

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 G0- arrest of cell cycle, dying or damages cells Synthesis- replication of DNA G2- continuation of growth and preparation
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Mitosis or meiosis see respective sections

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

Complete dominance	Dominant allele masks the recessive allele Recessive allele only has an effect when homozygous Dominant is capital letter, recessive lowercase.
Incomplete dominance	Neither allele is wholly dominant Heterozygous individual will show a blending 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. Can transport gases and small lipophilic molecules
Facilitated diffusion	Down the concentration gradient through transport proteins, passive. Channels transport small charged ions Carrier proteins transport small uncharged molecules like glucose
Osmosis	Net movement of water across a semipermeable membrane. Water moves from low solute concentration to high. Membrane must be permeable to water but not solute. Dilates 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 purine 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 fossil An empty space filled with rocks

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.