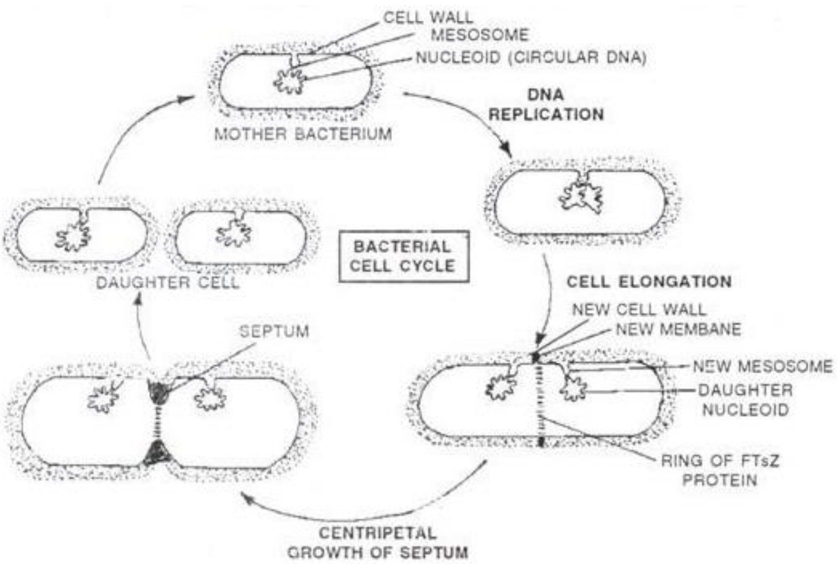
▪ Bacteria can reproduce by binary fission or by budding off spores.

▪ This allows bacteria to reproduce very rapidly in favourable conditions.

BACTERIAL CLASSIFICATION AND INDENTIFICATION

▪ Bacteria can be classified by their shape, cluster or strain.

shape	▪ coccus (spherical) ▪ bacillus (rod) ▪ spirilli (spiral) ▪ vibrio (comma)
cluster	▪ diplococci (two) ▪ streptococci (chains) ▪ staphylococcus (clusters)
strain	▪ gram positive (purple) ▪ gram negative (pink)



CAUSES OF BACTERIAL DISEASE

▪ Bacteria can be transmitted via direct contact, in food and water, and in droplets of moisture in the air.
▪ Once inside the host, bacteria divide rapidly.
▪ Some bacteria damage the host tissues directly, or release toxins, whilst others interfere with the immune system.

FUNGI

▪ Fungi are eukaryotes that reproduce using spores.
▪ Cell walls are made of chitin.
▪ As with bacteria, not all fungi are pathogenic.

EXTERNAL FUNGAL DISEASES

▪ Most fungal diseases in animals are external.
→ These diseases irritate or inflame the skin.
▪ As they grow on the skin, fungi produce spores.
→ Infected skin flakes off, carrying spores with it.
→ If these spores come into contact with damage skin, they may cause new infections.
▪ Spores are long-lived; an adaptation that improves their transmission.

INTERNAL FUNGAL DISEASES

▪ Internal fungal disease is rare in animals.
▪ These diseases are usually harmless unless the immune system is weak.

PROTISTS

▪ Protists are unicellular, eukaryotic organisms.
▪ Protists are able to reproduce asexually and sexually.
▪ From 6500 species, less than 24 species cause disease in humans but infect millions.
▪ No effective treatments exist from diseases caused by pathogenic protists.

PATHOGENIC FACTORS AFFECTING DISEASE TRANSMISSION

▪ Pathogenic factors influencing the ability of a pathogen to spread include:
→ the mechanism of transmission;
→ the method of transmission (some climate/geographical areas may restrict the spread of disease);
→ the mode of transmission (particular groups can be more susceptible);
EX: those sharing syringes/needles are more susceptible to Hepatitis C.
→ a pathogen's **infectivity** (ability to spread) and **natural history** (course diseases follow if untreated);
→ the growth of a pathogen in individuals.

ENVIRONEMTAL FACTORS AFFECTING DISEASE TRANSMISSION

▪ **Infrastructure** and **climate** affect the spread of disease.
▪ Some diseases are well adapted to certain environments:
→ dengue fever is prone to transmission in urban environments as mosquitoes (*Aedes aegypti*) are well adapted to living and reproducing in water tanks/buckets.
▪ Increases in temperature and changes in rainfall are likely to result in the spread of disease.
▪ The displacement of populations or the breakdown of usual sanitation from natural catastrophes are a significant influence in the spread of disease.

HOST FACTORS AFFECTING DISEASE TRANSMISSION

▪ Risk of exposure can be linked with age, sex or socioeconomic status.
→ the elderly, poor and chronically ill are more susceptible because of weak immunity or health care

▪ The introduction of a pathogen into previously unexposed populations increase the impact of disease.
▪ Population density influences disease spread; large populations in close proximity are more susceptible to smaller, less dense populations.
→ the movement of these populations allow disease to spread across large areas (ie. when isolated populations come into contact with another).

MODES OF TRANSMISSION
▪ Transmission and spread of disease is facilitated by regional and global movement of organisms.
▪ Different pathogens have different modes of transmission.
▪ Pathogens need to escape from one host and enter another.
▪ Many pathogens do not survive long outside of a host.

DIRECT TRANSMISSION
▪ Many pathogens have adaptations to ensure they are transmitted from one host to another when the skin of the two hosts come into direct contact.
▪ This usually involves symptoms on the skin:
→ pathogens form fluid-filled lesions on the skin (prompting scratching to spread the infection to new areas or a new host);
→ asymptomatic shedding of the virus can occur (before symptoms occur, unaware of contagiousness).
▪ **Zoonotic** infections are naturally transmitted between vertebrate animals and humans.

TRANSMISSION VIA BODILY FLUIDS
▪ Body fluids are any liquids that comes from inside the body.
▪ A pathogen must survive outside the body to be transmissible via bodily fluids.
▪ A variety of pathogens can be spread through sexual contact (ie. HIV, hepatitis B, HPV).

FOODBORNE TRANSMISSION
▪ Pathogens found on food materials gain easy access into the body via the gastrointestinal (GI) tract.
▪ Pathogens are spread to food from the faces of an infected person; across hand contamination is common.
▪ Bacteria must be able to reproduce outside the host.
▪ **Temperature danger zone** (5–60^{O}C) is where bacteria can grow and reproduce.

WATERBORNE TRANSMISSION
▪ Waterborne diseases are found in contaminated waters.
▪ Faecal-oral route of transmission is common in such diseases.
▪ Water can be disinfected by irradiation, with chemicals (such as chlorine) and sanitation systems.

AIRBORNE TRANSMISSION
▪ Airborne pathogens are found in small droplets of water.
▪ Airborne disease, as suggested in the name, is spread by air not by person-to-person.
▪ This mode of transmission can occur from nasal or throat excretions.

VECTORS
▪ Vectors are living organisms that transmit pathogens.
→ Examples of vectors include mosquitoes, ticks, fleas and lice.
▪ The pathogen may be dependent on the vector for the completion of its life cycle.
▪ Using a vector is an adaptation for transmission:
→ the pathogen may not otherwise come into contact with a new host;
→ a vector may enable a pathogen to penetrate the outer defences of the host.

OUTLINE OF MAJOR PATHOGENS

▪ tuberculosis (mycobacterium tuberculosis) ⟶ bacterial pathogen
▪ tetanus (clostridium tetani) ⟶ bacterial pathogen
▪ crown gall (agrobacterium tumefaciens) ⟶ bacterial pathogen
▪ amphibian chytrid fungal disease (batrachytrium dendrobatidis) ⟶ fungal pathogen
▪ malaria (cause by protists: plasmodium falciparum, plasmodium virax) ⟶ protistic pathogen
▪ jarrah dieback (phytophthora cinnamomi) ⟶ protist plant
▪ influenza (human influenza a + b) ⟶ viral inflection
▪ ross river virus (cause by alphavirus) ⟶ viral inflection
▪ viral disease of honeybees (deformed wing virus) ⟶ virus
▪ bat lyssavirus (zoonotic virus) ⟶ virus

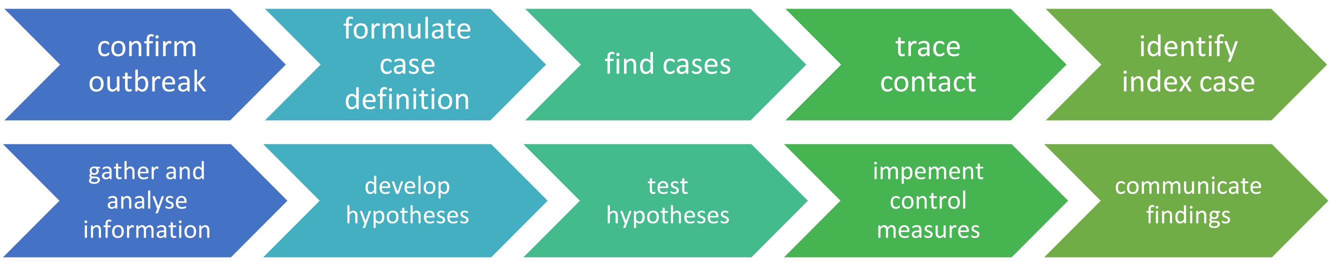
PREVENTING THE SPREAD OF DISEASE

▪ Management strategies used to control the spread of disease include: quarantine, immunisation, disruption of a pathogen's life cycle, medication and physical preventative measures.
▪ **Hand-washing** reduces infection rates, prevents contraction and prevents the spread of disease, especially diseases that are spread by direct contact.
⟶ **nosocomial infections** (infections spread by healthcare workers) are extremely serious in their morbidity and mortality, therefore, hand-washing is an effective strategy.
▪ **Immunisation** is effective, substantially reducing the spread of disease:
⟶ children in Australia are routinely vaccinated against disease (e.g. tetanus, polio and Hepatitis B);
⟶ eradication of disease can occur (e.g. smallpox).
▪ **Herd immunity** can occur when disease spread cannot occur when a large enough proportion is immune to a disease.
⟶ those with health conditions against immunisations rely on herd immunity for protection from disease
▪ **Anti-vaccinators** object immunisation of children with varying reasons:
⟶ false reports outlined that measles vaccines were linked to autism, therefore vaccination rates dropped substantially (scientific evidence disproves the link);
⟶ vaccinations can lead to severe reactions (this is rare, however).
▪ **Quarantine** stops individuals carrying a disease from entering healthy populations:
⟶ individuals are stopped from entering until the incubation period has passed;
⟶ used to prevent spread of all pathogens.

MONITORING DISEASE ACTIVITY

▪ In order to define and control disease outbreaks, public health authorities need to know when/where particular infections are occurring.
▪ Disease is actively and globally monitored by the World Health Organisation (WHO).
▪ In Australia, a list of 70 **notifiable diseases** must be reported and notified of diagnosis.
▪ There are limitations of collecting data: some individuals don't see care or get diagnosed properly.

MANAGING AN OUTBREAK



PREDICTING DISEASE SPREAD
▪ Mathematic models can predict the spread of disease and are important in controlling outbreaks.
▪ For a model to have good predictability, it needs to:
Reflect the complexity of the pathogen
Consider the host, pathogen and environmental interrelationships

EPIDEMIOLOGY
▪ Epidemiology is the branch of medicine that deals with the distribution, incidence and control of disease.
▪ Though there are improvements in prevention and treatment, infectious diseases are still a major cause of death globally.