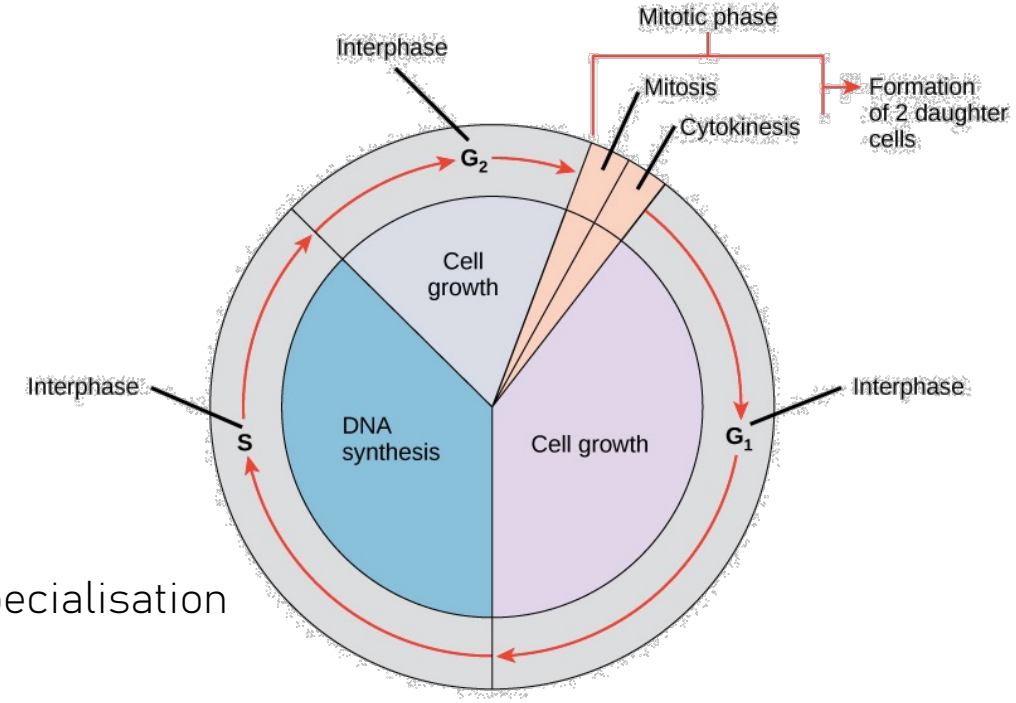
Cells

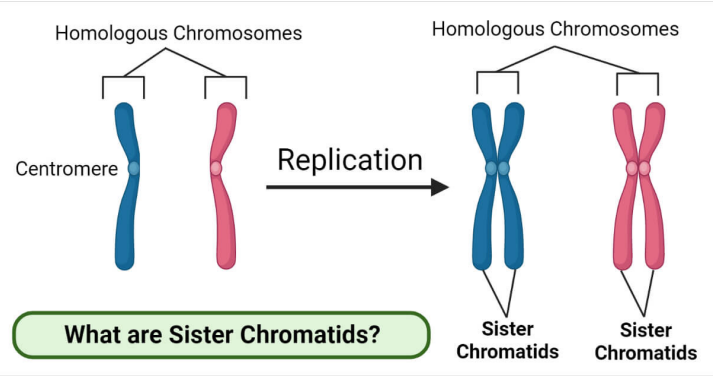
Topics covered:

- Cell cycle
- Cell death
- Mitosis and meiosis
- Stem cells
- Membrane transport

Cells cycle

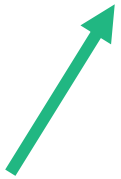
- Stages
- G0 phase – when the cell are in a quiescent phase – specialisation takes place here
- G1 phase – preparation for replication
- S phase – DNA replication – chromosomes number stay the same but it now exists are 2 sister chromatids
- G2 phase – Cell growth and prep for mitosis
- M phase – mitosis
- Cytokinesis – the cytoplasm is pinched to form 2 cells





Cell cycle regulation

P53 activates CDK inhibitor proteins to block cyclin-CDK activity. P53 then activates the repair enzymes to repair the DNA, if its isn't repairable then the p53 triggers programmed cells death so damaged DNA is not passed on



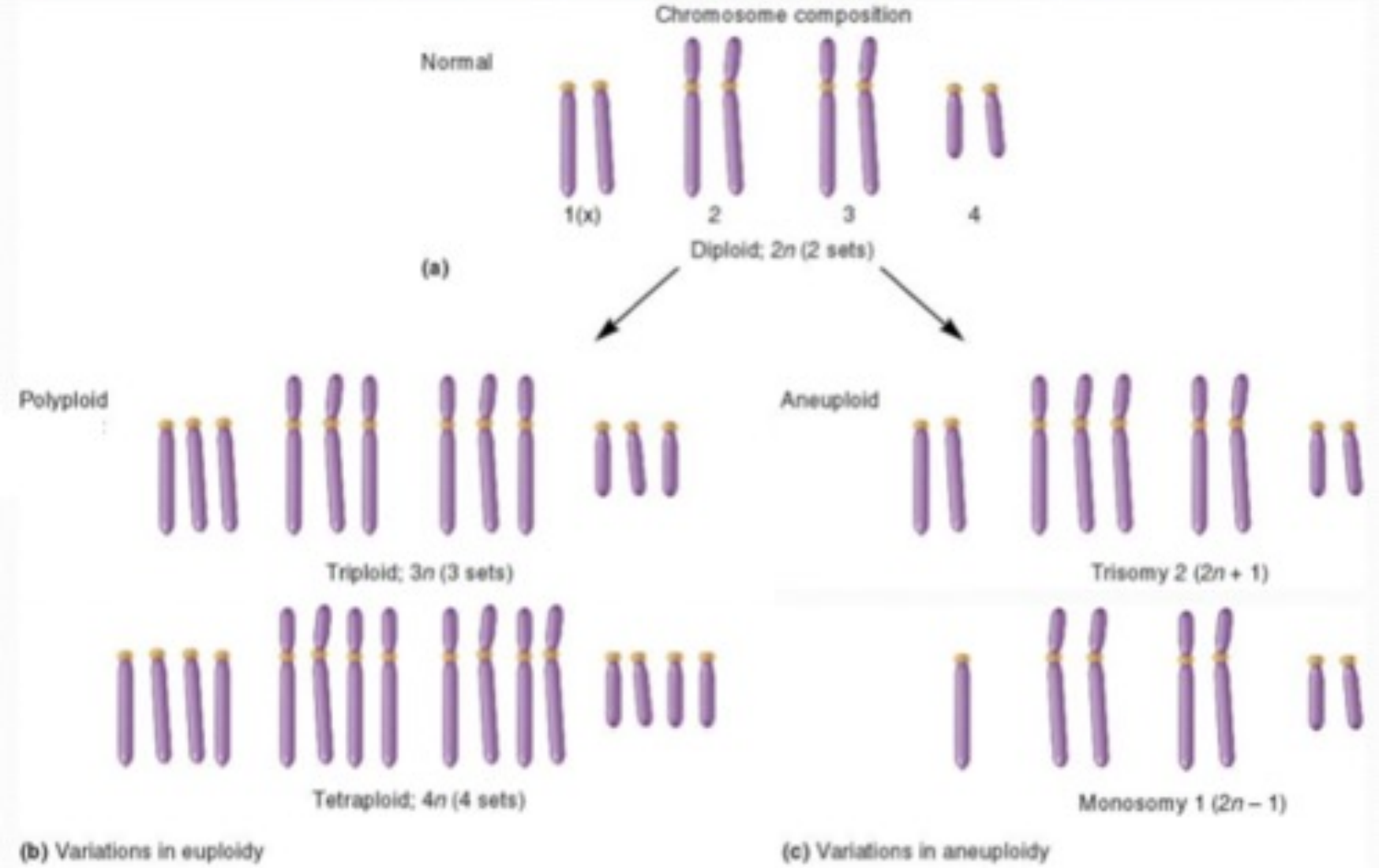
- There are checkpoints –
- G1 – p53 acts on this site – to check cell size, nutrients, growth factors and DNA integrity
- S – checks if DNA is replication properly
- G2 – ensures DNA fidelity (to ensure low error replication)
- Spindle chromosome – ensures chromatids attach to the spindles correctly

DNA fidelity = the ability of DNA polymerase to accurately synthesize a new strand from the template strand.
High Fidelity Copy= Means a very low-error DNA copy is produced from replication

Polyploidy and Aneuploidy

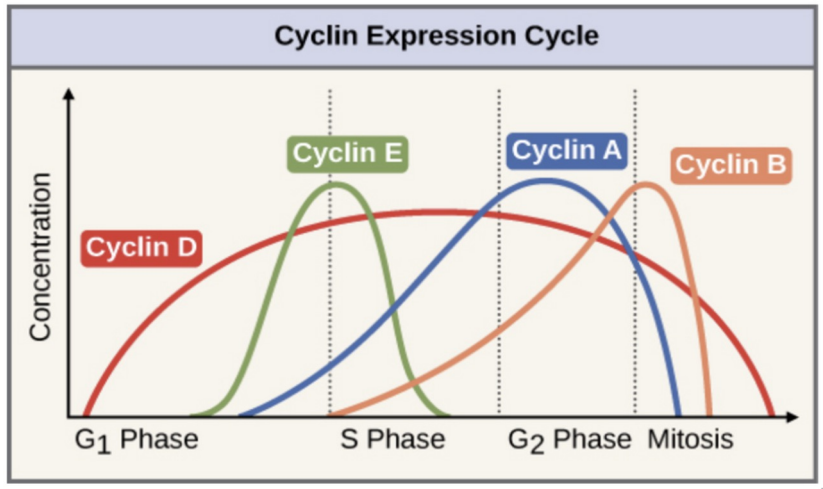
- Polyploidy = a numerical chromosomal abnormality in which an entire set of chromosomes has been added.
- Aneuploidy = the presence of an abnormal number of chromosomes in a cell (eg. trisomy 21 = 3 copies of chromosome 21 -> Down's syndrome) (eg monosomy= loss of one chromosome.)

Polyploidy *versus* Aneuploidy



Cyclins and CDK

- Cyclin - group of related proteins that control the progression of a cell through the cell cycle by activating CDKs
- CDK – cyclin dependent kinases
  - they activate the cyclin by bindijng, which phosphorylates the cyclin, activating it
- Different cyclins are present in different amounts
  - G1 - S transition = Cyclin D
  - S = Cyclin E
  - G2 - M transition = Cyclin A
  - Mitosis = Cyclin B



Cells death

- Apoptosis – controlled and programmed cell death
- Necrosis – cell death due to acute cellular injury and it isn't regulated
- Anoikis – controlled cell death, only in cells that are in contact with other cells i.e epithelial
- Autophagy – degradation and recycling of cellular components (damaged organelles, unused proteins) – may or may not lead to death

Apoptosis

Intrinsic	Extrinsic
1. Pro-apoptotic molecules BAX and BAC get activated 2. Cause an increase the permeability of the mitochondria 3. Causing it to release cytochrome C which cause the formation of apoptosome 4. Leads to the activation of caspase	1. Death ligand FAS and TRAIL bind to death receptors on the cell surface receptors 2. This leads to the activation of caspase molecules

Caspase - are proteolytic enzymes that are responsible for the proteolytic cleavage and breakdown of cellular components

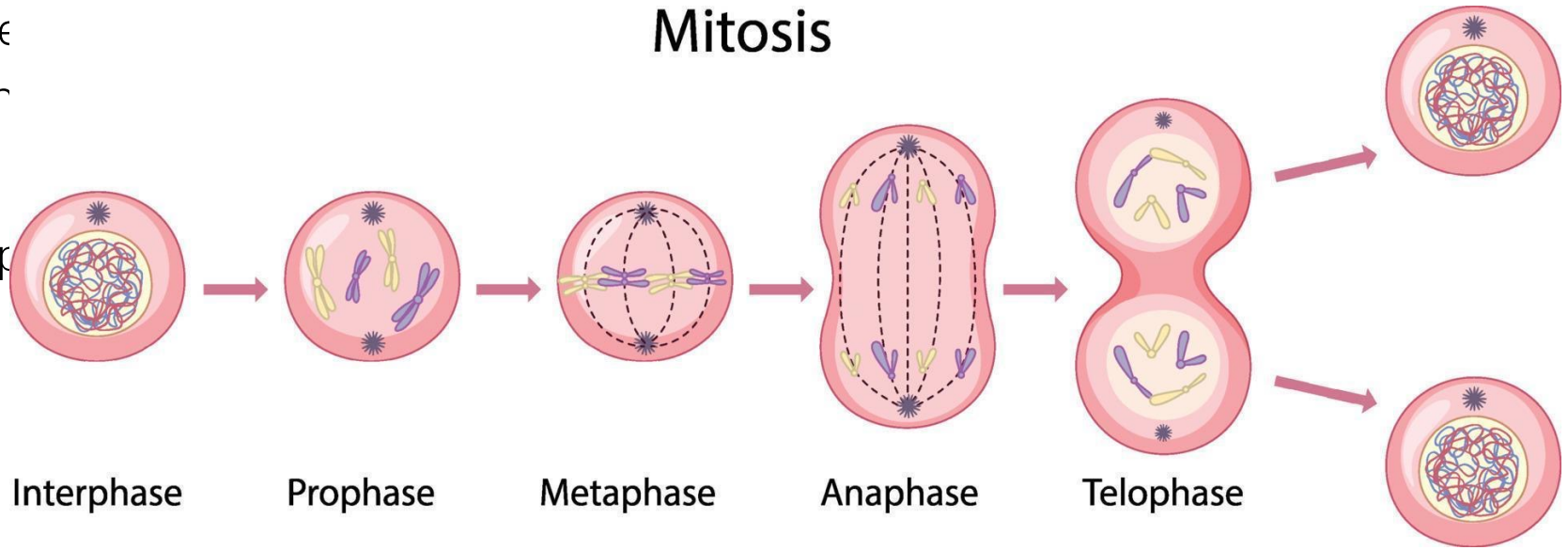
Necrosis, Anoikis, Autophagy

- Necrosis - Loss of membrane Integrity, Initiates an inflammatory response
- Anoikis –
  - Due to loss of cell-ECM (extracellular matrix) interaction
  - No inflammatory response
- Autophagy - Involves formation of an autophagosome(double membrane vesicle) that encapsulates cytoplasm, malformed proteins, organelles, or pathogens and then fuses with lysosome for degradation.

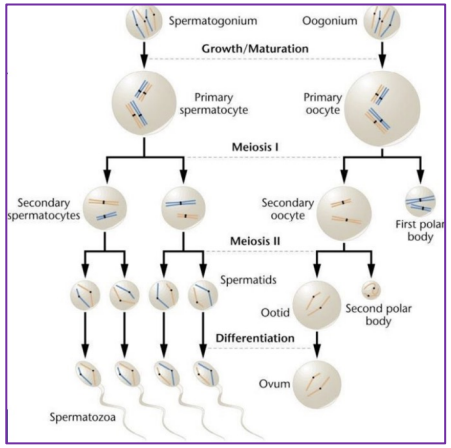
Mitosis and interphase

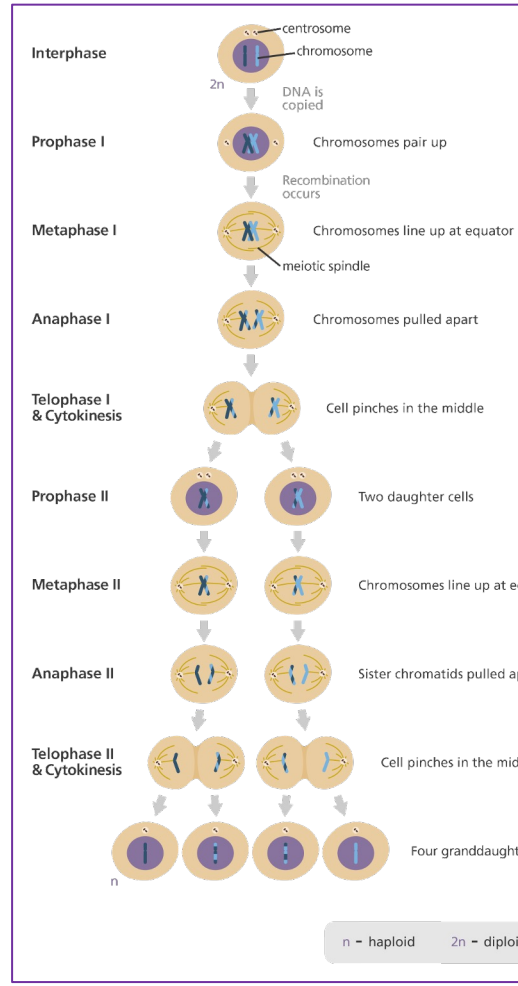
Interphase – the period where the cell increases its chemical composition to prepare for mitosis (nuclear division).

- Prophase = chromosomes condense, spindle forms, nucleolus degrades
- Metaphase = sister chromatids line up at equator. Spindle checkpoint before proceeding to anaphase.
- Anaphase = sister chromatids split at centromere & pulled apart to opposite poles of cell
- Telophase = mitotic spindle chromosomes, chromosor (chromatin).
- Cytokinesis = cytoplasm sp

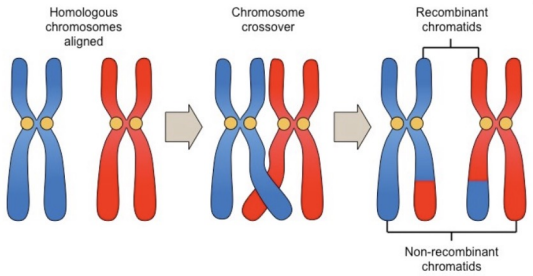


Meiosis





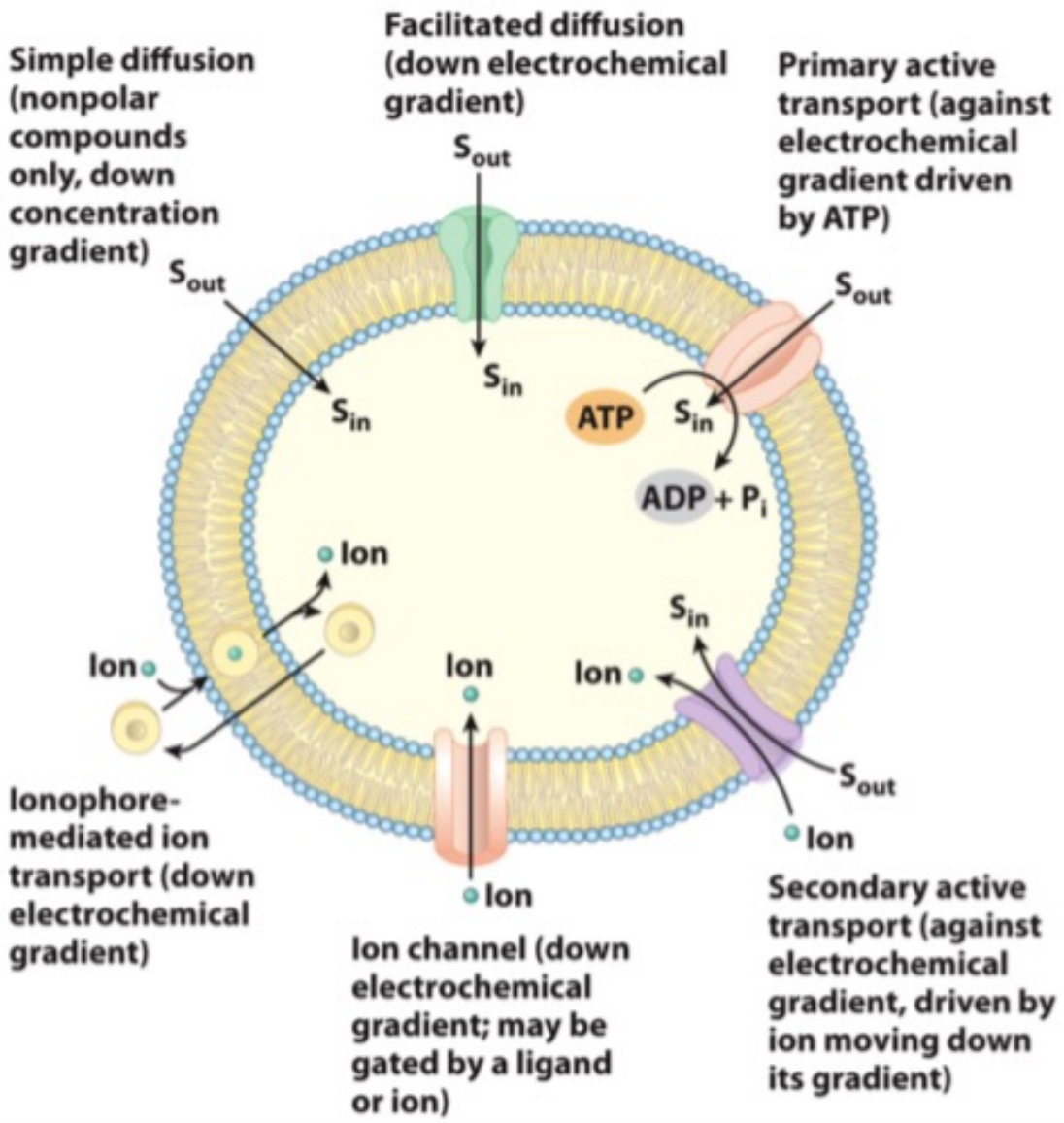
- 1 diploid cells undergoes 2 rounds of division -> resulting in 4 haploid cells
- Metaphase 1 – independent assortment of homologous chromosomes
- Prophase 1 - Chiasmata = exchanging of genetic material between homologous non-sister chromatids.
- Problems that might happen-
  - Germline mutation – heartibale change in the DNA that occurred in a germ cell (egg of sperm) -> more DNA replication = higher the change of error
    - Hence older people are more likely to have a offspring with disorder
  - Chromosome Non-dysjunction – is a failure of the sister chromatids to separate properly during cell division



STEM CELLS- undifferentiated cells that have the ability to specialise into cells of different potency

- Totipotent – can differentiate into any cells type (embryonic and extraembryonic)
- Pluripotent = can develop into cells of the 3 germs layers (endoderm, ectoderm and mesoderm)
- Multipotent – can develop into several different cells types (haematopoietic and epithelial stem cells)

- Potency increases the more differentiated it gets, i.e the totipotent stem cell has the highest potency



Types of transport

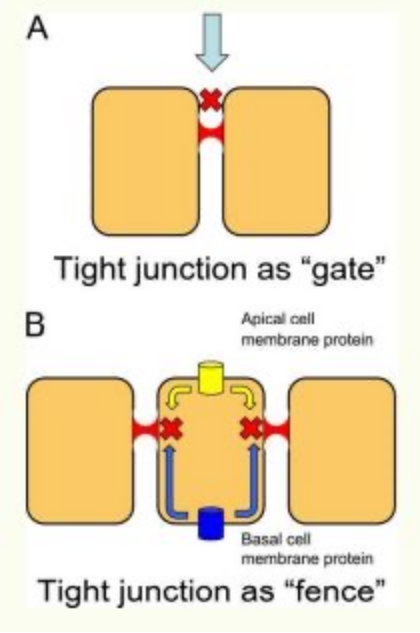
- Endocytosis – beings substance into the cells from a vesicle around cell
- Exocytosis – expels vesicles from cells -> releases to extracellular space
- Pinocytosis – process by which the liquid droplets are ingested by living cells
- Phagocytosis – Uptake of solid particles by cell

Cell signalling

- Endocrine – releases hormones that travel in the blood
- Autocrine – cell secretes hormone that acts on it self e.g prostaglandin
- Paracrine – cell secretes hormone that acts on nearby cells e.g nitrous oxide
- Juxtracrine/synaptic – neurotransmitters from pre synaptic neuron to post synaptic neuron
- Neurocrine – neurotransmitters acting on nervous tissue

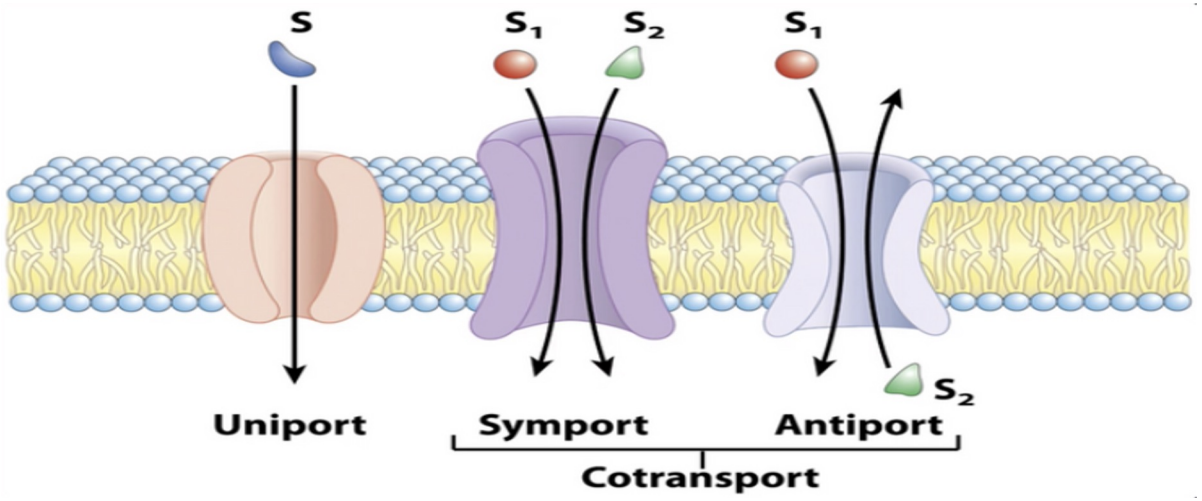
Direct cell to cell communication

- Tight junctions – joins cells
  - Restricts passage of molecules, stops movement of substances between cells
  - Fence and gate function
- Gap junctions – allows movement of molecules
  - Formed by connexons aligned together to from a channel between 2 cells
  - Allows passage of excitatory signals
- Cell adhesions – attaching to neighbouring cells
  - Maintain cell position via integrins



Types of transporters

- Uniporter = single substance moves in a single direction
- Symporter = two substances move in the same direction. (eg. Na+ Glucose transport)
- Antiporter = two substances move in opposite direction. (eg. Na+/H+ transport).

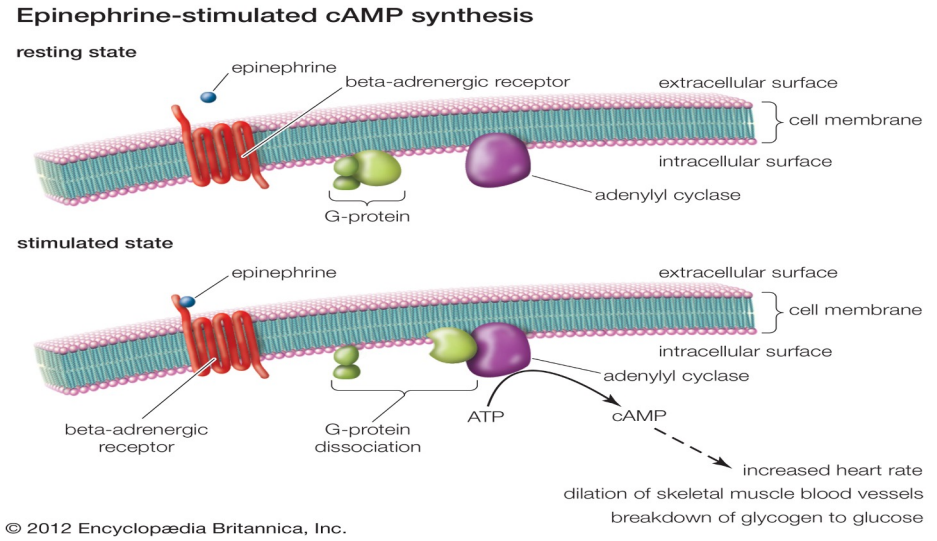


GPCR – G-protein coupled receptors

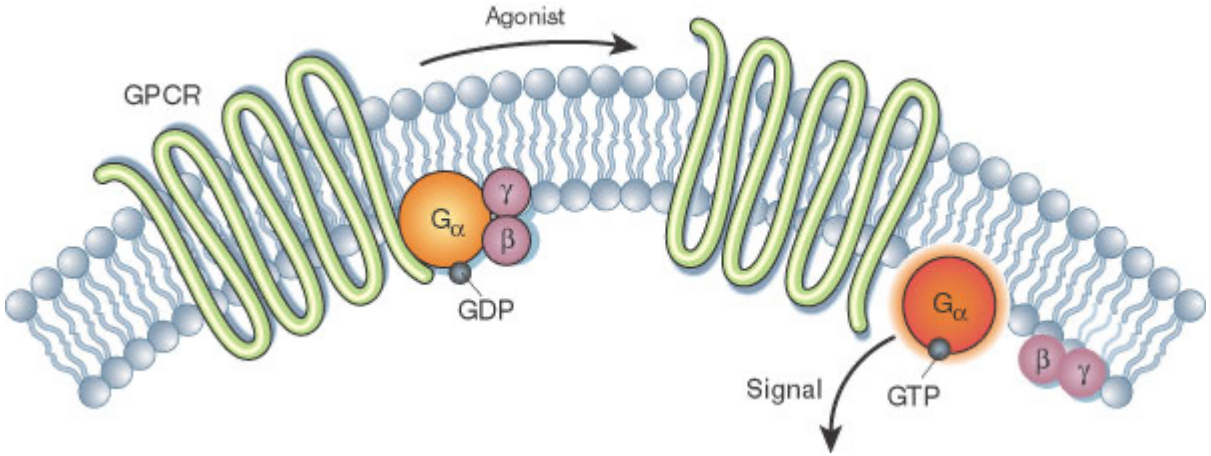
- G proteins consists of an alpha, beta and gamma subunit
- It forms GDP when inactive, which turns into GTP when active

Molecules bind to these receptors and activate an internal signal transduction pathway to eventually lead to a cellular response

Example in adrenergic receptors



Pathway for GPCR

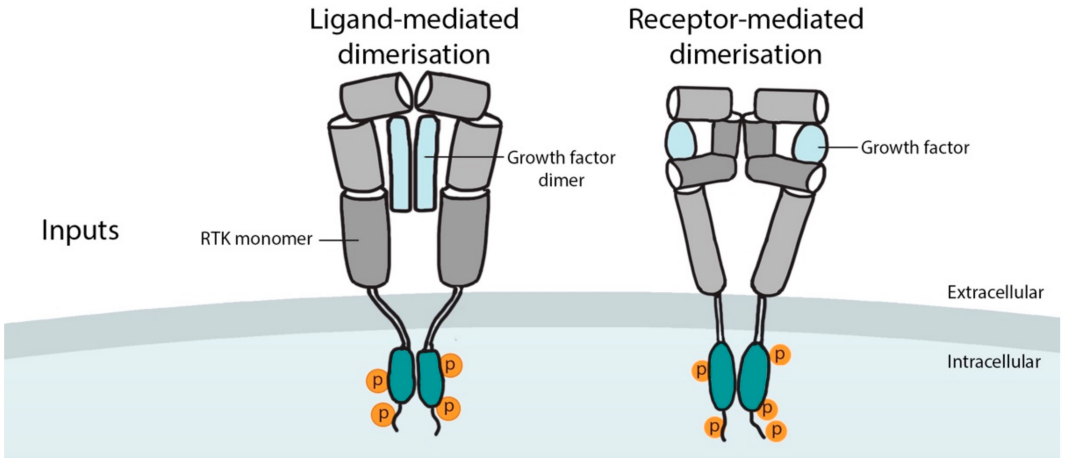


1. Extracellular ligand binds to the receptor creating a conformational change in the teritary structure of the receptor
2. This cause a interaction between the receptor and G-protein
3. GDP (initially bound to alpha subunit) is replaced by GTP
4. The G-protein the disoociated
   - Alpha-GTP complex binds and activates adenylate cyclase or phospholipase C
   - Beta and gamma complex mainly bind and activate ion channels and kinases
5. Alpha subunit stimulate the AC to convert ATP to cyclic AMP -> activates protein kinase A -> phosphorylates enzymes and proteins

An example in a sympathetic response – causes the release of glucose when glucagon binds

Tyrosine Kinase receptors

- Kinase – enzyme the phosphorylates compounds
- This recepters are formed by amino acid tyrosine
- STEPS
  1. Ligand binds to the receptors
  2. The tyrosine polypeptide join together to form a dimer
  3. The ligand activate the tyrosine regions to phosphorylate each other -> response in the cell



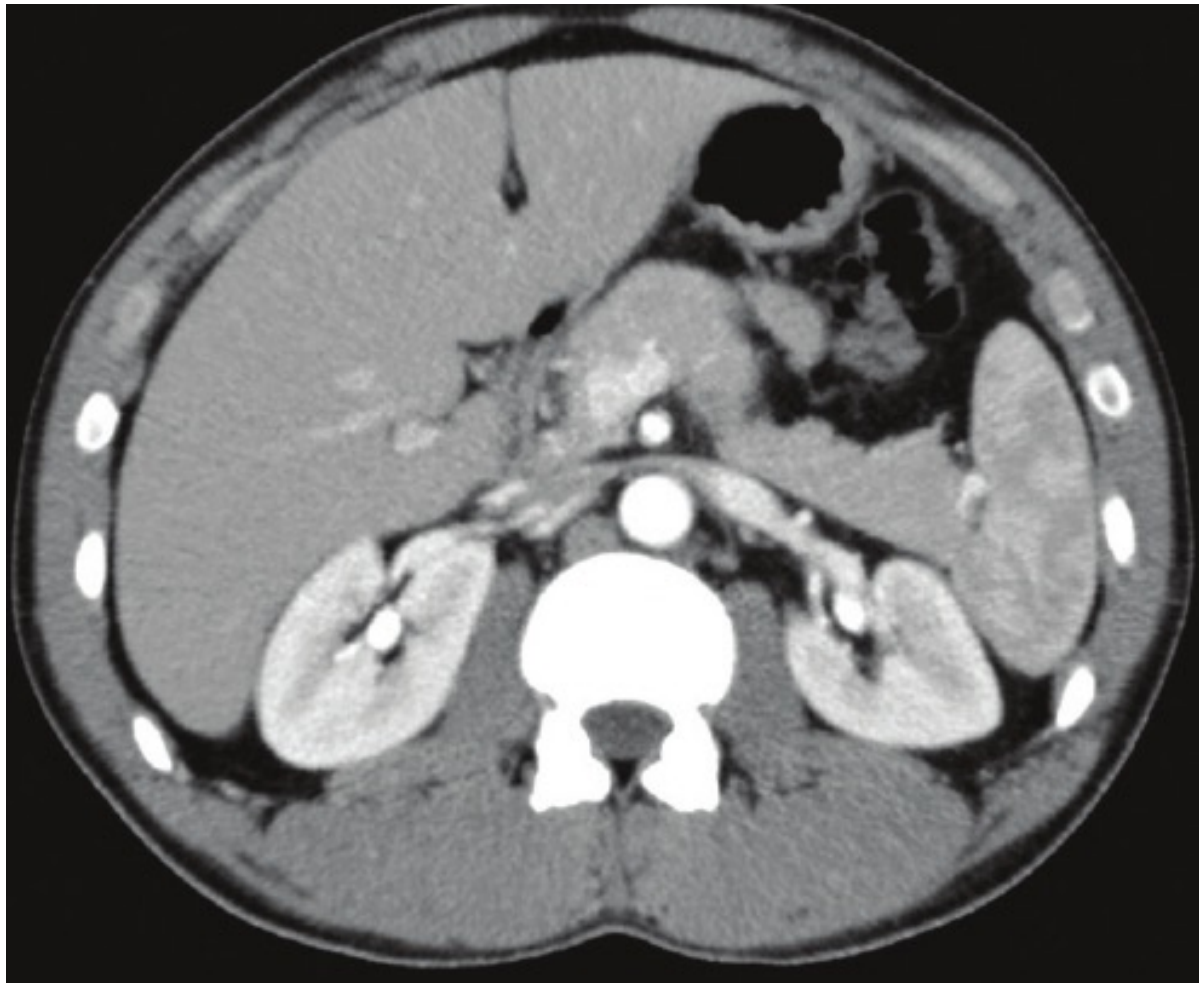
Example is insulin causes GLUT4 channels to be presented ->
more glucose moves in

Definitions

- Hormones - Chemical messengers that are released from a cell, travel in the blood to a target site, and affect change at the target site
- Nervous system –
  - Sympathetic – fight or flight
  - Parasympathetic – rest and digest
- Homeostasis - Maintenance of stable conditions in the body's internal, physical & chemical environment.

CT Scans

- Dense tissues like bone show up as white areas
- Both air and fat show up as dark gray or black
- Soft tissues and any fluid, including blood, will show up in various shades of gray
- Different types of contrast (which shine bright white on the films) are used to better define the structures inside you



The superfamily of metabotropic receptors involves in many transduction pathways commonly mediated by changes in the activity of intracellular calcium or cyclic AMP

A. Cys-loop pentameric
B. GPCR
C. Histadine kinases
D. Tyrosine kinase
E. Nuclear

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A. RNA polymerase
B. DNA polymerase
C. The expression of cyclins
D. The expression of CDKs
E. Rb

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At which cell cycle checkpoint does the p53 act on

A. G0
B. G1
C. G2
D. S
E. Mitosis

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