Edith Cowan University

2021 ATAR Revision Seminar

12 ATAR Biology
ECU Revision Seminar
Unit 4 Summary Book

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ATAR Biology

Curriculum Dot points

Examination and study tips

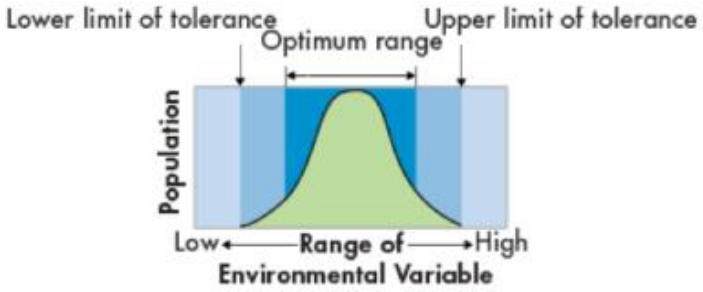
Revision notes Examination questions

Examination marker comments

Homeostasis: the process by which the body maintains a relatively constant internal environment within tolerance limits.

Tolerance Limits

- Tolerance Range: a set range in which an organism can tolerate different levels of organic and inorganic materials, pressure and temperature.
- Homeostasis maintains the set range within the **optimum range.**
- When homeostasis fails to do this the organism will go into **physiological stress.**

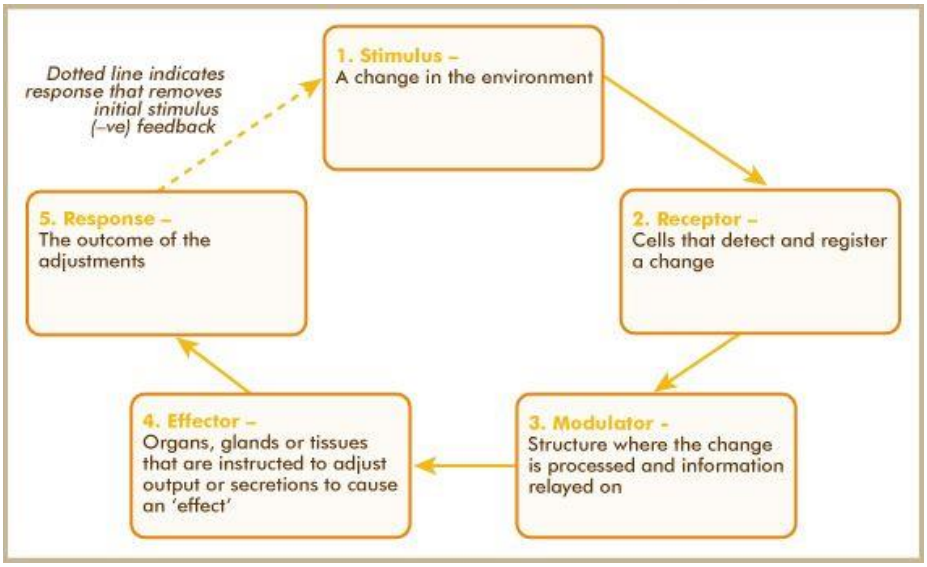


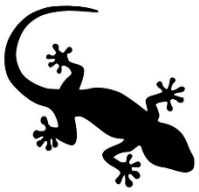
Organisms communicate constantly with their environment, internal and external.
The principles of communication involve:

- **Production** of a signal that contains information to be transferred
- **Detection** of the signal
- **Transfer** of this signal until it reaches its targets
- A **response** to the signal by the target
- **Switching off** a signal once it has been responded to.

Stimuli may be:

- physical- light, heat, pressure
- Chemical- hormones, neurotransmitters.
- Receptors respond to stimuli
- They can be external or internal
- 5 main types: chemoreceptors, mechanoreceptors, photoreceptors, thermoreceptors, pain receptors





When answering a question that involves feedback loops consider the following:

- Receptor detects stimulus/change
- Receptor produces a signal (may be chemical or electrical)
- The signal is sent to a processing centre or brain or central nervous system or modulator
- Processing centre or brain or central nervous system or modulator coordinates a response
- A message is sent to effector (usually a muscle or gland in animals)
- Effector brings about a response
- Specific example (e.g. glucose levels in animals, water balance in a plant)

Positive Feedback v's Negative feedback

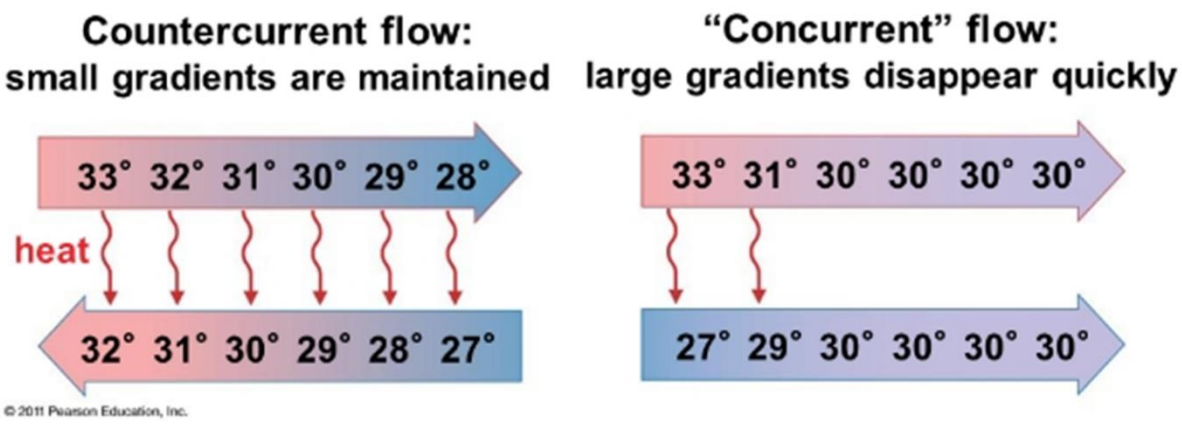
Positive feedback	Negative feedback
Reinforces (amplifies) the change detected It will continue until a result is achieved.	Reduces the change- it is the reverse of the stimulus. Promotes equilibrium.
Example 1: Labour (child birth): oxytoxin hormone is released when the babies head pushes against the cervix. Oxytoxin causes contraction of the uterus- pushing the babies head against the cervix. This continues until the baby is born. Example 2: Blood clotting Example 3: Fruit ripening	Example 1: temperature regulation- sweating to reduce a rise in body temperature. Example 2: osmoregulation Example 3: blood sugar regulation

Temperature Regulation

ENDOTHERMS	ECTOTHERMS
Endotherms are animals which regulate their body temperature by internal means.	Ectotherms are animals which regulate their body temperature via external means.
All Mammals and Birds.	Reptiles, Amphibians, Fish
Examples of adaptations for temperature regulation: • blubber • piloerection • counter-current heat exchange • shivering • sweating • huddling	Examples of adaptations for temperature regulation: • basking behaviour • burrows • nocturnal • aestivation/torpor/brumation

Counter-current Flow

- Found in fish gills, legs of artic birds, seal fins, tuna muscle, platypus feet, mammalian kidneys.
- Involves 2 fluids passing close to each other.
- Counter current exchange helps to maximise the exchange of substances (heat, gas, salts…) for example
    - Concurrent flow (same direction); exchange occurs until there is equilibrium.
    - Counter-current flow (opposite direction); the diffusion gradient is maintained therefore exchange of substances is increased.



A word about Metabolism!

The sum total of all chemical reactions (and therefore energy exchange) in an organism.

Reactions can be:

- Catabolic- releasing energy by breaking bonds.
- Anabolic- require energy by building bonds.

Metabolism can be measured in three ways.

- The energy released as heat OR
- The amount of food used OR
- The amount of oxygen consumed to produce energy.

Metabolic rate is the amount of heat produced in a given time. Metabolic rate varies with temperature, activity, and food intake.

Body size and metabolic rate

Endothermic animals: **Small animals have a LARGE S.A./Vol ratio.**

- This means they LOSE body heat at a rapid rate.
- Therefore, they must have a HIGH metabolic rate (respiration) to replace heat loss.
- These animals consume LARGE amounts of food relative to their body weight.

The table below compares various sized animals and their oxygen consumption. You can see that a mouse consumes more oxygen than an elephant per gram. This tells us the mouse has a much higher metabolism than an elephant.

ANIMAL	BODY WEIGHT (g)	OXYGEN CONSUMPTION (cm3/hr)	OXYGEN CONSUMPTION (mm3/g/hr)
Mouse	25	40	1580
Rat	226	197	872
Rabbit	2200	1025	466
Dog	11,700	3,721	318
Man	70,000	14,140	202
Horse	700,000	74,200	106
Elephant	3,800,000	134,000	67

Inputs		Outputs
Environment: • Radiation • Convection • Conduction Respiration (metabolism)	35 degrees C	Evaporation (lungs, skin) Wastes (urine, faeces) Lungs (warming air) Environment: • Radiation • Convection • Conduction

Hibernation v's Torpor

Hibernation is a long period of dormancy. An animal will find a warm, dry place to rest over the winter or sometimes longer. In Australia this generally only happens in very cold areas.

Torpor is very similar to hibernation except it occurs over much shorter periods. It is triggered by cooler temperatures and a lack of food. An animal may enter torpor for as short as a day. This is more common in Australia.

Brumation is a term used for the hibernation-like state that ectothermic animals such as snakes, utilize during very cold weather.

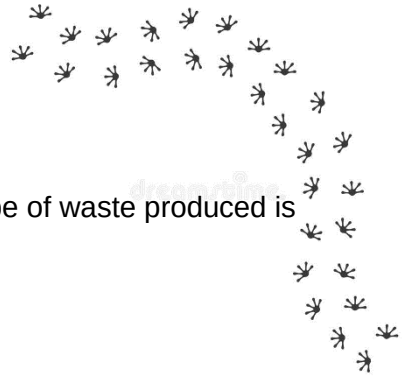
Aestivation is a period of rest in shady and moist place during summer, often used by animals such as frogs during very hot weather.

Osmoregulation

The terrestrial environment is very dry (in comparison to an aquatic one). Terrestrial animals are under continual water stress, therefore they are always regulating water losses and gains. Animals and plants have behavioural, structural and physiological adaptations to regulate their internal environments.

Water Loss through:

- Respiratory surfaces
  - Evaporation: the dryer it is the greater the loss of water through evaporation. Therefore, animals have adaptations to;
    - Increase humidity
    - Decrease temperature
- Sweating and panting.
- Faeces
- Kidneys- removal of nitrogenous wastes (urea, ammonia, uric acid). The type of waste produced is dependent on the availability of water.
    - Birds & reptiles: uric acid as they need to conserve water.
    - Mammals: urea which leads to increased water loss.



Osmoregulation in Aquatic Environments

Osmoconformers: Maintain body fluid concentration at the same as environment. Usually confined to very limited environments. For example; marine plankton, crabs, sharks.

[Sharks and rays retain urea so that their blood concentration is similar to seawater, that is why they are osmoconformers.]

See work book for osmoregulation in marine and freshwater fish.

Nitrogenous Wastes- it's all about water availability!

Any metabolic **waste** product that contains nitrogen. Urea and uric acid are the most common **nitrogenous waste** products in terrestrial animals; freshwater fish excrete ammonia and marine fish excrete urea.

- The amount of nitrogenous wastes produced is related to diet.
  → herbivores have less N-wastes
  → carnivores have more N-wastes
- Nitrogen enters the body via protein (amino acids).
- When the protein is metabolised (broken down) ammonia is left over.

- Ammonia can then be excreted as is or converted to the less toxic forms: urea or uric acid.

NITROGENOUS WASTE	LEVEL OF TOXICITY	METABOLIC COST	SOLUBILITY [WATER REQUIREMENTS]	EXAMPLES
Ammonia [small molecule]	VERY toxic [but in aquatic environs very diluted]	LOW energy cost Direct product of amino acid metabolism	HIGHLY soluble HIGH water requirements [to dilute toxicity]	Freshwater fish, turtles, crocodiles. Most aquatic invertebrates
Urea [larger molecule]	LESS toxic than ammonia [moderate toxicity]	SOME energy required to produce urea from ammonia & carbon dioxide	HIGHLY soluble HIGH water requirements	Mammals, amphibians, most marine fish, sharks, lungfish during aestivation
Uric acid [large molecule]	NON-toxic	HIGH energy cost. Produced from ammonia and carbon dioxide	INSOLUBLE Low water requirements, can be stored for long periods making it suitable for cleidoic [impervious] eggs	Terrestrial reptiles, birds, insects, land crabs, land snails

Plant Homeostasis

An arid environment is one were soils have low water-holding capacity combined with low rainfall and high temperatures. The number one issue for plants living in arid environments is **water loss**. Plants that have adapted to live in these conditions are called **XEROPHYTES.**

Xerophytes have adaptations to conserve moisture and prevent leaf temperature from rising too much. They have an increased tolerance to desiccation (drying out).

Xerophytes include:

- schlerophylls (hard leathery leaves),
- succulents (water storage in leaves), and
- ephemerals (rapid life cycle when water is available).

Plant adaptations for Arid environments

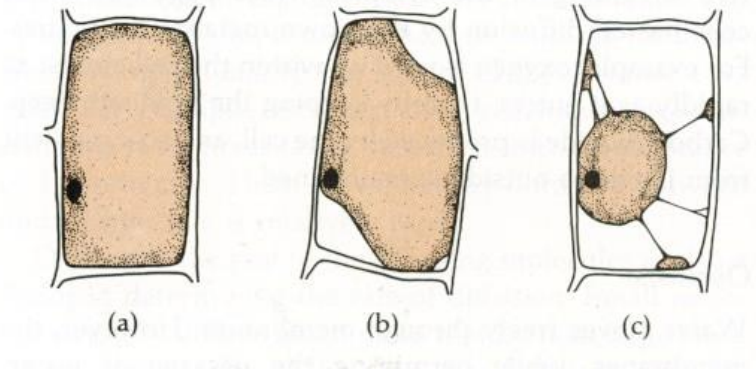
Plant species	Adaptation	Benefits
Spinifex	Leaves roll into a tube during the hottest part of the day.	Reduces surface area exposed to sun. Traps a layer of moist air within tube.
Melaleuca	Long narrow leaves	Reduces surface area where water may be lost
Hakea	Needle shaped leaves	Reduces surface area where water may be lost
-	Fewer stomata, may be sunken in grooves or pits. May have hairs surrounding stomata.	Reduces water loss via evaporation.
	Stomata close in hottest part of the day.	Reduces transpiration rate.

Plant Species	Adaptation	Benefit
Woody shrubs: *Acacia, Eremophila, Grevillea*	Hairy leaves and stems Silver hairs	Insulation against the heat Reflects the heat
Eucalyptus	Leaves hang vertically- edge on to the sun	Reduces total surface area exposed to sun
Acacia *Casuarina* *Allocasurina*	Reduced number of leaves. • Phyllodes- flattened leaf stems • Cladodes- flattened stems	Reduces water loss ia evaporation due to far fewer stomata.
-	Tap root + surface roots	Allows access to deeper soil water but also surface water from light rainfalls. Surface roots out compete other plants- leading to bare patches around trees.

HALOPHYTES are plants that have a higher than normal tolerance to saline conditions. The biggest issue faced by halophytes is water loss and control of salt levels.

Transpiration allows water to travel upwards through the xylem.

- However, this also brings with it salt.
- Excess salt must be removed from the shoots- otherwise cells will lose their turgidity due to water loss. (principle of osmosis)
- Turgidity of cells is required for metabolism and growth.



Guard cells control the size of the stoma (opening). **Turgid** guard cells open the stoma, **flaccid** guard cells close it.

The water content of the cell determines whether a cell is flaccid or turgid.

Adaptions to reduce Transpiration and water loss

Adaptation	How it reduces water loss
Reduced number and size of leaves	Reduces surface area
Fewer stomata	Less stomata= less water loss
Sunken or protected stomata	Wind can increase transpiration rate by pulling away water particles from the leaf surface. Sunken or protected stomata help prevent this.
Hairs covering leaves	As above + increase humidity around stomata.

Adaptations to regulate salt concentration.

1. Higher osmotic pressure in cytoplasm.
2. Excluding salt from leaf cells. [salts are stored in the vacuole]
3. Returning salts to roots.
4. Waxy endodermis to exclude salts
5. Diluting incoming salt by increased growth.
6. Shedding salt laden leaves.
7. Excreting salt from glands. [actively transporting salts into 'bladder cells' that burst when full releasing salts to external environment]

Talk to your plants. But if you really want results, bring in a motivational speaker.


Biology Frog says…

Infectious Disease: one that is passed on from one organism to another (contagious), caused by a pathogen.

- Pathogens are:, viruses, bacteria, fungi, protists, parasites and prions. (*Note prions & macro-parasite are not in the syllabus)*

Non-infectious Disease: cannot be passed to another person (non-communicable) and are not caused by pathogens.

- nutritional disease, degenerative disease, environmental; disease, genetic diseases, autoimmune disease.

Other terminology

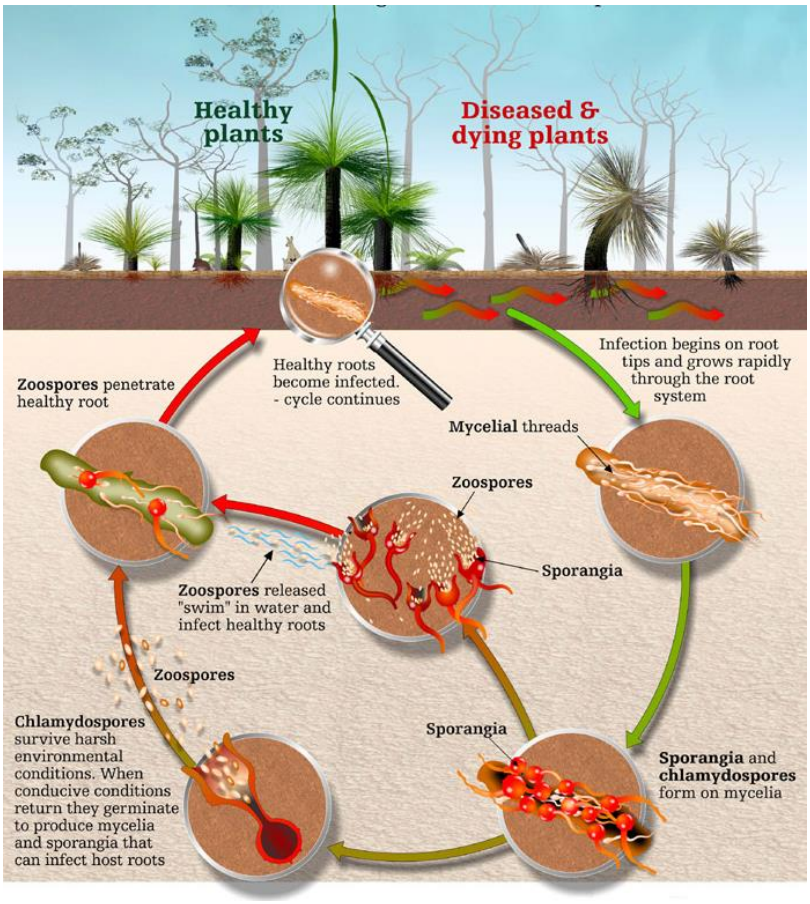
- endemic: a common disease
- outbreak: a sudden increase in the incidence of the disease
- susceptibility: how likely an individual is to get a disease
- Resistance: the ability to resist infection
- Symptoms: effects of the disease
- Incubation period: the time between infection and onset of symptoms.
- Pathogenicity: the disease-causing capacity of a pathogen
- Virulence: the intensity of the effect.

Diseases

Phytophthora cinnamoni- dieback

- Protist – parasitic water mould.
- Active in wet conditions [likes areas with 400mm + annual rainfall]
- Does not photosynthesis- gains nutrients from a host source.
- Attaches to the host plants root system.
- **Mycelium** feeds off the host plant. The mycelium will produce either **sporangia** OR **chlamydospores**.
- In FAVOURABLE conditions sporangia are produced. The sporangia release **zoospores** (motile spores).
  - Zoospores are short lived, can travel short distances by 'swimming' in water or passively in surface or sub-surface water. They can move very fast downhill.
- In UNFAVOURABLE conditions **chlamydospore**s are produced.
  - Chlamydospores are hardy, survive in dead plant material and soil. When conditions improve, they produce mycelia and zoospores.

*The lifecycle of P.cinnamomi is an **important factor** in why it can spread so effectively.*



Malaria

SPOROZOITES reproduce asexually 2-4 weeks.

MEROZOITES "burst out" of liver into blood -

Toxins cause:

- fever (up to 41°C)
- shivering fits
- headaches
- nausea
- profuse sweating

Reinvasion of liver may occur

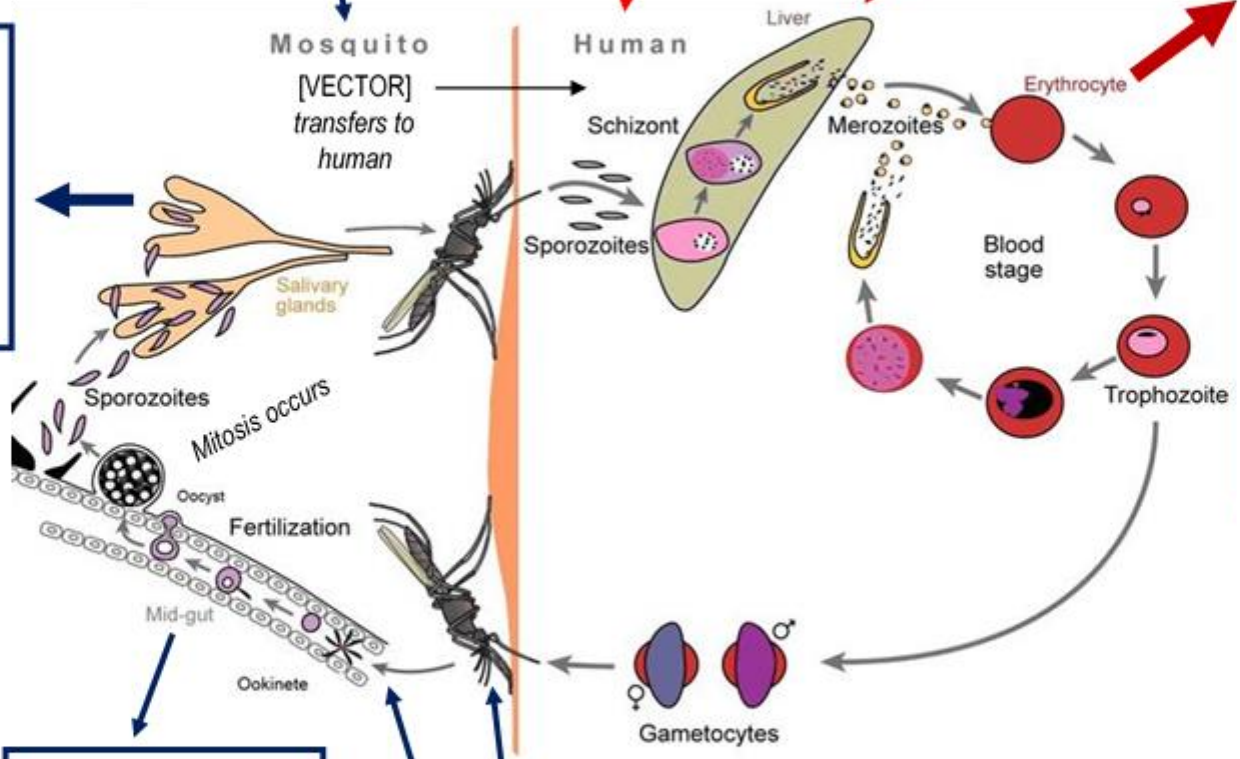
Attack lasts 2+ hours then weak, haemolytic anaemia due to loss of RBC's & Hb.

Affect of merozoite invasion of RBC's:

- loss of shape
- increased permeability
- increased rigidity
  - RBC's cannot fit through small blood vessels causing clots.
- increased adhesiveness, mainly to blood vessel walls and each other, blocking blood flow.
- lead to organ failure (and death)

Saliva of mosquito contains anticoagulants, preventing blood clotting in the proboscis.

If there are sporozites in the saliva, then the host will become infected.



'sexual reproduction' = fertilisation

Mosquito bites host and sucks up gametocytes in blood.

Gametocytes mature into gametes in mosquitos' gut.

Host Responses

- Plasmodium invades RBC's, the host produces antibodies however, the cell membrane of Plasmodium changes! Therefore, surface antigen changes so it is not recognised by antibodies.
- Sporozoites in the liver are isolated from the immune system, therefore, they are hidden.

Viruses

- ALL viruses are pathogenic
- Small 30-300nm
- Infectious particles surrounded by a protein coat called a capsid [shape dependent on type of virus].
- NOT cellular- do not comply to cell theory.
- DO Not contain cellular/metabolic machinery, therefore:
    - CANNOT reproduce on their own.
    - CANNOT metabolise on their own.
- DO contain nucleic acid- either DNA or RNA.
- Lack metabolic enzymes and ribosomes.
    - can only express their genes when inside a living host cell.
    - use host cell's metabolic machinery and chemical pathways to produce more viral proteins and nucleic acid.
- Host range is the number of host species a virus can infect.
- Viruses operate under a "lock and key" fit with host cells.
    - Viral surface proteins and specific receptor molecules on the outside of the host cell.
- Examples include; Influenza, Ross River virus, measles, HIV, chicken pox, HPV, glandular fever.

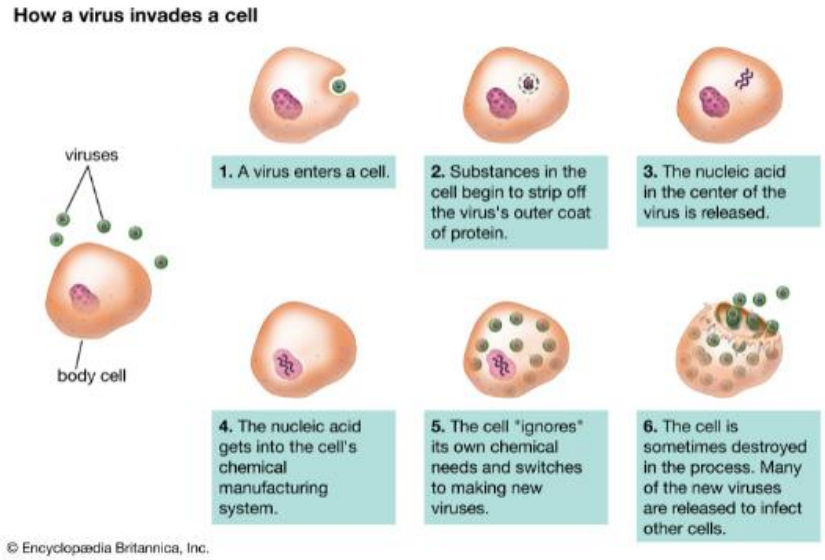
Bee Viruses

- strong correlation to the presence of varroa mites
- viruses thought to enter bee's bodies through openings made by the mite bites.
- to date varroa mites do not exist in Australia
- there are NO cures for bee viruses

Virus	Description	Impact
Sacbrood	Infects the bee larvae Larvae die before pupation	Reduces colony population- no new bees to replace aging bees.
Black Queen cell virus	Infects queen larval cells/capsules Pupal queens or queen larvae die	No replacement queen bees
Kashmir	Affects adult bees, reducing their life span.	Can rapidly deplete the adult population of a colony
Paralysis	Common in adult bees- causes trembling and crawling behaviour, often gather in groups of bees.	Inability of bees to function normally

3 ways Beekeepers can minimise the risk of viral infections.

- replace queen bee on a regular basis
- do not breed from bees that exhibit viral symptoms
- minimise nutritional stress by providing a good sugar syrup supply

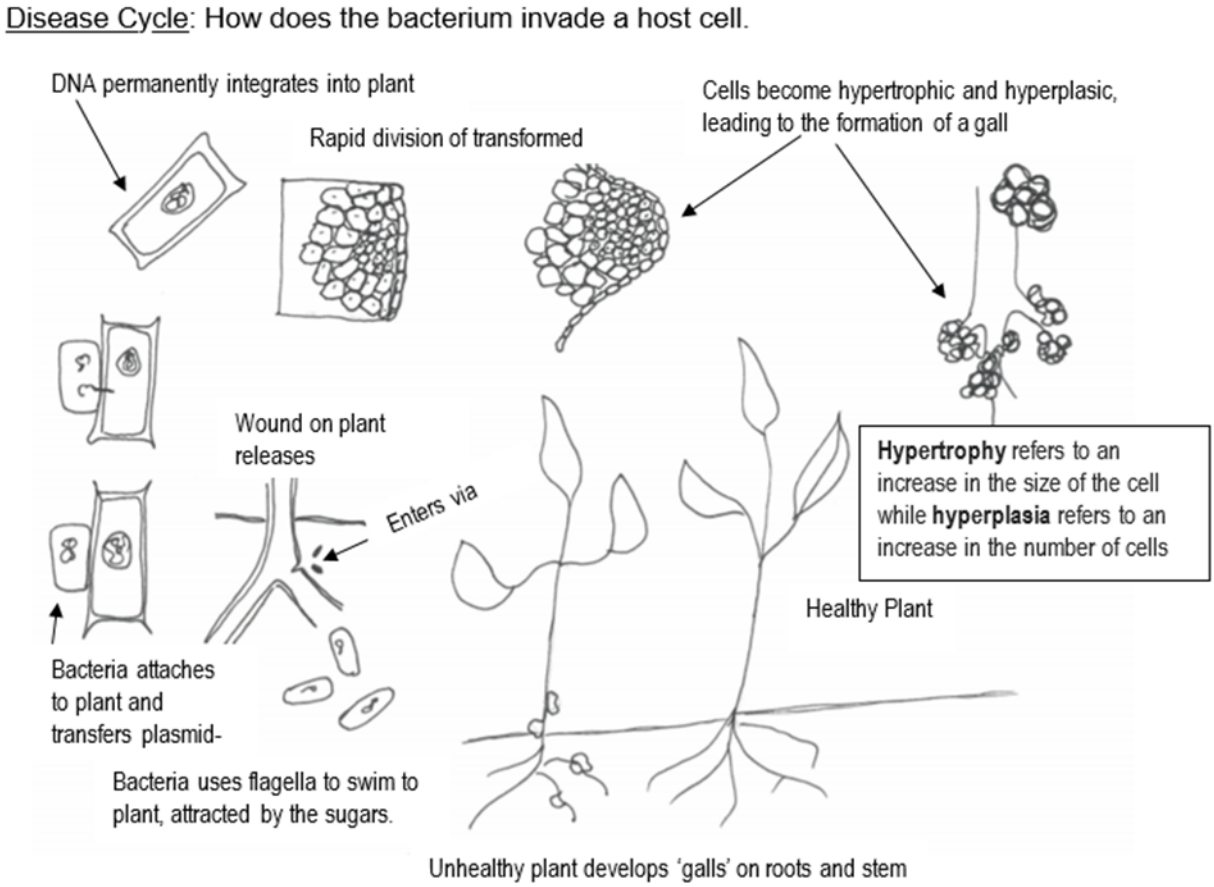


Bacteria

- bacteria that causes disease are known as “pathogenic bacteria” – very few bacteria fall into this category.
- bacteria cause disease through the toxins they release.
- bacteria are spread through water, food, air and/or direct contact
- bacterial disease can be treated with antibiotics, vaccinations. NOT ALL bacterial diseases can be cured.

Tetanus	Transmitted from soil into open wounds, eg a dirty nail puncturing a foot	Prolonged strong contractions of skeletal muscles. Can lead to death. Prevented by vaccination.
Plant Crown Gall	Tumour-like growth, caused by *agrobacterium tumefaciens.* *Bacteria transfers Ti (tumour inducing) Plasmid (circular DNA) to a plant cell.*	As tumour grows plant grows poorly and may eventually die. Crown Gall is important in biotechnology as it can be used to insert genes into a plant.
Tuberculosis	Caused by a bacteria that affects the lungs, spread by droplets in the air.	Damages the surface of the lung- causes thickening and scarring. May spread to other organs in the body. Prevented by vaccination. Treatment requires long term use of antibiotics.

Crown Gall disease *Agrobacterium tumrfaciens*



Impacts

- causes galls/growths/tumours
- (usually) on roots **or** at ground level **or** on roots and stems
- (galls/growths/tumours) can prevent the uptake/movement of water **or** nutrients
- slows plant growth **or** plants become stunted/unproductive/unhealthy **or** plants can die
- *Agrobacterium*/bacteria genes are expressed (in the plant)
- (results in) production of some chemicals/hormones (cause the galls/growths/tumours)
- also changes expression of (some) plant genes

Agrobacterium and Biotech

- Vector- used to transfer foreign genes/DNA into plant species
- Because:
  - it naturally/normally transfers DNA/genes to plants (during disease production)
  - it can infect a broad range of host plants
- This natural ability can be exploited **or** bacteria requires little modification to perform this role
- Plasmid/DNA contains sequence for integration into plant genome
- Can be used to clone target DNA

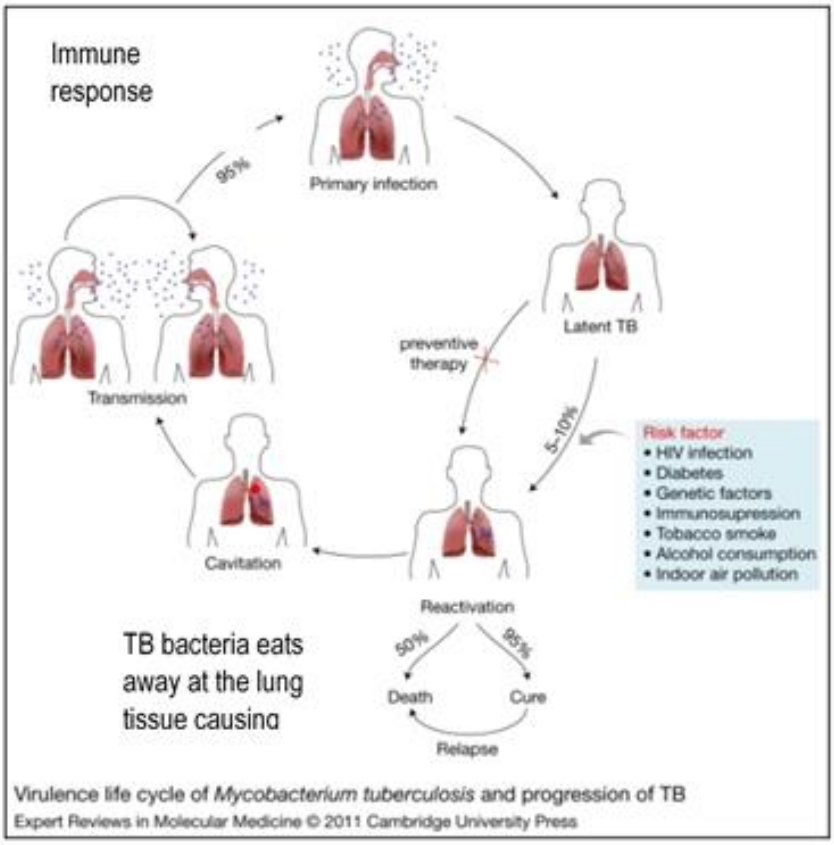
Tuberculosis

Bacteria- *Mycobacterium tuberculosis*

- Primary TB Infection – person is infected but not ill.
- Latent TB- the bacteria is inactive .

If no preventative action:

- bacteria is reactivated.
- Cavitation- bacteria attacks lung tissues causing 'caves'.
- Transmission occurs at this stage (when coughing is present)



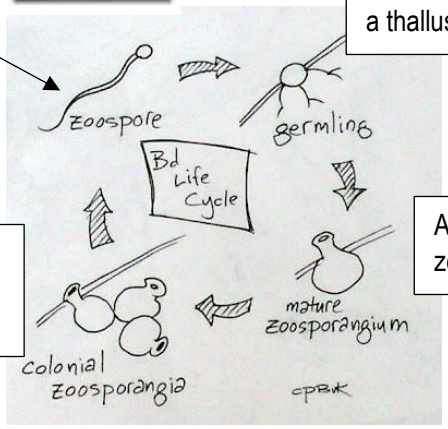
Virulence life cycle of *Mycobacterium tuberculosis* and progression of TB

Fungus

Chytridiomycosis Life Cycle (frog fungus)

Batrachochytrium dendrobatidis (Bd)

Occurs in water, zoospores then make contact with the frog skin



The zoospores send rhizomes into the frog skin, developing into a thallus.

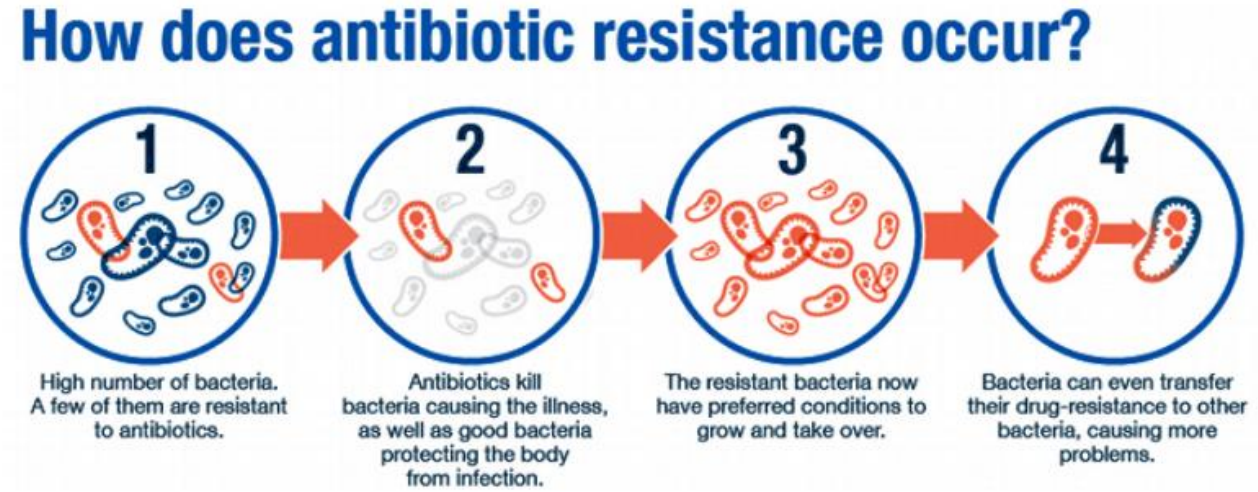
Asexual reproduction in the (now) zoosporangium produces more zoospores.

Zoospores are released and enter the water or reinfect the host.

Zoonoses

- Diseases that originated in animals that can affect humans
- Pathogens that can cause a zoonoses disease: Bacteria, parasites, protozoa, fungi, viruses
- Zoonoses can be spread to humans by:
    - Close contact with infected animals
    - Contact with saliva, blood, urine, faeces of infected animal
    - Water or soil contaminated by infected animals
    - Being bitten by a vector such as tick, mosquito
    - Eating or drinking unpasteurised dairy products, undercooked meat, unwashed fruit & veg that are contaminated with faeces from infected animal
- Examples

Pathogen	Disease
Bacteria	Anthrax, brucellosis, leptospirosis, Q Fever, Salmonella, Psittacosis
Virus	Aust Bat Lyssavirus, Hendra, Ebola, Rabies
Protozoa	Toxoplasmosis, Giardia, Cryptosporidiosis
Fungi	Ringworm



http://modmedmicro.nsms.ox.ac.uk/learn-more-about-antibiotic-resistance/

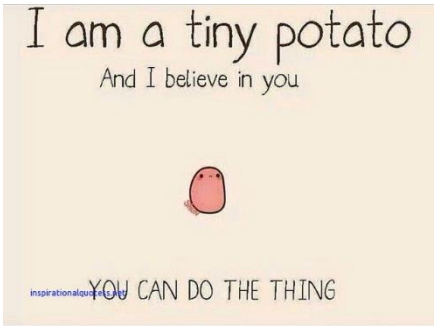
Spread of Disease and Management Strategies

Pathogen factors that affect disease transmission

1. **Vectors**: such as mosquitos and the transmission of malaria, or Ross River or Zika viruses.
2. **Risk factors**: such as blood borne diseases are more likely to infect people who require blood transfusions, share needles. Eg Hepatitis C virus.
3. **Infectivity**: the ability of a pathogen to spread from host to host. Eg influenza spreads by droplets in the air, these are easily passed from one person to the next.
4. **Natural History**: stages of infection- before the development of symptoms (asymptomatic), during infection.
5. **Persistence:** length of time a pathogen remains with host. Some pathogens may remain with a host who is an asymptomatic carrier. Eg tuberculosis (TB) may remain latent (dormant) for several years.

Host Factors

Characteristics of the host population.



- Behaviours: eg drug users sharing needles
- Age: elderly are more susceptible to disease
- Gender
- Socio-economic status
- Exposure history: populations that have been exposed previously have some individuals with immunity.
- Population density

Host Factors: Human Movement

Carrier populations moving into populations that have never been exposed before.

- Europeans and Indigenous Australians. Introduced diseases such as small pox, measles, influenza, typhoid. High mortality in Indigenous populations.

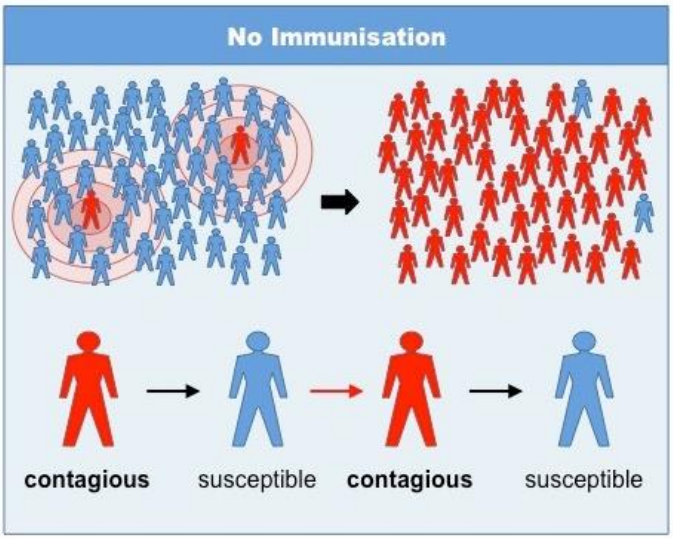
Travel

- By air- spreads disease quicker than boat travel. Eg SARS epidemic in 2003.
- Includes plant & animal disease eg myrtle rust travelled from South America to Australia (2010).

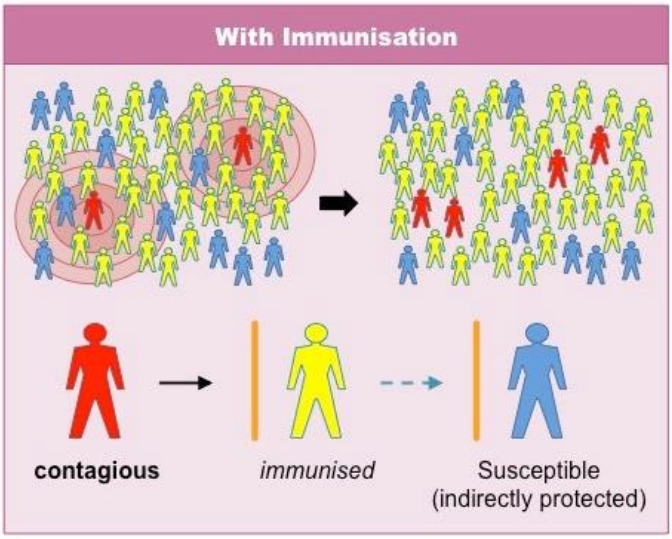
> Don't let what you cannot do interfere with what you can do. – *John Wooden*

Preventing the spread of disease

- Hand Hygiene: Regular hand washing prevents infection transmission, in particular faecal-oral or direct contact routes.
- Immunisation: Immunisation (vaccination) programs are a highly effective public health intervention, resulting in large reduction of disease. There is the potential to eradicate disease by making spread impossible. Eg small pox.
    - Herd Immunity: not all individuals need to be vaccinated to prevent the spread of disease. If a large proportion of the population is immune, then there will be too few individuals for the disease to spread. This effect is called **herd immunity**.



Infectious agent passes freely from contagious to susceptible



Contagion **cannot** freely pass via immunised to susceptible

https://ib.bioninja.com.au/higher-level/topic-11-animal-physiology/111-antibody-production-and/vaccination.html

- Quarantine: the enforced isolated of an individual or individuals at risk of carrying disease to prevent the spread of that disease.

Congratulations! You have now completed your revision booklet!

Edith Cowan University would like to wish all students the best of luck with their future exams!