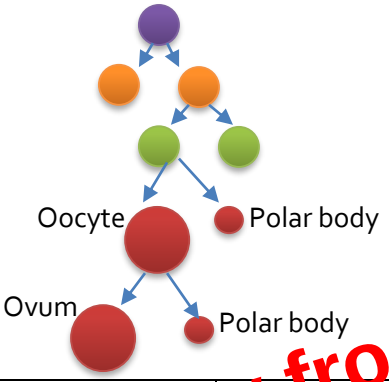
Hormonal control of spermatogenesis

Hormone	Where it's secreted	Effect on testes
FSH	Pituitary	Stimulates the germinal epithelium to begin spermatogenesis (up to meiosis II)
LH	Pituitary	Stimulates the leydig cells to produce testosterone
Testosterone	Testes (leydig cells in interstitial spaces)	stimulates the spermatogenesis to completion

Ova

Oogenesis

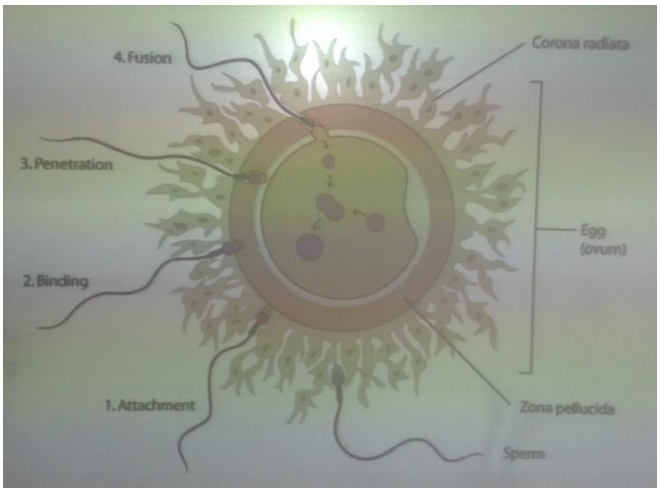
1. Germinal epithelium goes through Mitosis to produce oogonium (during foetal development)
2. Oogonium goes through mitosis to produce oocyte (during childhood)
3. Primary oocyte goes through meiosis I to produce secondary oocyte (during menstrual cycle)
4. Secondary oocyte goes through meiosis II to produce ovum (during fertilization)



	Oogenesis	Spermatogenesis
Number of gametes	Millions of oogonia formed Hundreds of thousands of primary oocytes Few secondary oocytes 1 ovum per menstrual cycle	Millions and millions
Timing of the formation of gametes	Start during pregnancy Ends during pregnancy Completed during fertilisation	All through life from puberty
Timing of the release	Ovulation	During ejaculation/sexual reproduction

Fertilization

- Vagina is acidic, pH of semen is alkaline (prostate) to neuralise
- Sperm swim to oviduct
- Pass through follicle cells
- Hydrolytic enzyme of acrosome digest glycoprotein of zona pellucida causes *capacitation* – preparation of sperm
- Membrane of head of sperm fuses with oocyte membrane
- As this happens cortical granules release contents outside oocyte by exocytosis which prevents more sperm crossing membrane (*cortical reaction*)
- Also triggers rest of meiosis II (2nd polar body formed)
- Male/female nuclei join – fertilization complete



- Rough endoplasmic reticulum
  - Lots of ribosomes
  - Protein synthesis
- There are free-floating ribosomes
  - Free-floating
    - Produce proteins used within the cell
  - Stuck to ER
    - Proteins packaged and secreted out

What is a cell?

- CELL THEORY
  - Old concepts
    - Cells are the building blocks of life
    - Cells are the smallest unit of life
    - Cells are derived from other cells
  - New concepts
    - cells contain the blueprint for their own growth, development and behavior
    - Cells are the site of all the chemical reactions needed to sustain life
    - Cells (and multi-cellular organisms) show emergent properties

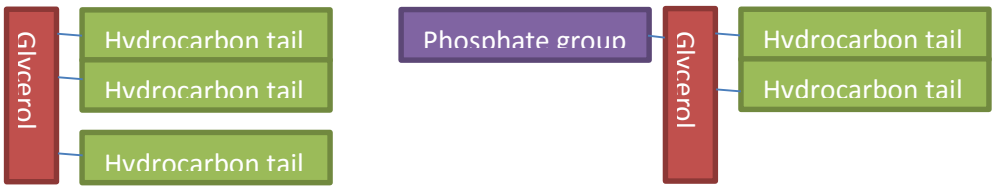
Cell Membrane

The structure of the plasma membrane

- The basic structure of all cellular membranes is the same
  - Nuclear membrane
  - Chloroplast membrane
  - SER & RER
  - Golgi
  - Vesicles (incl. lysosomes)
- They are all **bilayers of phospholipid molecules**
  - the membrane bilayer is made of 2 layers of phospholipids
  - a phospholipid is a modified lipid (a lipid (glycerol + 3 fatty acids) where one of the fatty acids is replaced with a phosphate group

The functions of membranes are

- Control of entry/exit of material
- Recognition (cell - cell/cell - molecule)
- Boundary between cell and environment
- Isolation of organelles within cells
- Internal transport (Endoplasmic reticulum)
- Isolation of enzymes (lysosomes)
- Provide metabolic surfaces (RER, mesosomes in prokaryotes, crista in mitochondria)



A lipid (triglyceride) Phospholipid

- Hydrocarbons are long chains of CH2 and so they are very hydrophobic (“water hating”)
- The phosphate has lots of Oxygen and so is highly hydrophilic (“water loving”)
- This means they are both soluble and insoluble in water
- The phospholipids give the membrane its basic structure as well as its fluid nature (it is called the fluid mosaic model)
- But membranes also have a lot of other molecules attached or embedded in them included
  - Proteins
  - Glycoproteins
  - Glycolipids
  - Cholesterol
- These carry out the specific functions of the membrane

7. Transpiration Stream
    1. Evaporation
    2. Osmotic pressures
    3. Mass flow
8. Role of transpiration
    1. Unavoidable as they have stomata
    2. Bring H2O + ions
    3. Cools
9. Adaptations to reduce transpiration
    1. Stomata
    2. Waxy cuticle
    3. C4 plants open stomata at night (normal plants are C3 as make a 3-C compound in photosynthesis
10. Factors affecting rate of transpiration

Anything that will affect the rate of evaporation will affect the rate of transpiration:

1. Light (only because this determines if the stomata are open or closed)
2. Temperature
3. Wind
4. Humidity

Xerophytes, mesophytes, hydrophytes

- **Xerophyte:** plants adapted to low water environments
- **Mesophytes:** plants adapted to average water environments
- **Hydrophytes:** plants adapted to high water environments

Phloem

Functions of Phloem

Source	Sink
Leaves	Root & shoot Apices
Storage organs	Flowers, Fruits, Seeds etc. Buds Storage organs

Direction of Flow in Phloem

- Plant material is sent up and down the plant

How do we know?

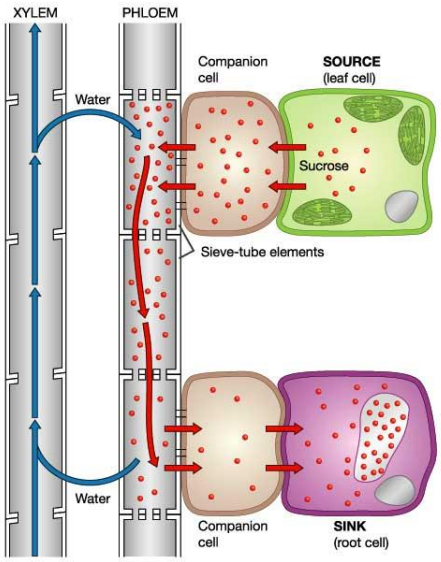
- Use radioactive substrates and aphids (greenfly)

Phloem structure

- Phloem vessels are made of sieve tube element joined end to end
- Cells still contain some cytoplasm with some organelles (but no mitochondria or nucleus)
- Each sieve tube has a companion cell
- Both sieve tube element and companion cell form from same mitotic division
- If one dies the other does too
- The ends of the sieve tubes are perforated - to form end plates

Phloem transport (translocation)

- Active transport of material (sugar & amino acids) into cells at source + out of cells in sinks
- Generates osmotic potential gradients + hydrostatic pressures
- Causing mass flow



Calvin Cycle

- The ATP and NADPH are formed during photophosphorylation are then used in the Light Independent reactions (aka carbon fixation or the carbon cycle)
- In the 1940s & 50s Melvin Calvin worked out the process of CO_2 fixation in photosynthesizing green algae
- By feeding the algae $^{14}CO_2$ and at time intervals looking at the products of fixation he could work out the sequence of events that lead to the formation of complex molecules.
- What he found was the dark reactions are a cycle of 3 segments:
  - carboxylation
  - reduction
  - regeneration
- The Light Independent Reactions
  - Carboxylation involves the addition of CO_2 to a 5-carbon compound called Ribulose 1,5 bisphosphate
  - By the enzyme ribulose 1,5 bisphosphate carboxylase (Rubisco)
  - To form an unstable 6-C compound that immediately breaks down into 2 molecules of 3-C Glycerate 3 phosphate (GP)
  - Rubisco is, by far, the most abundant protein in the world
  - It is estimated that as much as 1/4 of all the protein in leaves is rubisco
  - Rubisco, therefore, makes up a substantial part of our diets
  - Reduction of the GP to form Triose phosphate (TP) is the reverse of glycolysis in respiration and requires the energy from ATP (from the light reaction) and the reducing power of NADPH to complete the conversion
  - Regeneration of ribulose 1,5 bisphosphate requires 2 molecules of TP and one molecule of ATP

Measuring photosynthesis

- Generally we measure rates by disappearance of substrates or appearance products
- Limiting factors
  - In any complex process involving many different steps and components there will be many different factors affecting the rate
  - The actual rate of reaction will be determined by the factor that is in shortest supply (in chemistry this is the rate limiting step)
  - E.g. In the dark photosynthesis will not occur, no matter what the temperature, the concentration of CO_2 or the amount of water
- As the light intensity increases, the rate of photosynthesis increases
- But there will come to a point when increasing the light intensity further has no effect
- Because a different factor is now in short supply e.g. CO_2 concentration
- There are 4 main limiting factors for photosynthesis:
  - Light
  - CO_2 concentration
  - Wavelength of light
  - Temperature
  - **NB Water is not a limiting factor**
- The light compensation point
  - As well as photosynthesising plants also respire:
    - $CO_2 + H_2O \rightarrow C_6H_{12}O_6 + O_2$
    - $C_6H_{12}O_6 + O_2 \rightarrow CO_2 + H_2O$
  - If the rate of photosynthesis is the same as that of respiration plants will produce as much O_2 in photosynthesis as they use in respiration
  - There will be no net production of O_2
  - The amount of light required to allow photosynthesis to proceed at this rate is called the light compensation point.

Cell Division

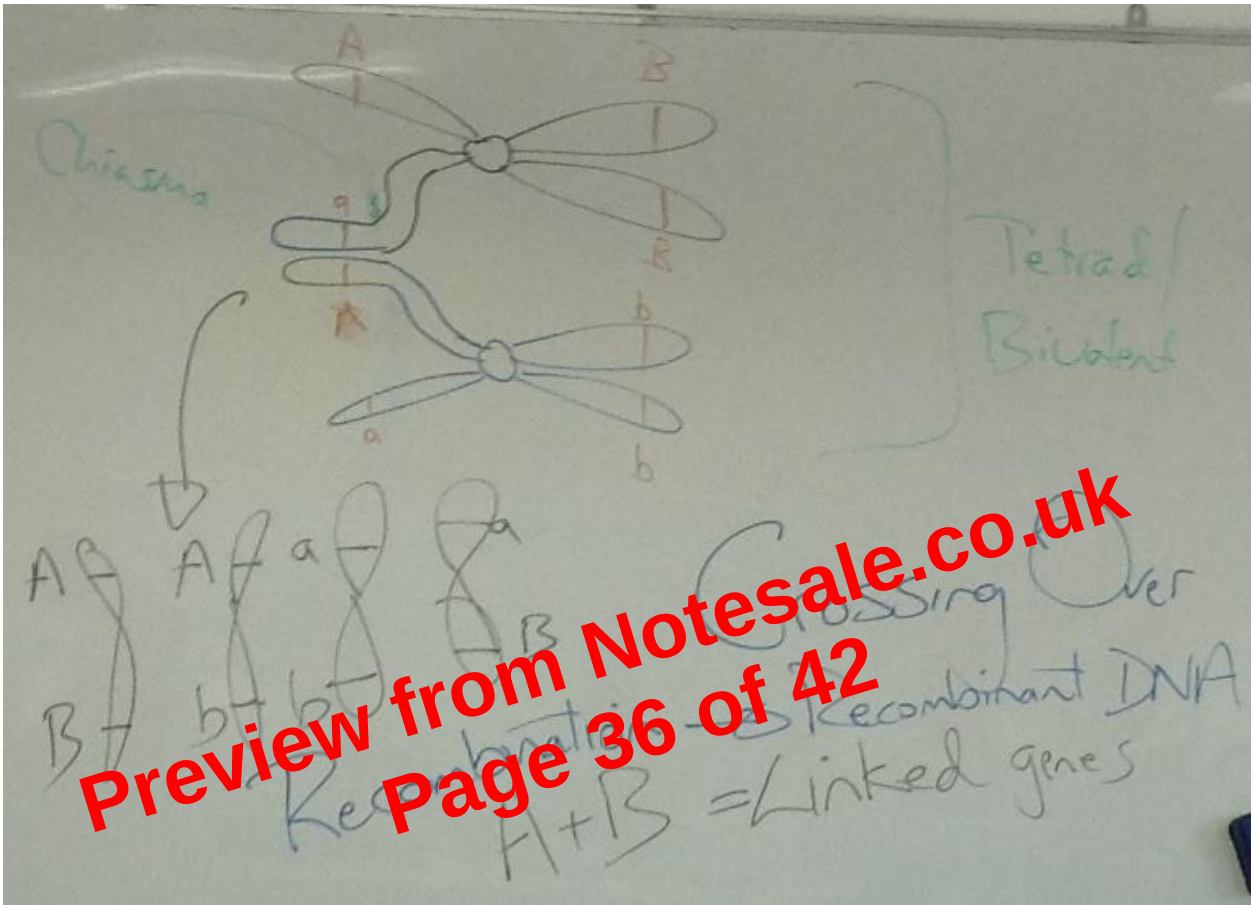
- Why do cells divide?
  - To allow us to grow
  - To replace old cells
  - To repair damaged tissues
  - Asexual reproduction
  - Formation of gametes in sexual production
  - 2 types of cell division

Meiosis

Bivalents

- In 1st stage of meisosis, DNA condense to form chromosomes
- But homologous pairs join together a chiasma to form *bivalents* or *tetrad*
-

Crossing over



Analogous characteristics

- Same function
- E.g. bat wing, butterfly wing, beetle wing, bird wing, flying fox "wing", flying fish "wing"
- Artificial classification

Linaean binomial classification system

- Swedish botanist (1707 – 1778)
- All organisms given 2 names – generic name (genus) and specific name (species)
- There then collected together into bigger and bigger groups (taxa)
- Taxonomy – Study of classification

Kingdom	Animalia
Phylum	Chordata
Class	Mammalia
Order	Primate
Family	Hominidae
Genus	*Homo*
Species	*sapiens*

RULES!

- Genus and species always in *italics* (or underlined)
- Genus always has a capital letter, species is lower case
- First time you use it you must spell it out in full (e.g. *Homo sapiens*) but second time can abbreviate genus (e.g. *H. sapiens*)
    - Exception is E. coli
- If you don't know the species, just write the genus and then sp (e.g. *H. sp*)
- If you mean all of the species you can write spp (e.g. *H. spp*)

Need to know characteristics of:

- Bryophytes
- Filicinophytes
- Coniferophytes
- Angiospermophytes
- Porifera
- Cnidaria
- Platyhelminthes
- Nematodes
- Molluscs
- Arthropods
- Plants
- Animals
- Viruses
- Fungi
- Protists

Evolution

- The change in organisms over millions of years due to the accumulative of many small changes driven by natural selection

Some more important terms:

- Reproductive success
    - Passing on genes to the next generation so that they too can then pass on
- Speciation
    - Formation of a new species
- Selection pressure
    - Anything that reduces the chances of reproductive success

Notes:

- Organisms evolve from common ancestors that split to create different species – speciation by divergence
- Frequently occurs due to separation of species geographically and so populations subsequently subjected to different

- As the half-life of ^{40}K is 1250 million years it can be used for specimens older than 100,000 years old (human fossils)
- There will however always be some degree of error as:
  - Any form of testing has some inherent error
  - It relies on accurate measurements of the various isotopes
  - You cannot guarantee a contaminant-free sample
  - Both argon and nitrogen are gases and so some will be lost
  - There is the assumption that the ratio is ^{12}C to ^{14}C stays the same

Chemistry of Life

Need to know how to draw Glucose: