DNA:

DNA:
- Found in nucleus and cytosol of Eukaryotes.
- Two strands wound together to form a double helix.
- Semi-conservative and negatively charged.

Nucleotide:
- 5 carbon sugar that is negatively charged.
- Adenine – Thymine (2 hydrogen bonds – weak).
- Guanine – Cytosine (3 hydrogen bonds – strong).

DNA Replication:
1. DNA helicase unwinds DNA by breaking hydrogen bonds.
2. DNA polymerase builds new strand, starting at promoter, from 5' to 3', and free nucleotides attach to bases.
    - DNA polymerase builds using okazaki fragments because it cannot build continuously in opposite direction.
3. Outcome = two double helix DNA molecules with one parental and one new strand.

How DNA becomes a Chromosome:
- Uncondensed DNA is condensed by histone proteins, thus making it a chromosome.

Cell Division:

Mitosis: Occurs in somatic cells.
Interphase: Preparation to divide, DNA replication, DNA starts to condense, nucleus breaks down.
Prophase: DNA in the form of chromosome, centrioles move to opposite poles, spindle forms.
Metaphase: Spindle attaches to centromere, chromosomes line up on equator.
Anaphase: Spindle contracts & pulls chromatids to opposite poles.
Telophase: Nucleus reforms, DNA uncondenses into chromatin.
Cytokinesis: Cytoplasm splits to form two identical diploid daughter cells.

Meiosis 1: Occurs in gonads (testes and ovaries).
Interphase 1: Preparation to divide, DNA replication, DNA starts to condense, nucleus breaks down.
Prophase 1: Each chromosome finds its homologous pair, crossing over occurs (exchanging chromosome segments).
Metaphase 1: Chromosomes line up in pairs.
Anaphase 1: Homologous pairs separate.
Telophase: Nucleus reforms, DNA uncondenses into chromatin.
Cytokinesis: Cytoplasm splits to form two daughter cells.

Meiosis 2: same as mitosis, results in 4 genetically different haploid cells.

	Mitosis	Meiosis
Purpose	Growth and repair	Production of gametes
Location	Somatic cells	Gametes
Number of Divisions	1	2
Product	2 identical diploid cells	4 genetically different haploid cells
Applications	Tissue culture	Creates new varieties of organisms

Binary Fission:
- Asexual reproduction by most prokaryotes where the cell divides into 2 identical daughter cells.

1. DNA is replicated.
2. Each DNA copy attaches to a different part of the plasma membrane.
3. The cell moves apart, replicates and original chromosomes are separated.

Protein Synthesis:
- The formation of proteins (chains of amino acids).

Transcription (DNA to mRNA):
- RNA helicase unzips DNA, exposing the template strand.
- RNA polymerase binds to promoter and attaches free nucleotides using new base pair rule with Uracil.
- RNA ligase glues the strand.
- A stop codon is reached, and pre-mRNA is released.

mRNA Modification:
- A poly-A-tail added to the 3' end.
- A methyl cap added to the 5' end.
- Non-coding sections of DNA (introns) are spliced out.
  - Mature mRNA leaves the nucleus to the cytoplasm.

Translation (adding amino acids to form a polypeptide chain):
- mRNA attaches to a ribosomal subunit which scans it until it finds the start codon AUG.
- tRNA carrying desired amino acids moves to the ribosome.
- Codon in mRNA binds to anti-codon in tRNA.
- Ribosome subunit moves along to read next codon and polypeptide bonds form.
- tRNA exits and can be reused.
- When a stop codon is reached, polypeptide is released.
- Polypeptide goes to the golgi body for modification into a protein.

Gene Expression:
- Process of information from a gene being transcribed into mRNA to being translated into a protein.

Regulatory Proteins:
- A protein that binds DNA to switch on or off gene expression, called activators and repressors.

Chemical Modification:

Acetylation:
- Activates gene expression by releasing enzyme that loosens DNA coil allowing protein synthesis.

Methylation:
- Represses gene expression by tightening DNA coil around histones to prevent protein synthesis.

Environmental Factors:
- May activate or inhibit gene expression i.e. food, temperature, light.

Prokaryotes:	**Eukaryotes:**
No membrane bound organelles	Membrane bound organelles
Plasmid (DNA)	DNA found in the nucleus
Haploid	Diploid

DNA Replication:	**Transcription:**
Duplicates DNA	Forms proteins
DNA to DNA	DNA to mRNA
Double strand	Single strand
Entire length of DNA	Small section of DNA
DNA polymerase	RNA polymerase
Similarities: template strand, both start in nucleus.	

Mutations:

- Any permanent, spontaneous change in DNA.
- Occurs in germ-line (sex cells) but only affects offspring.
- Occurs in somatic (body cells) but only affects the parent.

Causes of Mutations:

- Errors in cell division (mitosis, meiosis, DNA replication, protein synthesis).
- Errors include base pair substitution (RNA polymerase III fixes this) and reactive oxygen species (damages DNA).
- Errors are often minimal as the cell has check points before division.
- If an error occurs, apoptosis (programmed cell death) occurs.

Mutagens:

Physical: damages DNA by breaking bonds of bases e.g. UV Light.
Chemical: adds or removes bases e.g. Mustard Gas.
Biological: pathogen disrupts cell function by putting its DNA in the host cell e.g. Crown Gall.

Gene Mutations:

Point Mutation: a single change in one of the bases e.g. SNP – Polymorphism.
Substitution Mutation: the nucleotide is replaced.
1. Silent/Synonymous: no overall change, redundancy of the genetic code.
2. Missense: results in a different amino acid.
3. Nonsense: forms a stop codon and incomplete proteins are formed, premature termination of the polypeptide.
Frameshift Mutation: indel (section of DNA) drops out or is inserted.

Effects of Gene Mutations:

Deleterious: frameshift, missense & nonsense.
Beneficial: missense.
Neutral: silent/synonymous.

Chromosome Mutations:

- Occurs when there is a double strand break.

Deletion: a double strand break.
Duplication: an extra copy is made from a section of chromosome.
Inversion: chromosomal rearrangement.
Translocation: a broken off section attaches to another chromosome.

Variation in Chromosomes:

Diploid (2n) – humans.
Monoploidy (n) – one chromosome in karyotype.

- Advantage: is economical.
- Disadvantage: decreases variation causing a risk of extinction.

Polyploidy (more than 2n) – plants.

- Advantage: increase size and hardiness in plants.
- Disadvantage: lethal in humans.

Aneuploidy – if non-disjunction occurs.

Variation exists in the same species due to:

Mutations:

- The ultimate source of genetic variation.

Crossing over:

- In prophase 1, homologous pairs cross over.
- Exchanging chromosome segments creates diversity.

Random Assortment:

- In metaphase 1 homologous pairs divide in half to form haploid cells randomly.
- Each haploid cell has a mix of maternal and paternal genes.

Non-Disjunction:

- The failure of separating chromosomes e.g. Downs Syndrome on trisomy 21.

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Phenotypic Variation:
- Morphological – structure.
- Biochemical – pigments.
- Physiological – metabolic.
- Behavioural – cognitive.

Mendelian Genetics:

Genes: a unit of hereditary transmitting information from one generation to the next.
Allele: a different form of a gene.
Pure-breeding: a line of organisms that always produce offspring with the same phenotype.
Phenotype: physical appearance.
Genotype: the alleles of the individual.

Trait Inheritance:
Complete:
- One allele is expressed.

Incomplete:
- Phenotype is intermediate between homozygous individuals.
- A cross between a red and white rose makes a pink rose.

Co-dominant:
- Both alleles are fully expressed in the phenotype equally.
- A cross between a red and white cow makes a patched cow with both alleles present.

Test Cross:
- Crossing unknown genotype with a homozygous recessive individual.
- Used when the dominant phenotype could either be homozygous or heterozygous.

Ensuring Accuracy:
- Conduct multiple fertilisation events.
- Mate multiple times with a range of test cross individuals.

Lethal Alleles:
- Sometimes the dominant phenotype is vital for survival.
- Homozygous mutant recessive is lethal e.g. sickle cell anaemia.

Polygenetic Inheritance:
- Traits that show continuous variation as an increase in genes means an increase in variation.

Sex-Linked Inheritance:
- Involves genes/alleles located on sex chromosomes X and Y.

X-Linked Recessive: males will always express, females may be carriers.
X-linked Dominant: shows up in all affected males and females.
Y-linked Phenotypes: are exclusively male.

Pedigree Charts:
Dominant: present in every generation.
Recessive: if both parents are affected, all children will be affected.
Sex-Linked: every affected mother has an affected son; every affected father has affected/carrier daughter.

Evidence for Evolution:

Scale/Size:
Largest to smallest: Eon – Era – Period – Epoch

Evolution: The gradual process of change in the gene pool of a population from one generation to the next.

Evidence for Evolution:
1. The Fossil Record:
Conditions needed for a fossilisation:
- Absence of oxygen.
- Rapid sedimentation.
- Absence of volcanic activity.
- Protection from scavengers.
- Can also occur in dehydrated, freezing or tree-sap environments.

Mineralisation:
- Organic matter in a fossil is replaced by minerals from surrounding soil.

Example:
- Archaeopteryx – proof through fossils that there was a transition from dinosaurs to birds.

Types Fossil Dating:
Comparative Dating:
- Finding the relative (not exact) age of a fossil.
- Must be located in the same area/place to use comparative dating.
- Strata are deposited in a time sequence, w oldest on the bottom & youngest at the top.
- Assuming tectonic plates haven't shifted/inverted layers, relative age of fossils can be determined on the strata in which they're found.

Absolute Dating:
- Finding the numerical age of a fossil in years.

Types of Absolute Dating - Radiometric Dating:
- Carbon 14 transforms into Nitrogen 14 which takes 1 half-life (5730 years).
- 1 half-life allows for 50% of the C14 sample to decay into N14.
- This then allows the age in years to be estimated.

Types of Absolute Dating – Electron Spin Resonance:
- The more time in the soil = the more electrons absorbed.
- Measured via electromagnetism.

Types of Absolute Dating - Luminescence:
- Measuring age of a rock by using light that is emitted from it.
- Two types – thermos-luminescence and optically stimulated luminescence.

2. Comparative Anatomy:
Homologous Structures:
- Same structure but different in some ways due to common ancestor.
- E.g. Penta-dactyl limb has the same structure but is different in some ways to human limbs.

Vestigial Structures:
- Dominant/atrophied structures that have no function but are only present because of a common ancestor.

Embryology:
- All embryos will have pharyngeal slits, a dorsal nerve tube and a tail at one point due to common ancestor.

Divergent Evolution:
- Evolution into different species.
- Proven by homologous structures, vestigial structures and embryology.

Analogous Structures:
- Different structure but same function.

Convergent Evolution:
- Similarities in a species due to the environment.
- Proven by analogous structures.

3. Comparative Genomics:
Protein Conservation:
- Conservation of amino acids which assist in survival.

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Genetic Mutation:
- Increase in mutations = increase in time passed.
- Used to estimate at what point in time a species diverged.

Bioinformatics:
- Digital storage, retrieval, organisation and analysis of biological data.

The Pace of Evolution:
Gradualism: the steady slow divergence of lineages.
Punctuated Equilibrium: all is stable, but in response to environmental change, there's a fast divergence of lineages.

Extra Definitions:
Phylogeny: seeks to reconstruct evolutionary history of any given group of organisms, studying relationships.
Adaptive Radiation: rapid diversification due to drastic change in the environment.

Natural Selection:

Natural Selection:
- Individuals with the best combination of alleles survive and reproduce more successfully than other individuals.
- Leads to an increase in the favourable alleles in a population's gene pool, causing evolutionary change.
- Individuals that are not favoured will die and their alleles will be removed from the gene pool.

Gene Pool: The range of all genes and their alleles present in a population.
Population: Group of individuals of the same species, live in the same area, interbreed & produce fertile offspring.

Types of Natural Selection:
Stabilising: Environment is stable, selection pressures act against deleterious alleles.
Disruptive: Favours extremes instead of intermediate forms of genes.
Directional: An environment changes leads to a specific trait being favoured.

Selection Pressures:
- Competition for territory and food (between species).
- Predator-prey relationship.
- Competition within species.
- Sexual selection – leads to sexual dimorphism.

Sexual Selection:
- Individuals with certain traits are more likely to obtain mates and pass on genes,
- May be within a species or between species.
- E.g. large antlers on moose, or more colourful and larger feathers on a male peacock.

Causes of change in Allele Frequencies:
- Mutations.
- Immigration.
- Emigration.
- Reproduction rate.

Other factors that can change Allele Frequencies:
Genetic Drift:
- Random or Non-selective change in allele frequencies.
- More noticeable in smaller populations.

Bottleneck Effect:
- Population is suddenly reduced due to catastrophic event; only limited alleles remain for reproduction.
- New population isn't representative of the previous one. DECREASES VARIATION.

Founder Effect:
- Group becomes isolated from larger population and doesn't possess all alleles. DECREASES VARIATION.

Artificial Selection or Selective Breeding:
- Human intervention causing breeding of plants/animals to produce desirable traits in successive generations.

Speciation:

Speciation: The evolution of one or more new species from an ancestral species.
Macroevolution: Evolutionary changes that result in large-scale changes between species.
Microevolution: Relatively small-scale evolutionary changes that occur within a species.

Barriers to Gene Flow/Speciation:

Geographic Mechanisms:
- Individuals separated by geographic features e.g. seas, mountains.

Temporal Mechanisms:
- Individuals breed during different seasons or times of day.

Morphological/Pre-reproductive Mechanisms:
- Individuals have different reproductive structures meaning mating is physically impossible.

Post-reproductive mechanisms:
- Two different species have mated but offspring did not survive or is infertile e.g. Mule.

Mechanisms of Speciation:

Allopatric:
- Speciation that occurs due to physical or geographic isolation.
- Gene flow blocked and faces different selection pressures.
- Species can be separated by water, land, mountains, continental drift, rising sea levels, climate change.

Symptomatic:
- Speciation that occurs without geographic isolation.
- The evolution of two or more new species from a single population in the same place.
- May occur due to groups in population feeding on different things or choosing mates based on different characteristics.

Extinction:

- Lack of variation and genetic diversity reduces chance of individuals possessing alleles that produce a survival advantage in a changing environment.
- Efforts of conservation are usually focused on maintaining genetic diversity.
- Large populations are more resilient than smaller ones, as they have a more diverse gene pool.

Causes of Extinction:
- Habitat destruction.
- Disease.
- Introduction of another species into an area e.g. competitors or predators.
- Geological events e.g. volcanic eruptions.
- Climate change.
- Human impacts – pollution, poaching & human-wildlife conflict.

Preventing Extinction:
- Populations w reduced genetic diversity face an increased risk of extinction.
- Conservation is focused on preserving and maintaining genetic diversity.
- Large populations more diverse than small populations as large population will have more diverse gene pool.

Ways to Enhance Conservation:
- Setting up reserves where animals are protected from human-wildlife conflict and poaching.
- Creating wildlife corridors of natural landscape allowing migration and gene flow.
- Create legislation against poaching and habitat destruction.

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Biotechnology:

Biotechnology: The use of living things to produce useful products.

PCR – Polymerase Chain Reaction:
- Prokaryotes only have 1 copy of DNA + PCR increases amount of DNA available.

1. Denaturing:
- Heat to 95 degrees – breaks hydrogen bonds + strands denature.

2. Annealing:
- Cool to between 50 + 60 degrees – allows primer to attach to DNA at 3' end.

3. Extension:
- Heat to 72 degrees – Taq Polymerase builds new strand.

Plasmid: Circular section of DNA found in bacteria.

Advantages:
- Small, circular structure gives them stability.
- They replicate independently from bacterial chromosome.

Bacteria:
- Can be easily grown in a lab.
- Can incorporate foreign DNA.
- Expresses genes.

Gene Cloning:
- Using prokaryotes to make numerous copies of a specific gene.
- Don't use PCR as it doesn't work with larger DNA segments + gene cloning can be used on any gene.

Process:
- Plasmid is extracted by rupturing bacteria's cell wall.
- Target Gene is isolated and removed using restriction enzyme – endonuclease.
- Same restriction enzyme cuts plasmid + target gene to ensure complementary sticky ends.
- Target gene and plasmid anneals (comes together) with help of DNA ligase.
- After binding, becomes permanent part of plasmid DNA, known as a recombinant plasmid.
- Recombinant plasmids placed in bacterial culture where they grow + divide.
- If bacteria uptakes the recombinant plasmid, it has undergone transformation.

Gel Electrophoresis:
- DNA molecules move from negative charge to positive charge as DNA is negatively charged (- and - = repel).
- Small DNA molecules travel further towards positive charge than larger DNA molecules.
- Buffer solution controls pH.

DNA Sequencing:

1. PCR: to amplify DNA.
2. Heat to denature and separate strands.
3. Cool for primer to attach.
4. Heat for DNA polymerase.
- ddNTP dideoxynucleotides-triphosphate (missing OH groups) 'free nucleotides' added on to make new strand.

5. DNA polymerase synthesises new strand.
6. Keeps synthesising until reaches ddNTP.
7. Premature terminates of synthesising.
8. Acrylamide gel – 'high resolving power' ie can separate strands that differ only by one base pair.
9. Put through electrophoresis and computer (peaks show nucleotides).

Probing:
- Sample of DNA – looking for a specific gene.
- Micro-array (Nylon Filter)
- Reverse transcription: DNA – CDNA (copy DNA) – single stranded.
- If binding occurs, then they have it indicated by fluorescing (hybridisation) of probe – gene/disease is present.

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Homeostasis:

- The maintenance of a relatively constant internal temperature (within tolerance limits) despite changes in the external environment.

Stimulus: change to internal or external conditions.
Receptor: specialised nerve endings that detect the change.
Modulator: coordinates the response.
Effector: organ or gland that carries out the response.
Response: the action of the effector.

Types of receptors:
Chemoreceptors: smell, taste.
Mechanoreceptors: pressure, touch, balance, sound vibrations.
Photoreceptors: light.
Thermoreceptors: external or internal temperature variations.
Painreceptors: pain.

Negative Feedback: opposes the stimulus and restores the system – homeostasis.
Positive Feedback: enhances the stimulus – contractions during birth.

Nervous System:
- Central Nervous System: brain, spinal cord, processes and stores information.
- Peripheral Nervous System: all other neurons, transmits information.

Endocrine System:
- Produces hormones (chemical substances) secreted into bloodstream to target specific cells/organs.

Compare and Contrast:	Nervous	Endocrine
Speed	Fast	Slow
Duration	Short	Long
Travel via	Nerves	Bloodstream
Signal	Electrochemical	Chemical

Thermoregulation: Animals

- The way an organism maintains a relatively constant internal temperature.
- Extreme rise in internal temperature – enzymes denature, metabolic processes fail & hyperthermia.
- Extreme fall in internal temperature – enzymes slow down & hypothermia.

Organisms:
Endotherms: organisms that retain heat through metabolic activity – mammals, birds, fast-swimming fish.
Ectotherms: organisms that retain heat by absorbing it from external sources – fish & reptiles.
Homeothermic: organisms that can maintain a relatively constant internal temperature.
Poikilothermic: organisms that can't control or maintain a relatively constant internal temperature.

Heat Transfer:
Conduction: heat transfer from a hot to cold object via direct contact.
Convection: heat transfer when hot air or water rises and is exchanged by cool air or water.
Evaporation: water or sweat transforms to vapour, cooling the skin.
Radiation: heat transfer via infra-red waves.

Adaptations:

	Hot	Cold
Structural	Lack of feathers/fur so no insulation. Light coloured skin to retain less heat.	Feathers/fur to increase insulation. Dark coloured skin to retain more heat.
Physiological	**Vasodilation:** blood vessels dilate to reduce heat.	**Vasoconstriction:** blood vessels constrict to retain heat.
Behavioural	Shelter from sun & reduce activity.	Shelter from cold & increase activity.

Negative Feedback Loop:

Stimulus	Increase in temperature.	Decrease in temperature.
Receptor	Thermoreceptors.	Thermoreceptors.
Modulator	Hypothalamus.	Hypothalamus.
Effector	Sweat glands. Vascular smooth muscle. Skeletal muscles.	Sweat glands. Vascular smooth muscles. Skeletal muscles.
Response	Sweating (increase evaporation). Vasodilation (increase radiation & convection). Decrease in thyroxine (decrease in metabolism). Move to shade (decrease radiation). Panting (increase evaporation).	Stop sweating (decrease evaporation). Vasoconstriction (decrease radiation & convection). Increase in thyroxine (increase in metabolism). Huddling (increase conduction). Piloerection (trap warm air, convection).
Feedback	Decrease in temperature.	Increase in temperature.

Thermoregulation: Plants

- Plants need to maintain temperature within limits that allow enzyme function to continue.

Adaptations to Gain Heat:
- Large leaves: larger surface area.
- Dark green colouration: dark colours absorb heat better than light colours.

Adaptations to Lose Heat:
- Small leaves: cool down quicker.
- Opening of stomata pores to increase transpiration: evaporative cooling.
- Waxy reflective leaves.
- Pale colouration.

Osmoregulation: Animals

- Maintenance of a relatively constant water level in an organism (within tolerance limits), despite changes in external environment.
- Concentration of intracellular water must match concentration of intercellular fluid.

Hypernatremia (Dehydration):
- Cells shrink (plasmolysis).

Hyponatremia:
- Cells swell.

Nitrogenous Wastes:
- Form from protein synthesis (ammonia converted to urea/uric acid in terrestrial organisms).
- Toxic and reduce reaction rates.
- Ammonia – highly toxic but low energy efficiency.
- Urea – moderately toxic and moderate energy efficiency.
- Uric acid – low toxicity but high energy efficiency.

Kidneys:
- Remove nitrogenous wastes from body.
- Regulate water concentration in blood.
- Maintain ion levels in the blood.

Nephron:
- Filtration unit of kidney.
- Bowman's capsule and glomerulus filter blood, filtrate moves through Loop of Henle and blood vessels add or remove substances from urine.
- The larger the vascularisation of nephron and length of Loop of Henle, the greater the reabsorption of water into the blood, thus reducing water loss.
- The smaller the glomerulus and Bowman's capsule, the less filtration occurs, thus reducing water loss.

Hypertonic Habitat: decrease of solute, decrease in osmotic pressure.
Hypotonic Habitat: increase in solute, increase in osmotic pressure.

Osmoregulatory Mechanisms used in Fresh Water vs Salt Water:

Fresh Water:
- Osmoreceptors detect a rise in water as are hypertonic to environment so water moves in via osmosis.
- They don't drink, produce dilute urine and pump salt in via gills.

Salt Water:
- Osmoreceptors detect decrease in water as are hypotonic to environment so water moves out via osmosis.
- Always drink, produce concentrated urine and pump salt out via gills.

Osmoregulators:
- Actively control internal osmotic and salt concentration despite salt concentrations in environment.
- Fish in fresh and saline environments.

Osmoconformers:
- Attempt to match salt concentration of environment by storing urea and salts in marine environment or removing urea and salts in freshwater environments.
- Most aquatic invertebrates.

Adaptations:

Freshwater Fish:	- Shorter loop of Henle = less reabsorption of water in kidney tubules. - Ion pump in gills = pump ions in to prevent hypernatremia.
Marine Fish:	- Longer loop of Henle = more reabsorption of water in kidney tubules. - Ion pump in gills = pump ions out as too concentrated.
Terrestrial Fish:	- Medium to very long look of Henley = more reabsorption. - Waterproof layer to prevent water loss through surface. - Fat stores to be metabolised for water.

Negative Feedback Loop:

Stimulus	Increase in water/decrease in osmotic pressure.	Decrease in water/increase in osmotic pressure.
Receptor	Osmoreceptors.	Osmoreceptors.
Modulator	Hypothalamus.	Hypothalamus.
Effector	Decrease in anti-diuretic hormone for kidney. Ion pumps in gills. Skeletal muscles.	Increase in anti-diuretic hormone for kidney. Ion pumps in gills. Skeletal muscles.
Response	Decrease in permeability, decrease in water reabsorption, more urination. Pumps in ions to prevent hyponatremia. Less drinking.	Increase in permeability, increase in water reabsorption, more urination. Pumps out ions as too concentrated. Drinking, aestivation.
Feedback	Decrease in water/increase in osmotic pressure.	Increase in water/decrease in osmotic pressure.

Osmoregulation: Plants

- Water gain (through root hair cells) must equal water loss (evaporation from unprotected surfaces, transpiration through stomatal pores).

Guard Cells:
- Control opening & closing of the stomata (place plants lose water from).
- CO_2 in and O_2 out, and a decrease in H_2O due to transpiration.
- Transpiration only occurs when stomata is open.

Xerophyte:
- Plants that live in dry conditions e.g. cacti.

Adaptations:
- Sunken stomata – maintains humid air around stomata.
- Stomatal hairs – maintains humid air around stomata.
- Low stomatal concentration – smaller surface area for diffusion.
- Longer roots – maximise water gain.
- Thick waxy cuticle – reduces evaporation through leaf cells.

Halophyte:
- Plants that live in salty conditions e.g. mangroves.

Adaptations:
- Salt glands in leaves – excrete salt.
- Waxy cells & root epidermis impermeable membrane – blocks salt uptake but allows passage of water.
- Thick cuticles.
- Tissue partitioning.

Disease:

- Diseases are any condition that interferes with how an organism functions.
- **Endemic:** disease is permanently common in a population at a low level.
- **Epidemic:** a considerable increase in the number of cases of disease.
- **Pandemic:** epidemics spread across continents.
- **Pathogen:** infective agent that causes disease.
- **Virulent:** a pathogen that causes severe and harmful effects.

Modes of Transmission:
- airborne, waterborne, foodborne, vector, direct (asymptomatic shedding), indirect (fomite) and body fluids.

Pathogens:

BACTERIA	VIRUS	FUNGI	PROTISTS
- Unicellular. - Prokaryotic. - Reproduce via binary fission (bad because no variation so decreases in survival) and conjugation (good because ensures variation so increase in survival). - Have a cell wall and plasma membrane. - Non-pathogenic bacteria called commensal. - No membrane bound organelles.	- Non-cellular. - Requires host cell composed of core DNA/RNA (never both) surrounded by protein coat. - Reproduce by infecting living cells. - Membrane bound organelles.	- Mostly multicellular. - Eukaryotic. - Cell walls contain chitin rather than cellulose. - Asexual reproduction or sexual.	- Unicellular. - Eukaryotic. - Asexual via binary fission and sexual reproduction (multiple fission).

	Pathogen Class	Transmission	Life Cycle	Virulence	Symptoms	Management	Zoonosis
Tuberculosis	Myobacterium Tuberculosis	Indirect Airborne	Infected droplet enters lungs. Pathogen has chemical properties allowing to stay undetected. Replicates every 15-20 hours via binary fission inside macrophage, causing it to rupture and pathogen moves from lungs to blood.	Many pathogens in air. Lives in droplet for 4hrs. Withstands disinfectants.	Chronic cough. Fever & sweats. Appetite & weight loss.	Antibiotics. Quarantine. Physical protection.	Yes via cattle.
Tetanus	Clostridium Tetani	Indirect (soil borne and fomites).	Anaerobic bacteria in soil exposed to air. Enters host through open wound. Bacteria multiplies via binary fission. Releases toxin called tetanospasmin.	Anaerobic conditions allow germination. Occurs worldwide.	Muscle spasms. Lock Jaw. High Blood Pressure.	Antibiotics. Control of spasm. Tetanus Toxoid Vaccine.	Yes via scratches.
Crown Gall	Agrobacterium Tumefaciens.	Indirect (soil borne and fomite).	Plant penetrated via wounds made from digging/root feeding insects. Bacteria enters plant and produces tumour inducing principle. Interrupts xylem and phloem. Causes decay. Bacteria released into soil.	Flagella allow movement. T-pilus for conjugation. Live in soil for many years.	Rough surface galls. Turn brown. Loss of vigour. May die.	Antibiotics. Plant removal. Avoid wounding. Chemical treatment.	No.
Chytridiomycosis	Batrachochytrium Dendrobatitis.	Indirect (water borne).	Zoospores released from zoosporangium and swim through water until meet frog. Enters keratinised skin cell and encysts in cell. Forms zoosporangia in thallus (asexual) and zoospores released.	Mobility due to flagella. Many zoospores per reproductive cycle.	Lack of appetite. Lethargy, Abnormal posture. Pigmentation.	Antifungal drugs. Heat therapy. Quarantine.	No.
Malaria	Plasmodium.	Indirect (vector – anopheles).	Anopheles mosquito bites human exchanging sporozoites. Sporozoites mature into merozoites which enter RBCs and cause RBCs to burst. Merozoites form gametocytes.	RBCs sticky so adhere to vessel walls and organs. Can live dormant in liver cells.	Anaemia. Sweating. Headaches. Nausea.	Insect repellent. Citronella candles. Interrupt vector. Eliminate still water.	Yes via monkeys.
Jarrah Dieback	Phytophthora Cinnamomi.	Indirect (soil borne).	Chlamydospores remain dormant until conditions suitable. Hyphae germinates and releases sporangia which release zoosporangia. Zoosporangia go to jarrah plant via water in soil & absorb nutrients causing root tissue to deteriorate.	Survive in roots for long. Makes several zoospores.	Root rotting. Wilting & foliage. Necrosis. Water stress.	Disrupt life cycle via fungicides (phosphite salts) Clean shoes and tires.	No.
Influenza	Influenza Virus	Indirect (air borne & fomite) and direct.	Viruses contain DNA or RNA but never both. Virus particles reach vulnerable host & genetic material is inserted into host via reverse transcription. Virus particles cause cell to lyse & they get released to find more vulnerable hosts.		Fever. Fatigue. Headaches. Naval congestion.	Hygiene. Quarantine.	Yes via birds.
Ross River Virus	Alphavirus.	Indirect (vector).	Virus lands on cell surface & engulfs in cell membrane. RNA is released & instructs cell to make new RNA proteins, creating new viral surface proteins. Cell lyses, releasing new virus particles.		Fever. Aches & pains. Headaches. Exhaustion.	Insect repellent. Citronella candles. Interrupt vector. Eliminate still water.	Yes via wallaby's and kangaroos.

Harman Heer

Australian Bat Lyssavirus	Australian Bat Lyssavirus.	Indirect (vector bat).	Virus enters human via infected saliva via bite or scratch, entering the host cell. Reverse transcription occurs – uses host cell to replicate DNA. Once matured, virus exits cell (cell lyses) into hosts nervous system. Virus reaches brain causing inflammation & infection spreading through nerves to organs.		Fatigue. Headaches. Paralysis.	Minimise contact w bat. Wear protective clothing. Call pest removal.	Yes via bats.
Viral Honeybee Disease	Acute Bee Paralysis Virus.	Indirect (vector varroa mites).	Virus mite (adult virus) enters brood (bee larvae) cell. Virus mite lays eggs & eggs grow with bee larvae. Mature bee emerges carrying infected mite.		Crippled bees. Impaired flight. Increase in susceptibility.	Breeding resistant honeybees via biotechnology. Sugar-shaking - grooming where bees lick mite off.	No.