Biology Notes

Life Processes

- there are 8 life processes which are common to most living things:
    - Movement (either with muscles or by slow growth)
    - Reproduce (produce offspring)
    - Sensitivity (sense and respond to stimuli)
    - Control (manage their internal conditions)
    - Nutrition (make or get food)
    - Excretion (get rid of toxic waste products)
    - Respiration (get energy from food)
    - Growth (increase in size and mass using materials from food)
- **MRS C. NERG**

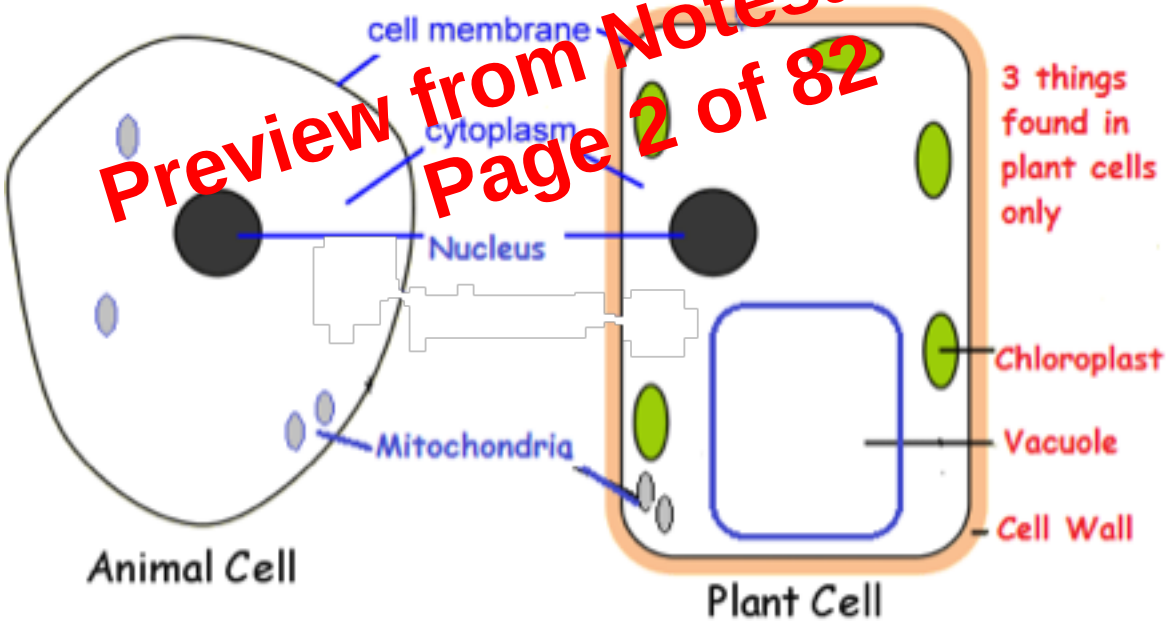
Cytology

- Levels of organisation in organisms:
    - Organelles (differentiated structure within a cell with a specific function)
    - Cells (smallest structural unit of an organism that is considered to be living as it is capable of independent functioning)
    - Tissues (selection of similar specialised cells performing the same function together)
    - Organs (different tissues working together for the same purpose)
    - Systems (a group of organs working together to perform a life process)
- Cell structures
    - nucleus (controls all the activities of the cell and contains DNA)
    - cytoplasm (jelly-like substance in which chemical reaction occur (called the metabolism) and organelles sit)
    - cell (surface) membrane (forms a boundary between a cell and outside and is selectively permeable, controlling which chemicals pass in and out of a cell)
    - cell wall (non-living material outside cell membrane of plants, made mainly of cellulose, tough so keeps cell shape and prevents it bursting in high

turgor pressure, freely permeable having large holes to let chemicals through)

- chloroplast (found in green parts of plants, use light energy to make food through photosynthesis contain chlorophyll)
- permanent vacuole (a large central store of cell sap found in plants, stores water, sugars, mineral ions as well as maintaining structure, animal cells have small temporary vacuoles)
- mitochondrion (carries out some of the reactions involved in respiration, most of the energy from respiration is released within)
- starch (in plants)/ glycogen (in animals) granules (store energy)

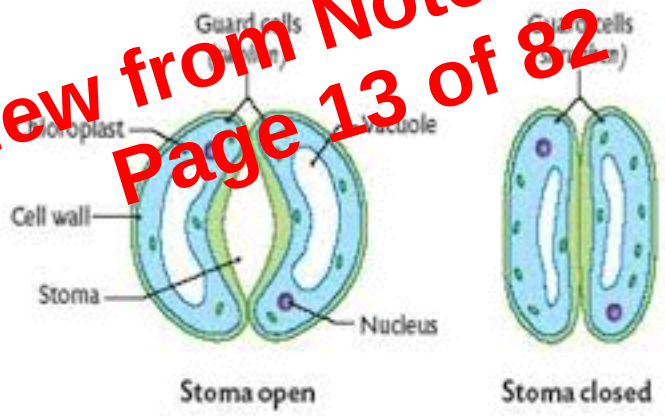
- Cell structures only found in plant cells
  - Cell Wall
  - Chloroplasts
  - Permanent vacuole
  - starch granules



- Preparation of microscope slides
  - place thin layer of tissue on slide
  - use a pipet to transfer dyes onto the sample (e.g. methylene blue to observe the nucleus in an animal cell or iodine to stain starch granules in plant cells)

- stomata in lower epidermis (allow air to enter and exit leaf)
- air spaces in spongey mesophyll (gives the leaf a large surface area over which gas exchange can occur)

- Stomata and guard cells
  - the top of the leaf is covered in a waxy cuticle to prevent water loss
  - thus oxygen, carbon dioxide and water vapour mostly pass through holes in the leaf called stomata
  - water is vital for the plant to photosynthesise and so transpiration through the stomata must be limited but it is also vital that n through them
  - guard cells control the stomatal opening
  - during the day the guard cells are turgid (since they have a lot of chloroplasts and so produce a lot of sugar which draws in water through osmosis) and so the stomatal opening is open allowing in the gasses needed for metabolism and the waste products out
  - however at night or when the plant is suffering from a lack of water, the guard cells are flaccid and so the stomatal opening is closed preventing excess water loss



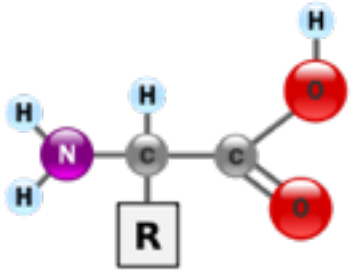
- Metabolism in plants
  - plants respire all the time
  - however they only photosynthesise in the presence of light
  - this means that the net exchange of carbon dioxide and oxygen depends on light intensity
  - when light levels are low respiration produces more carbon dioxide than photosynthesis uses and uses more oxygen than photosynthesis produces meaning that overall carbon dioxide moves out of the stomata and oxygen moves in

- they are heterotrophs
- they have no cell walls and store energy as glycogen
- they usually have a nervous system and are able to more around
- five vertebrate (have a back bone) groups: fish, amphibians, birds, reptiles, mammals
- some are invertebrates (lacking a back bone) like sponges, molluscs, worms, crustaceans and insects
- examples include *Homo Sapiens*, humans and *Mosquitos*, small midge-like flies

Biochemistry

Formation

- Carbohydrates: Carbon, Hydrogen, Oxygen in $C_nH_{2n}0_n$ ($n \geq 3$): generally provide energy
  - Examples:
    - Polysaccharides (Many sugars) – Cellulose, Starch, Glycogen (multiple units of glucose)
    - Monosaccharides (single sugars) – Glucose, Galactose, Fructose
    - Disaccharides (double sugars) – Sucrose (Glucose+Fructose), Lactose (Glucose+Galactose), Maltose (Glucose+Sucrose)
- Proteins: long chains of Amino Acids - CHONS (Carbon, Hydrogen, Oxygen, Nitrogen, Sulphur): generally for growth
  - There are 20 different kinds of amino acids each one is determined by the R group made from nitrates and sulphates.
  - Essential amino acids are ones we must have in our diets. Nonessential amino acids can be synthesised in the human body
  - amino acids are joined by a peptide bond and a short chain of amino acids is referred to as a peptide



        - NB: Doesn't work with Sucrose, which has to be reduced first.
    - Test for protein - Add sodium hydroxide to a suspension of protein in water. This breaks the peptide bonds. Add Copper Sulphate solution. Positive test = the solution will turn from blue to purple.
    - Test for Lipids 1 = Will leave a translucent mark on blotting paper, which won't dry out.
    - Test for Lipids 2 = Add Ethanol to an oil. Then add water. Positive test = Liquid turns white and opaque.

Enzymes

- Biological Catalysts = Speeds up a reaction by providing an alternate pathway with a lower activation energy, without being used up itself. Found in cells/alimentary canal.
    - Catabolic = Breaks down. Eg. Salivary amylase turns starch to maltose.
    - Anabolic = Builds up. Eg. DNA Polymerase turns nucleotides to DNA.
- Lock and Key Theory
    - Enzyme has active site which fits one substrate only.
    - This active site provides surface for reaction
    - Enzyme + Substrate ⇔Enzyme-Substrate Complex ⇔Enzyme + Product
- Denaturation = Loss of 3D Shape of an enzyme, and therefore loss of active site shape
- Effect of Temp.
    - Speed of reaction will rise until a point (40) where the enzyme will denature.
    - At this point it won't work any more, because no more active site shape.
- Effect of pH
    - Enzymes only work in very specific pH ranges (usually roughly neutral.)
    - Once they leave this range, they will stop working permanently, due to denaturation.
- Experiments to work this out:
    - Place enzyme+substrate in water baths at different temperatures, and see how long it takes for the enzyme to break down the substrate.
        - Eg. Place starch and amylase in test-tube at different temperatures from 20 – 80 degrees. Do a starch test on samples (taken with pipettes) every 30 seconds, and see how long until there is no starch left.

1. Cut three cores and measure their mass. Place one in pure water, one in water with a high sugar concentration and one in a solution of similar concentration tho that of the potato

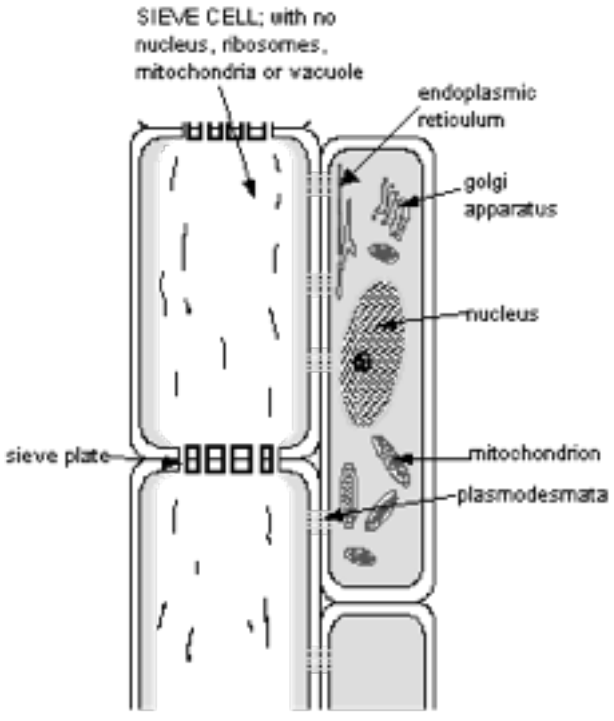
2. The one in pure water will swell up and gain mass due to water passing from the high water potential of the pure water to the comparatively low water potential of the potato core via osmosis

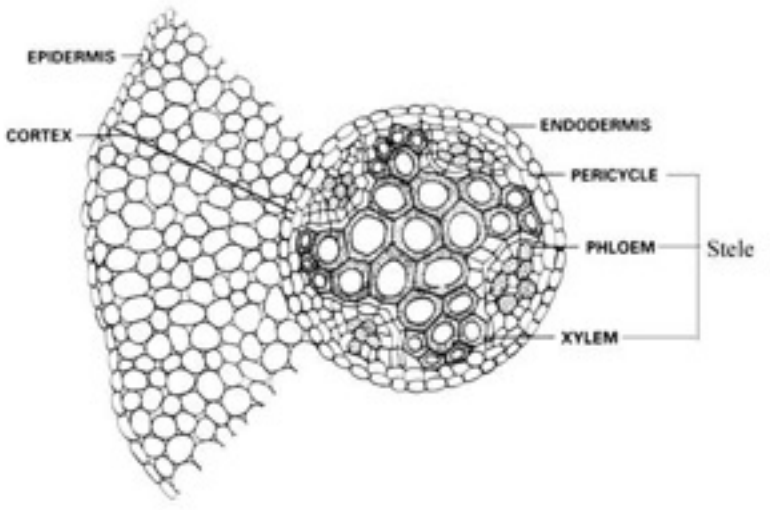
3. The one in the water with a high sugar concentration will shrink and lose mass due to water passing from the high water potential of the water with a high sugar concentration to the comparatively low water potential of the potato core via osmosis

4. The one put in the solution of similar concentration tho that of the potato will remain the same size and mass as there is no water-potential gradient and so no osmosis occurs

- Phloem (transporting sucrose and amino acids):

1. transports sucrose and amino acids from the leaves (sources) to the rest of the plant (sinks) especially growing areas/storage areas/fruits and seeds
2. made up of sieve cells (living but with no nucleus or mitochondria and small holes at the end called sieve plates) and companion cells
3. works on a pressure flow system (and so can move substances up and down the plant)
4. sucrose (formed from glucose and fructose molecules via a condensation reaction d) and amino acids (synthesised in the leaves) are moved into the sieve cells by the companion cells via active transport
5. this causes water potential of the leaf sieve tube to decrease
6. water then moves into the sieve cell via osmosis
7. this increases the turgor pressure which then forces the dissolved sucrose and amino acids along the phloem to the sinks
8. in the sinks the companion cells move the sugars and amino acids out of the sieve cells via active transport
9. this increases the water potential of the root sieve cells
10. water then moves out of the sieve cells via osmosis
11. this lowers the tutor pressure
12. thus a turgor pressure gradient is maintained from source to sink ensuring the flow of sugars and amino acids up or down\





Cost	Initially high but then very low	Generally high restricting use to wealthy nations

Diet and Digestion

Diet:

- Diet: The food that we eat
- *Balanced* Diet: All the necessary foods in their right properties for a healthy life.
- Components:
    1. Carbohydrates
    2. Fibre
    3. Protein
    4. Lipids
    5. Minerals
    6. Vitamins
    7. Water
    8. Nucleic Acids

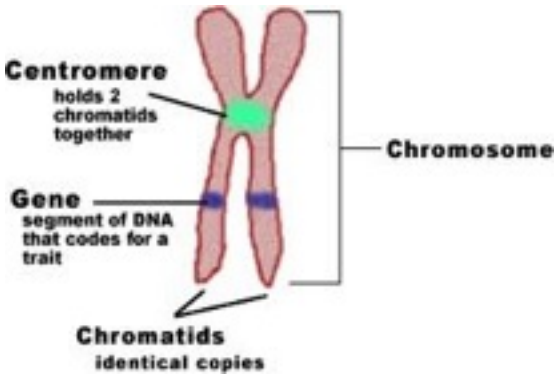
Carbohydrates	Lipids	Proteins
Sugars/Starch	Oils/Fats	
Energy (storage)	Long term energy stores	Growth/Enzymes
17kJ	39kJ	18kJ

- Factors determining diet:
    1. Fitness
    2. Daily Exercise
    3. Age
    4. Sex
    5. Pregnancy
    6. Illness
    7. Allergies

Vitamins

Vitamin	Why	Deficiency	Storage

2. Then DNA replicates but remains joins. This is prophase. Here there are 43 chromosomes with 2 chromatids per chromosome.



3. Then the cell splits via mitosis to form two identical daughter cells with 46 chromosomes each

- Meiosis:

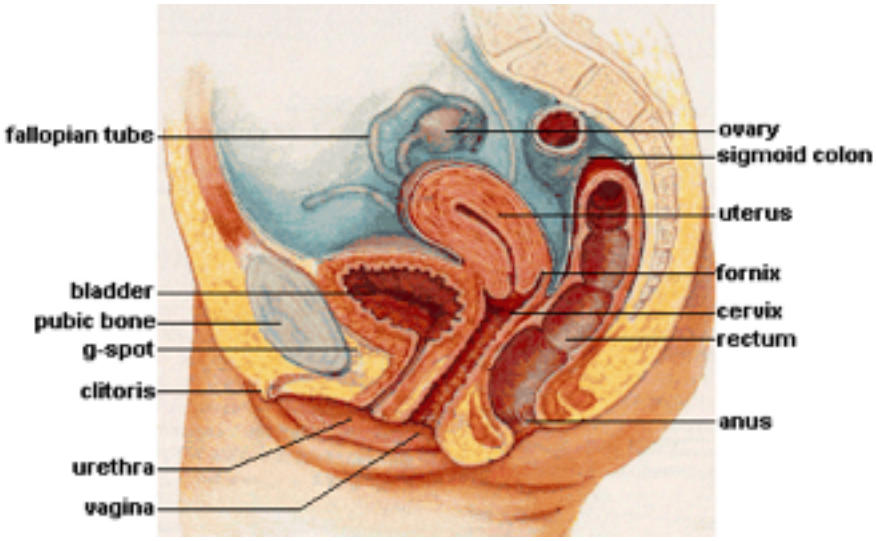
1. Meiosis creates gonads which need half the number of chromosomes. It therefore needs to make haploid cells so when the two gametes fuse it makes a diploid cell.
2. The process starts the same as mitosis making the DNA replicate so there is one cell with 43 pairs of chromatids.
3. Then reduction division occurs when the cell splits making 2 cells with 46 chromatids and 23 chromosomes.
4. The lasts stage is similar to mitosis where the 2 cells split and the chromatids separate creating 4 haploid cells with 23 chromosomes in each.
5. During this crossing over occurs here non-sister chromatids cross over break and rejoin ⚧ infinite genetic variation.

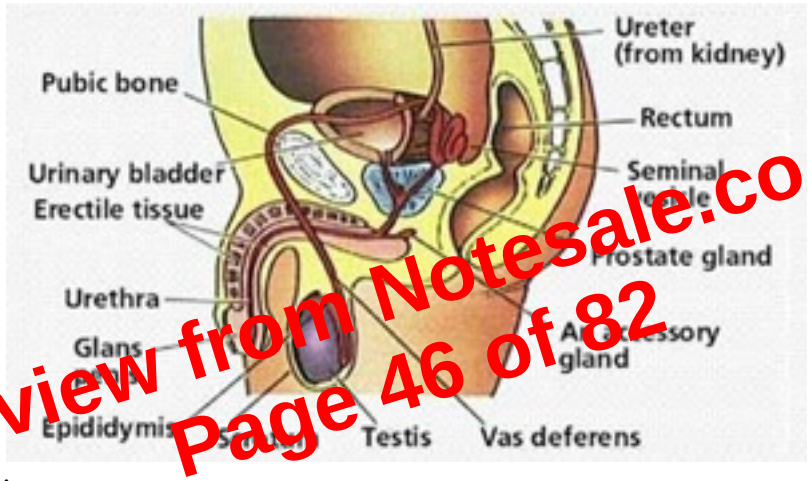
- Fertilisation is the fusion of nuclei of the male and female gametes creating a single zygote.
- The zygote divides into a hollow ball of cells called a blastosyst which embed itself in the endometrium using enzymes.
- If this is successful it develops into an embryo which has various features:

1. Placenta for oxygen and food to enter and Carbon Dioxide and waste to leave.
2. The placenta secrets progesterone to keep the placenta attached
3. The embryo has an amniotic sac and fluid to protect it.

<u>Sex</u>

- Primary sexual characteristics are determined by genes XY-Male and XX-female.
- Secondary characteristics are determined by hormones at puberty.





Plant Reproduction

- Pollination: the movement of pollen from anther to stigma
- Cross pollination: 2 plants
- Self-Pollination: one plant
- Plants have mechanisms to stop self-pollination as they want to cross-pollinate for larger genetic variation i.e.
    1. Carpel and stamen mature at different times
    2. Carpel and stamen are at different heights
    3. Genetic markers stop own pollen from growing if it touches their own stigma
- Plants usually either insect or wind pollinate:

Feature	Insect	Wind

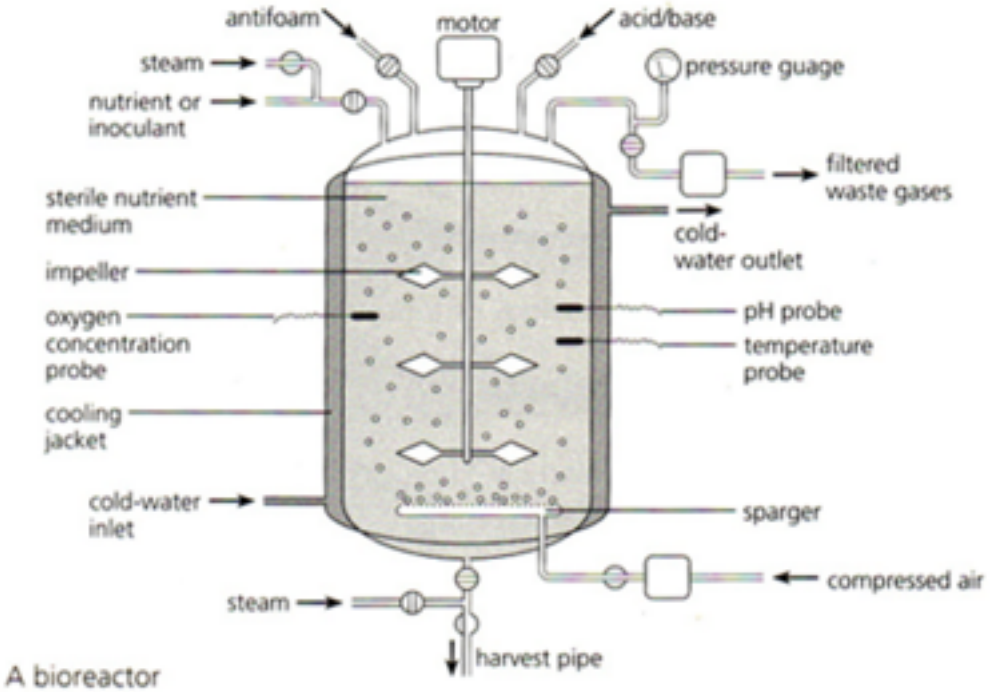
Fish farming

- Fish farming is the method of producing fish to meet the world's protein demand
- Managing:
    1. Intraspecific predation: group fish by age and size and feed them adequately
    2. Controlling interspecific predation: group fish by specific species. Make sure animals from the external environment aren't predators or can't get into farms
    3. Controlling disease: remove any diseased fish, anti-biotics/vaccines, don't overcrowd, keep continuous supply of fresh water flowing through, and chemically treat water.
    4. Waste products: flowing water, have floating farms so waste drops out the bottom, use waste for hydroponic plant growing.
    5. Quality and frequency of feed: use high energy pellets either form smaller trash fish or largely corn syrup to feed fish cheaply. Find the goldilocks zone for feeding; too little malnutrition; too much wastes
    6. Selective breeding: select fish which are big, sell well and look nice to breed so you get maximum profit.

DNA and Cell Division

DNA

- In the nucleus of the cell long rod-like structures called chromosomes are found.
- Chromosomes exist in matching homologous pairs i.e. in humans there are 23 pairs
- DNA, deoxyribonucleic acid, is the unit of inheritance in an organism and consists of genes
- Gene: a unit of inheritance made from length of DNA which codes for the production of a particular protein and thus contributes to a particular characteristic of an organism.
- Structure of DNA:
    1. Two anti-parallel strands made of phosphates forming the phosphate backbone which holds the nucleotides together
    2. The phosphate and bases are connected by a deoxyribose sugar
    3. The bases are Adenine (A), Cytosine (C), Thymine (T), and Guanine (G)
    4. The DNA molecule is in the shape of a double helix completing a full spiral every 10.4 bases



A bioreactor

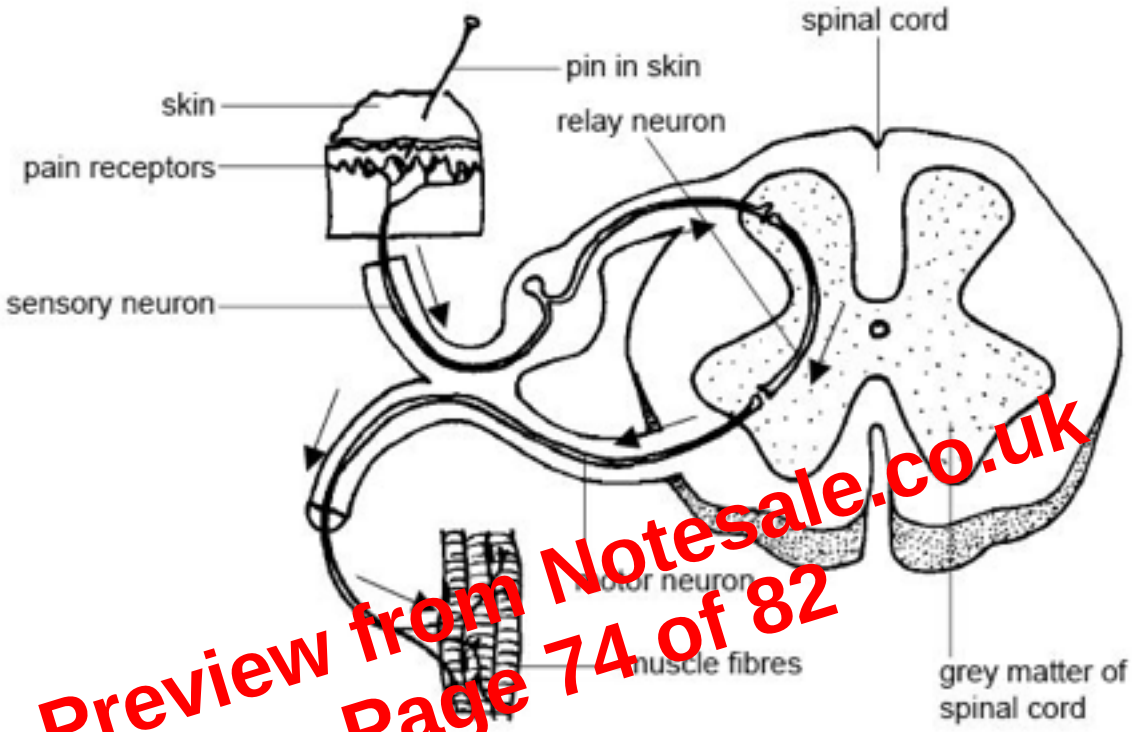
- The inlet: at the start of the process nutrients are fed in through pipes which can be opened and closed by valves. An extra nutrient will be fed in through here during it.
- Probes: measure the pH and temperature so the contents can be controlled for maximum growth
- Water jacket: filled with cold water as fermentation produces heat so the jacket is needed to stop overheating which would cause denaturation and death of the micro-organisms
- The fermenters are made of materials that will not corrode such as stainless steel as many microorganism produce acidic waste
- Air inlet is used to supply oxygen to the organisms if they respire aerobically. The air is filtered to avoid contamination
- Stirring paddles: mix up the contents to keep the organisms in suspension and spread them out evenly so they get more exposure to nutrients. It also helps maintain the temperature and spread the nutrients evenly as well. Some fermenters use air jets in

Making Beer

- soak barley seeds in water and lay them out on a flat surface in a malthouse
- the seeds geminate and produce the enzyme amylase which breaks down the starch into maltose
- the seeds are heated, killing them but not denaturing the amylase, producing a dried product called malt

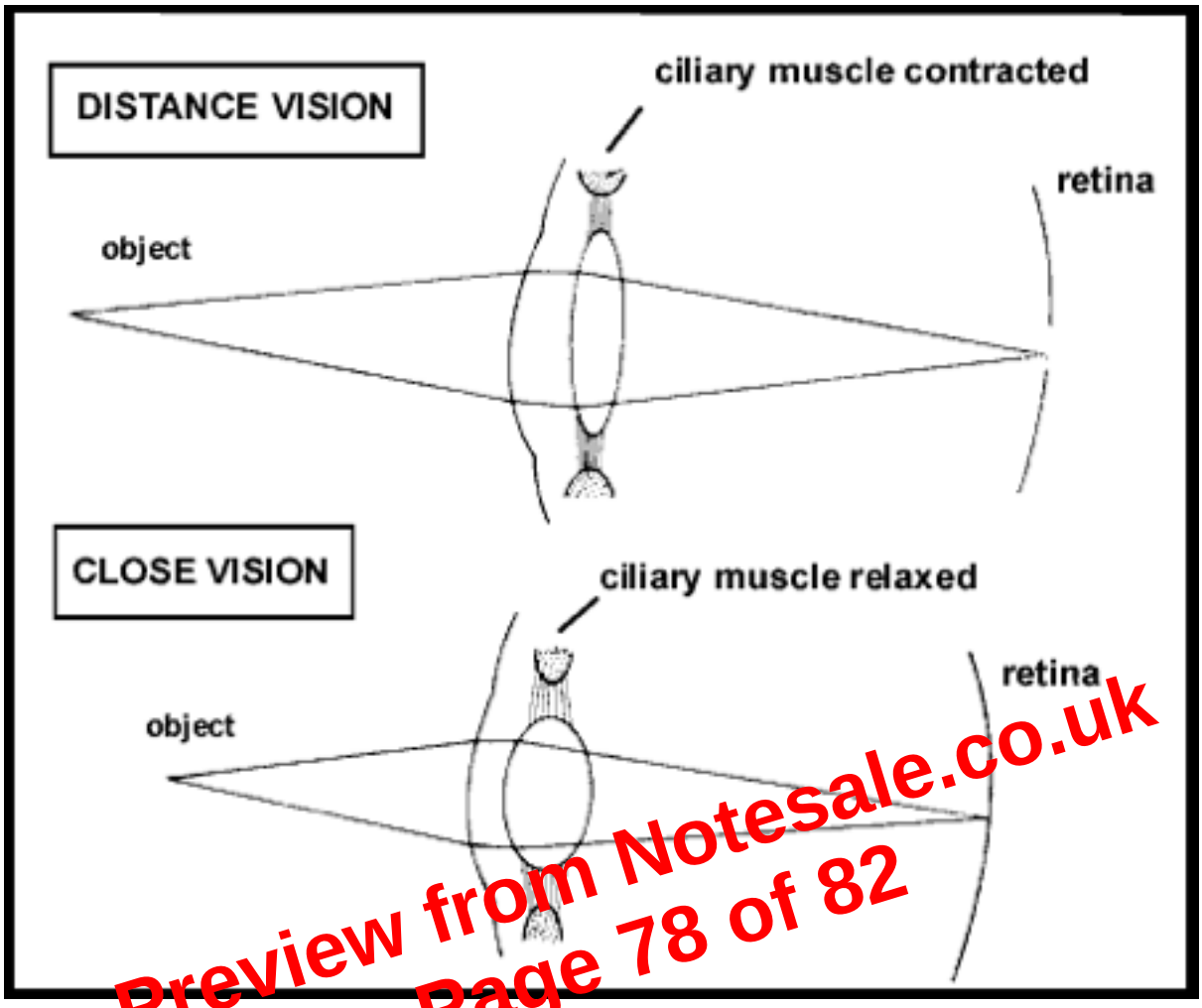
- Axon- - the longest dendron that carries impulses to the effector organ
- Myelin sheath - insulating layer of fat that is layer down by the Schwann cells which prevents short circuits and speeds up impulses
- Nerve-muscle junctions - special synapses found on motor end plate that cause the muscle to contract

o reflex actions



- reflex arc
  - stimulus is detected by receptors
  - this generates electrical impulses in the sensory neurone
  - the sensory nerve enters the CNS through the dorsal root
  - in the grey matter of the spinal cord it connects to a relay neurone by a synapse
  - the relay neurone carries the impulse to the motor neurone where the impulse goes across another synapse
  - the motor neurone elves the CNS through the ventral root
  - the impulse is carried to the effector organ where it is transmitted across the nerve-muscle junctions
  - the muscle contracts

- this is the process that allows us to focus on objects at different distances



- when an objects is far away the light comes in at a gentle angle and so needs to be refracted less. The ciliary muscles contract pulling the suspensory ligaments taught and stretching the lens out so it is flatter and refracts less.
- when an object is close the light comes in at a sharp angle and so needs to be refracted more. The ciliary muscles relax allowing the suspensory ligaments to go slack and allowing the lens to return to its natural rounded shape which refracts more
- this ensures that the image always falls on the fovea
- NB the image is always upside down and our brain has to interpret it the right way up

Glands and Hormones

- gland is an organ that secretes a substance