

### Meiosis

Used for sexual reproduction, combines genetic material from two parents to produce genetically unique offspring.

Halves the number of chromosomes in gamete, occurs in germline cells.

2 sets of division - Meiosis I and Meiosis II

**Prophase I** Chromosomes condense  
Homologs pair up  
Crossing over occurs

**Metaphase I** Homologous pairs line up along metaphase plate

**Anaphase I** Homologous pairs are separated  
Sister chromatids stay together

Telophase and cytokinesis follow same steps as Mitosis

Genetic variation in meiosis

**Crossing over** Occurs in Prophase I  
Homologous pairs come together  
Internal chromatids cross at chiasma  
Genetic info is swapped

**Independent assortment** Occurs in Metaphase I  
Homologous pairs line up randomly  
Gametes do not receive just paternal or maternal information  
More than 8 million combinations

There is not further duplication of DNA between meiosis I and meiosis II, meiosis II is the same as mitosis except 4 daughter cells are produced.

### Mitosis

Mitosis is the process used for growth and repair of cells as well as reproduction of unicellular organisms.

It comes after interphase and before cytokinesis, order can be remembered using Isaac please make another two cells.

**Prophase** Replicated DNA condenses into chromosomes wrapped around histones  
Centrioles produce spindle fibres and migrate to poles  
Nuclear membrane breaks down  
Nucleolus disappears  
Spindle fibres attach to chromosomes at centromere

**Metaphase** Spindle fibres line the chromosome up on the metaphase plate

**Anaphase** Spindle fibres contract  
Sister chromatids are pulled to the poles

**Telophase** Chromosomes reach the poles  
New nuclear membrane forms  
Spindle fibres break down  
Chromosomes condense

### Cells

Smallest unit of life. Contains organelles.

If metabolic rate is greater than material exchange rate then the cell will die.

**Prokaryotes** No nucleus  
No membrane bound organelles  
1 circular chromosome  
Commonly contains cytoplasm, nucleoid, plasmids, ribosomes, cell wall, slime capsule, flagella and pili

### Cells (cont)

**Eukaryotes** All multicellular organisms  
Membrane bound organelles.  
Shares plasma membrane, cytoplasm, DNA and ribosome features with prokaryotes.

### Mechanisms of change

Change in allele frequency in a gene pool

**Mutation** Random change in DNA sequence

**Sexual reproduction** New gene combinations and alter allele frequency

**Gene flow** Immigration or emigration of alleles in a gene pool

**Genetic drift** Random event changes composition, larger effects in smaller populations  
Bottleneck effect- dramatic decrease in population, unique alleles are lost  
Founder effect- small portion of population move, smaller gene pool

**Natural selection** Selection pressures leave fittest phenotypes

Mutation alone does not have a large effect when combined meaningful changes can be made.

### Evolution types

Evolution type:

**Divergent** New species result from the same ancestral species, allopatric speciation results in homologous structures.

**Convergent** Opposite of divergent, similar selection pressures cause similar adaptations. Result in analogous features

### Evolution types (cont)

Evidence of evolution can include a variety of different studies about an animal

|               |                                                                                                                                        |
|---------------|----------------------------------------------------------------------------------------------------------------------------------------|
| Fossil record | Order of species in time scale                                                                                                         |
| Biogeography  | Study of historical distribution of species past and present. Geographically closer together means it is more likely they are similar. |
| Morphology    | Analysis of features to see if they are homologous                                                                                     |
| Biochemistry  | Studying the similarities between the base pairs. DNA hybridisation can be used.                                                       |

### Cell cycle

Process of growth and division to form new cells

3 stages - interphase, meiosis/mitosis, cytokinesis

|            |                                                                                                                                                                                      |
|------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Interphase | G1- cell growth; cytosol, proteins and organelles<br>G0- arrest of cell cycle, dying or damages cells<br>Synthesis- replication of DNA<br>G2- continuation of growth and preparation |
|------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

Mitosis or meiosis see respective sections

|             |                                                                                                                                                                                                                   |
|-------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Cytokinesis | Differs from animal to plant<br>Division of cytoplasm and organelles before splitting of cells<br>Animals have cleavage furrow pinching the cells apart<br>Plants have a cell plate that turns into the cell wall |
|-------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

### Simple inheritance

|                      |                                                                                                                                                              |
|----------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Complete dominance   | Dominant allele masks the recessive allele<br>Recessive allele only has an effect when homozygous<br>Dominant is capital letter, recessive lowercase.        |
| Incomplete dominance | Neither allele is wholly dominant<br>Heterozygous individual will show a blending<br>Writing alleles- common base used superscript capitals used for allele. |
| Co-dominance         | Both alleles are dominant only one expressed in each cell                                                                                                    |

Inheritance patterns:

|                     |                                                                                                        |
|---------------------|--------------------------------------------------------------------------------------------------------|
| Autosomal dominant  | Find two parents with trait having child without                                                       |
| Autosomal recessive | Check for two parents without having a child with                                                      |
| X-linked dominant   | Occurs in every generation of family, all daughters have the trait when father has and mother doesn't. |
| X-linked recessive  | Does not occur in every generation of family, do all females with trait have father with.              |
| Y-linked            | Occurs in every generation of family, only in males, passing from father to son.                       |

Some genetic disorders include Down's syndrome which is trisomy for chromosome 21, Turner - monosomy for X without Y. Klinefelter two X chromosomes and a Y

### Transport across the membrane

The membrane is a phospholipid bilayer enclosing the cell. Made of phospholipids, proteins and cholesterol.

The phospholipid bilayer has outwards facing negatively hydrophilic phosphate heads and inwards facing lipid tails that are hydrophobic.

Types of transport:

|                       |                                                                                                                                                                                                     |
|-----------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Simple diffusion      | Down the concentration gradient, occurs due to the random movement overtime, passive.<br>Can transport gases and small lipophilic molecules                                                         |
| Facilitated diffusion | Down the concentration gradient through transport proteins, passive.<br>Channels transport small charged ions<br>Carrier proteins transport small uncharged molecules like glucose                  |
| Osmosis               | Net movement of water across a semipermeable membrane.<br>Water moves from low solute concentration to high.<br>Membrane must be permeable to water but not solute. Dilutes solution. Hypo to hyper |
| Active transport      | Requires ATP uses carrier proteins as pumps. Against the gradient. Sodium potassium pump for muscle and nerves.                                                                                     |

### Transport across the membrane (cont)

**Bulk transport** Substances too large to pass through proteins. ATP used to form vesicles which move between membrane and Golgi.

### Speciation

The evolution of two or more species from a single species to the point the viable offspring cannot be produced.

Isolating mechanisms prevent gene flow

**Prezygotic** Ecological- different areas  
Temporal- breeding season differs  
Behavioural- different mating behaviours  
Mechanical- physical characteristics are incompatible  
Gamete isolation- female reproductive tract is fatal to sperm

**Postzygotic** Zygote mortality- fertilisation occurs but zygote doesn't develop  
Inviability of zygote- develops to embryo but not further  
Sterile- offspring cannot reproduce

### Types of speciation:

**Allopatric** Occurs due to a geographical barrier and assumes no gene flow between populations

**Sympatric** Same geographic areas habitat preferences differ. Gene flow can occur.

### DNA structure

Double stranded double helix shape composed of nucleotides. Strands run from 5' to 3' and are antiparallel.

3 main components in a nucleotide. The nitrogenous bases hold strands together

**Nitrogenous bases** Adenine, thymine, cytosine, guanine.  
Form weak hydrogen bonds with complementary base.  
Chargaff's rule states A goes with T and C with G.  
A and G are purines with 1 ring.  
C and T are pyrimidines with 2 rings.  
A and T, 2 H bonds, C and G, 3 H bonds

**Phosphate group** Forms strong backbone with sugar molecules

**Sugar group** Deoxyribose sugar bound to phosphate at 5', nitrogenous base at 1' and previous nucleotide at 3'.

Semi-conservative replication as one strand from every new helix is from parent strand.

### Protein synthesis

DNA to protein - 3 stages; Transcription, mRNA processing, Translation

**Transcription** RNA polymerase unwinds dsDNA  
Adds RNA nucleotides complementary to template strand in 5' to 3' direction.  
Stops when polymerase reaches stop.  
dsDNA reanneals and primary RNA peels off

### Protein synthesis (cont)

**mRNA processing** Primary RNA transcript transformed into a form that can exit nucleus  
Leaves through a pore interacting with ribosome either in cytoplasm or on RER

**Translation** Small ribosomal subunit bonds to mRNA at 5'  
tRNA bonds to mRNA, the anticodon is complementary to codon.  
Large ribosomal unit attaches  
Next tRNA molecule enters the ribosome  
Complementary amino acids form polypeptide chain at opposite end  
Translation stops when a STOP is reached.

Proteins are large biological macromolecules, made up of amino acids, 3D shaped vital for correct functioning.

### RNA

Differs from DNA as it has a ribose sugar rather than deoxyribose, and uracil instead of thymine. It is also single stranded

### Types of RNA:

**mRNA** DNA is copied to RNA so it can be translated

**tRNA** Clover leaf shaped adapter molecule carrying amino acid

**rRNA** Important part of ribosome

### Mutations

Changes to DNA base sequence. Can be induced from exposure to mutagens or spontaneous.

Point mutations can be substitution insertion or deletion

**Silent mutations** Have no effect, base is changed but codon does not

**Missense** Can be minor- only one codon is altered, Major - frameshift where every acid past point is altered. Sickle cell anaemia

**Nonsense** Premature stop is created can result in cystic fibrosis.

Mutation can only be inherited if it occurs in a germline cell and is passed on.

### Natural selection

Mechanism by which evolution occurs

Removes less fit genes from gene pool, increasing allele frequency of fitter phenotypes.

Better phenotype means increased chance for reproduction thus higher allele frequency.

Can result in co-evolution if two species provide the selection pressure for each other.

### Fossils

Trace fossils are not the body but can be excrements or similar. Body fossils are bones or parts of the body preserved.

The process of fossilisation starts with organism death, the soft tissue decays and buried under sediment. The sediment solidifies and is exposed.

The process requires hard parts, quick burial, low oxygen environments.

Types of fossils:

**Mineralised** Organic matter is turned into minerals

### Fossils (cont)

**Mould** Organism completely decomposes and leaves an empty space

**Cast** An empty space filled with rocks fossil

Dating of fossils:

**Relative dating** Looks at the rock layer the fossil was found in and surrounding fossils with known age ranges

**Absolute dating** Uses radioisotopes which decay over time and measuring the level of different elements and the isotopes.

Transitional fossils are highly sought after as they can show traits from both the ancestral and modern forms of the organism.