RST

Knowledge Organiser: SPECIES DIVERSITY

Living organisms show a range of sizes, features and complexity. Two of the major groups we learn about can be grouped as follows:

Plants	Animals
Flowering - like daisy, rose, dandelion.	Vertebrates - have a backbone like birds, snakes, humans.
Non-flowering - like mosses and ferns.	Invertebrates - do not have a backbone like insects, spiders.

Classifying and naming organisms - Traditionally based on morphological features but more recently DNA analysis has been used to more accurately group organisms to show how related they are.

DOMAIN	The largest groups. There are 3 domains. Eukarya (which contains 4 of the 5 kingdoms) Bacteria and archaea.
KINGDOM	There are 5 kingdoms: animals, plants, fungi, single celled organisms and bacteria.
PHYLUM ↓	Groups get smaller and organisms more similar as they have more **morphological features** (body structures) in common.
CLASS ↓	
FAMILY ↓	
GENUS	The first part of an organism's scientific name. Starts with a capital letter, e.g. Panthera.
SPECIES	The second part of an organism's scientific name, e.g. tigris.

Panthera tigris

Scientific names are used as they are **universal**. Language barriers or the use of common names for organisms could be confusing. The use of these names from the binomial system by all scientists **avoids any confusion**.

Adaptations

Living things become adapted to their habitat.

These adaptations may be **morphological**.

Fennec foxes who live in hot climates have large ears to radiate heat away from their bodies.

Arctic foxes have small furry ears to reduce heat loss.

Adaptations may also be behavioural; the Fennec fox is mostly nocturnal (awake at night) and burrows under the sand to avoid the heat of the day in the desert.

Competition

All organisms compete for survival.

Animals compete for:

- food, territory and mates.

Plants compete for:

- light, water and minerals.

Interspecific competition - competition between different species.

Intraspecific competition – competition between members of the same species.

Other than competition, the size of a population is changed by: **predation, pollution or disease**.

Biodiversity

Biodiversity is a measure of:

- the variety of different species in a particular area
- the numbers of each of those species in a particular area.

It is important as it provides:

- food and potential foods
- industrial materials
- new medicines
- and enhances human well-being.

Biodiversity and endangered species can be conserved and protected by:

- Convention on International Trade in Endangered Species
- Sites of Special Scientific Interest
- captive breeding programmes
- national parks
- seed/sperm banks
- local biodiversity action plans.

Measuring biodiversity

Plants

To measure the biodiversity of plants in an area or to investigate the different distribution of plants we can use a **quadrat**.

It is important to take a **random sample** of an area to avoid collecting **biased data**.

A **larger sample** will give a valid estimate of the number of plants in the area.

Quadrat

1. Lay out two tape measures at right angles.
2. Use a pair of dice or a random number generator to generate co-ordinates.
3. Place the quadrat at those coordinates
4. Count the different species and the number of each in each quadrat.
5. Take a mean number of each species of plants from all the quadrats collected.
6. Multiply up to estimate how many in the whole area.

Quadrat, usually a 1 m square grid.

Measuring the distribution of plants can be carried out using quadrats set in a row 1m apart. This will give you an idea of how plant life changes along a particular route, e.g. along a seashore. This is called a **transect**.

Measuring biodiversity

Animals

Measuring the biodiversity of animals can not be achieved using quadrats as animals may move quickly out of the area.

Instead scientists use the **capture/recapture technique**.

Method

1. Carefully collect organisms found in 1 area without trampling habitat or leaving litter.
2. Mark the organisms and return them to the same area they were collected from.
3. Leave time for organisms to reintegrate into their community.
4. Return and again collect as many organisms as found, collect as those already marked and unmarked samples.
5. Use an equation to calculate the estimated population size.

When using capture/recapture data, assumptions made include:

- no death
- immigration or emigration
- marking technique does not affect chances of survival.

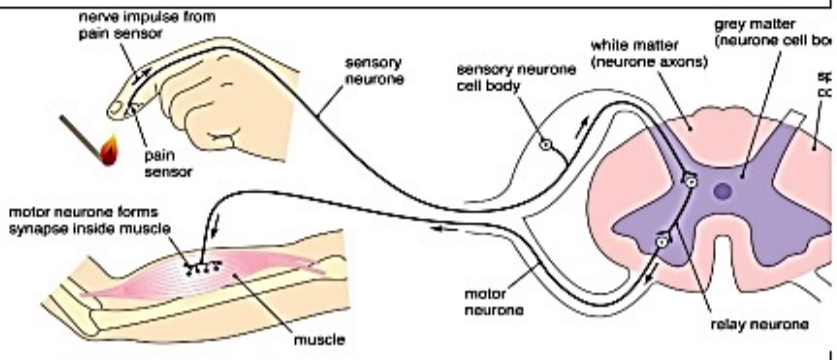
Biological Control

Biological control - The use of one organism to control the population size of another species by eating it. This is often the use of a predator species to control the number of a prey species that have become pests. A lot of research is needed to make sure that any alien species introduced into a habitat does not become invasive and affect the native species populations. A lot of research is needed to prevent any species introduced having a negative effect on non-targeted species.

Predator	An animal that hunts and eats another for food.
Prey	An animal that is eaten by a predator.
Pest	An organism that eats a crop plant.
Native species	An organism that lives in the country.
Alien species	An organism introduced into a country in which it does not normally live.
Invasive species	An alien organism that has had a negative effect on the native species.

Leave blank to allow students to glue.

Knowledge Organiser: Stimuli and Response

WHAT IS MEANT BY A STIMULUS?	Any physical or chemical change in the environment
WHAT TYPE OF CELL DETECTS A STIMULUS?	a receptor
DEFINE TROPISM	Growth responses made by plants to directional external stimuli.
DEFINE PHOTOTROPISM	Growth response to light
DEFINE GRAVITROPISM	Growth response to gravity
WHAT IS A NASTIC RESPONSE?	Rapid response by plants to external stimuli, independent of stimulus direction
WHAT IS ALLEOPATHY?	Where plants produce chemicals that inhibit growth of neighbouring plants
WHAT IS A COLEOPTILE?	The sheath surrounding the young grass shoot
WHAT IS IAA AND WHAT EFFECT DOES IT HAVE ON SHOOTS AND ROOTS?	An auxin hormone that stimulates growth in shoots and inhibits growth in roots
WHAT IS A TAXIS?	Orientation and response by animals to a directional stimulus
WHAT IS A KINESIS?	A non-directional response by animals to a stimulus. The speed of movement is proportional to the stimulus intensity.
WHAT IS A REFLEX?	Automatic, rapid response to a stimulus, involving only a few neurones and the CNS
DESCRIBE THE FUNCTION OF A SENSORY NEURONE	transmits an impulse from a sensory cell towards CNS
DESCRIBE THE FUNCTION OF A RELAY NEURONE	Neurone in CNS linking sensory and motor neurone
DESCRIBE THE FUNCTION OF A MOTOR NEURONE	transmits an impulse from CNS to an effector
WHAT IS AN EFFECTOR (GIVE 2 EXAMPLES)	Muscle or gland
WHAT IS A SYNAPSE?	Gap between neurones. A neurotransmitter diffuses across the gap to bring about an action potential in the post-synaptic membrane
WHAT IS A NEUROTRANSMITTER?	Chemical released across the synaptic cleft
DRAW A LABELLED DIAGRAM SHOWING A REFLEX ARC	

Leave blank to allow students to glue.

Knowledge Organiser: Stimuli and Response

NAME THE PRESSURE RECEPTOR DEEP IN SUBCUTANEOUS TISSUE	Pacinian corpuscle
IN THE EYE, WHAT IS MEANT BY ACCOMMODATION?	Changing shape of lens to focus light on the retina
DESCRIBE A ROD CELL FUNCTION	Detects presence of light photons only, therefore image is black and white only. High sensitivity and low acuity - many rod cells synapse with one bipolar cell
WHAT IS MEANT BY ACUITY?	Ability to produce a sharp image on the retina. A low acuity is the result of many receptor cells linked to one bipolar cell. A high visual acuity is the result of one receptor cell linked to one bipolar cell.
DESCRIBE A CONE CELL FUNCTION	Three types of receptor cell, detects 3 wavelengths of light. High visual acuity but low sensitivity. Each cone cell synapses with its own bipolar cell.
WHAT IS THE SAN?	Pacemaker of the heart. Myogenic. Causes atrial systole
WHAT IS MEANT BY MYOGENIC?	Needs no external nerve to contract
WHAT IS THE FUNCTION OF THE AVN?	Atrioventricular node, this sends an impulse down the Bundle of His to the Purkyne fibres of the heart
WHAT IS MEANT BY SYSTOLE?	Contraction
WHAT IS MEANT BY DIASTOLE?	Relaxing of the cardiac muscle
WHAT EFFECT DOES THE SYMPATHETIC NERVOUS SYSTEM HAVE ON THE SAN ?	Impulses down the cardiac nerve to the SAN. Releases the neurotransmitter noradrenaline, which causes the SAN to contract faster. This speeds up heart rate
WHAT EFFECT DOES THE PARASYMPATHETIC NERVOUS SYSTEM HAVE ON THE SAN ?	Impulses down the VAGUS nerve to the SAN. Releases the neurotransmitter acetylcholine, which causes the SAN to contract slower. This slows heart rate
WHAT IS A BARORECEPTOR AND WHERE ARE THEY FOUND?	Cells in arteries, such as aortic arch and internal carotid arteries that detect a change in blood pressure
WHAT IS A CHEMORECEPTOR AND WHERE ARE THEY FOUND?	Cells in arteries, such as aortic arch and internal carotid arteries that detect a change in oxygen and carbon dioxide concentrations

Leave blank to allow students to glue.

Knowledge Organiser: Nervous System and Muscles

The **nervous system** enables animals to respond to changes in the external or internal environment, also known as **stimuli**.

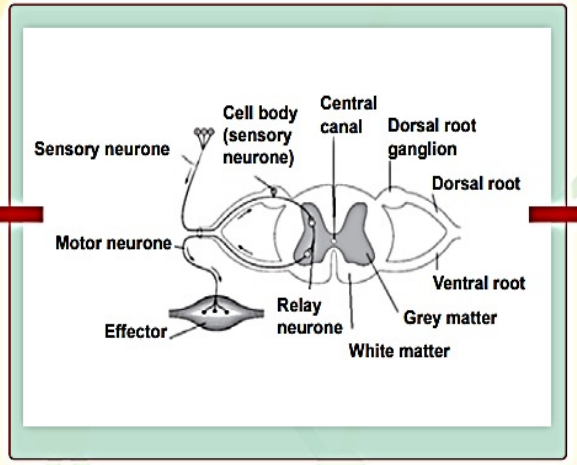
A nervous response follows this pathway:

Stimulus → Receptor → Sensory neurone → Co-ordinator → Motor neurone → Effector → Response

The co-ordinator is usually the **central nervous system** (CNS), brain and spinal cord. An effector is a muscle or gland. The motor and sensory neurones are part of the **peripheral nervous system**.

A reflex action is a **fast, automatic response** to a **stimulus** that has a **protective** function.

Receptors detect the harmful stimulus and send impulses through sensory neurones to a relay neurone in the spinal cord. This sends an impulse through a motor neurone to an effector, which responds to protect the body.



Structure of the spinal cord

Grey matter contains nuclei and cell bodies.

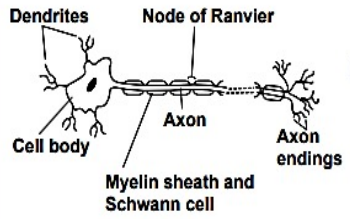
The **white matter** is myelinated.

The **central canal** contains cerebrospinal fluid.

The spinal cord is surrounded by membranes called **meninges**.

In simple organisms, like *Hydra*, receptors respond to a limited number of stimuli, so the number of effectors is small. They have a **nerve net** of identical branching neurones that are interconnected. The neurones are unmyelinated and send impulses in all directions.

Motor neurone



Dendrites transmit impulses into the cell body.

Schwann cells wrap around the axon and form the **myelin sheath**, an electrical insulator.

Nodes of Ranvier are gaps in the myelin sheath that form long local circuits with the next node, speeding transmission.

Axon transmits the impulse to the axon endings.

Axon endings innervate effectors.

Leave blank to allow students to glue.

Knowledge Organiser: Nervous System and Muscles

A nerve impulse is caused by Na^+ and K^+ ions moving across the neurone membrane. This causes a potential difference in charge between the inside and the outside of the membrane.

Resting potential

- The neurone is not transmitting an impulse.
- The membrane is **polarised** at **-70mV**.
- The axoplasm is more negative than the outside of the cell.
- Na^+ channels are closed, K^+ channels are leaky.
- A Na^+/K^+ pump uses ATP to move $3Na^+$ out of the axoplasm and $2K^+$ in.
- K^+ diffuses out but Na^+ can't diffuse in causing a charge difference.

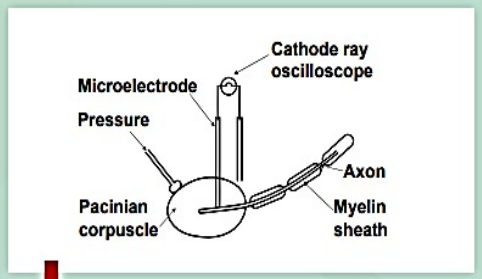
Action potential

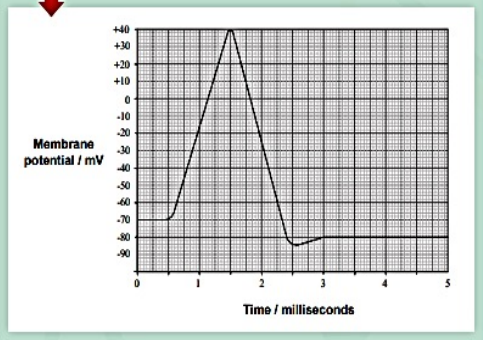
- A stimulus above **threshold** causes Na^+ channels to open.
- Na^+ ions diffuse into the axon rapidly.
- The membrane **depolarises** to **+40mV**.

Repolarisation

- Na^+ channels close and K^+ channels open.
- K^+ diffuse out rapidly.
- Overshoot causes **hyperpolarisation**.
- Resting potential is restored.

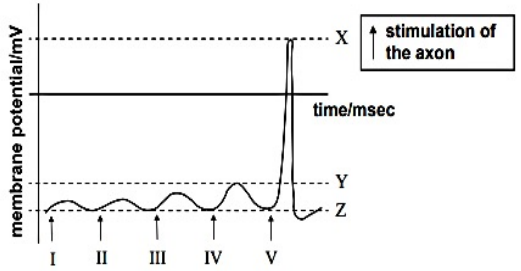
Charge difference is measured using an oscilloscope, which produces the trace below as an action potential passes the electrodes.





All or Nothing Law

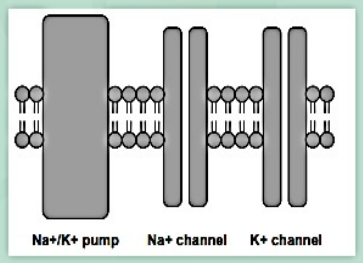
If the stimulus is below threshold (Y), no action potential takes place (I – IV). If the stimulus is above threshold, a whole action potential takes place (V).

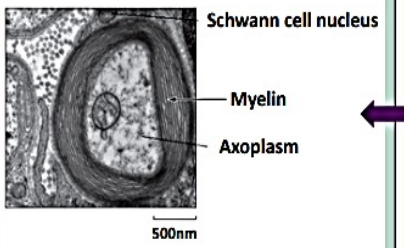


Transmission

The action potential is transmitted along a neurone when the depolarisation of the membrane sets up a **local circuit** with the next section. Transmission is in one direction, as during repolarisation the membrane cannot form an action potential. This is called the **refractory period**.

Axon membrane





Transmission speed is increased by:

- **Larger axon diameters** providing less resistance.
- **Higher temperatures** increasing rate of diffusion.
- **Myelin sheaths** mean depolarisations only happen at **nodes of Ranvier**. The local circuits are longer. The action potentials 'jump' from one node to the next. This is **saltatory** conduction.

Leave blank to allow students to glue.

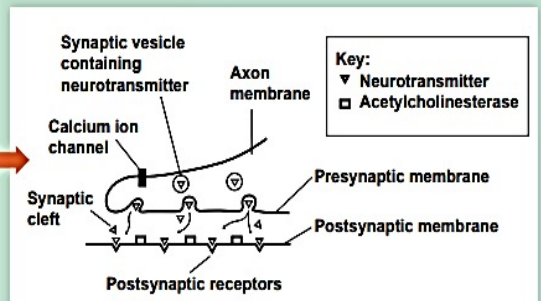
Knowledge Organiser: Nervous System and Muscles

A **synapse** is where the axon endings of one neurone meet an effector or another neurone. The gap between the two cells is a **synapse**. The wave of depolarisation cannot cross the gap.

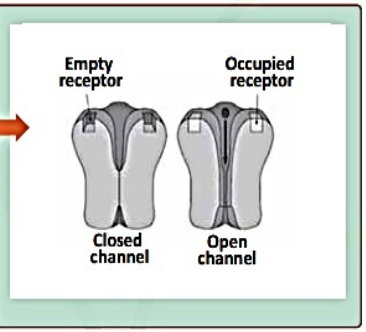
Synaptic transmission

1. Depolarisation of the axon membrane causes Ca^{2+} channels to open.
2. Ca^{2+} diffuse into the synaptic knob.
3. Ca^{2+} cause vesicles containing neurotransmitter to fuse with the presynaptic membrane.
4. Neurotransmitter is released into the synaptic cleft by exocytosis.
5. Neurotransmitter diffuses over the synaptic cleft and binds to receptors on the post synaptic membrane.
6. The binding causes Na^{+} channels on the postsynaptic membrane to open and the postsynaptic membrane depolarises.
7. An enzyme breaks the neurotransmitter down and the products are taken into the synaptic knob and resynthesised and packaged.

Structure of the synapse



Two main neurotransmitters are **acetylcholine** and **noradrenaline**.



Actions of chemicals on synapses

Antagonists affect synapses by **preventing** postsynaptic depolarisations.

Agonists cause **more** postsynaptic depolarisations.

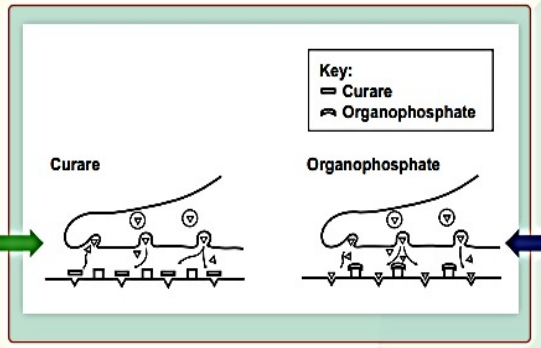
Ways in which **antagonists** may work:

- preventing Ca^{2+} channels opening and thus preventing exocytosis
- blocking receptors
- hyperpolarising the post-synaptic membrane so it is harder to reach threshold.

Ways in which **agonists** may work:

- inhibiting the enzymes that break down neurotransmitter
- causing exocytosis
- preventing uptake of neurotransmitter from the synaptic cleft
- binding to receptors and mimicking the neurotransmitter.

Antagonist blocking receptors



Agonist inhibiting acetylcholinesterase

Leave blank to allow students to glue.

Knowledge Organiser: Homeostasis

Homeostasis is the maintenance of a constant internal environment.

Examples of conditions that must be kept constant include:

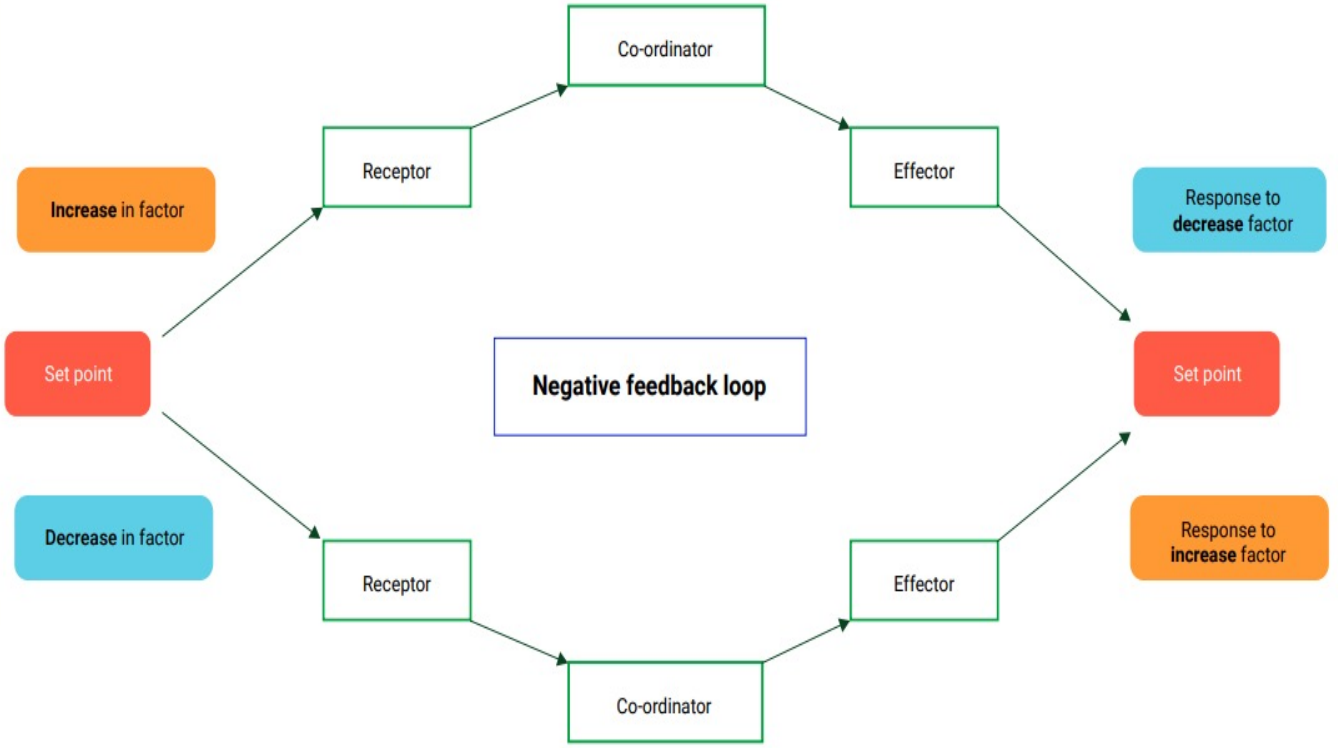
- blood glucose
- core body temperature
- blood solute potential.

Homeostasis is important so that cells can function efficiently even if:

- external conditions fluctuate
- the body has different levels of activity.

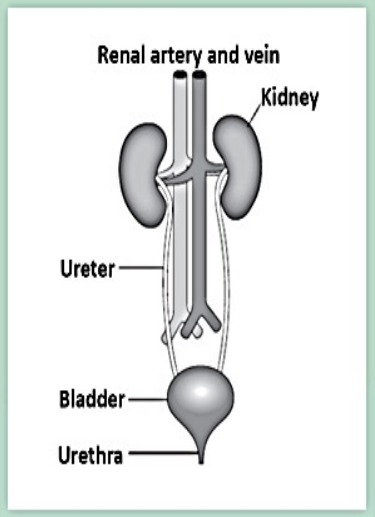
Each condition has a set point. Deviations are detected. A control centre sends impulses to an effector (muscle or gland), which returns conditions to the set point – this is **negative feedback**.

Negative feedback is a system that restores conditions to a set point when it detects a deviation. This results in narrow fluctuations around the set point.



Leave blank to allow students to glue.

Knowledge Organiser: Homeostasis



The **renal artery** supplies oxygen and glucose and has a high concentration of urea.

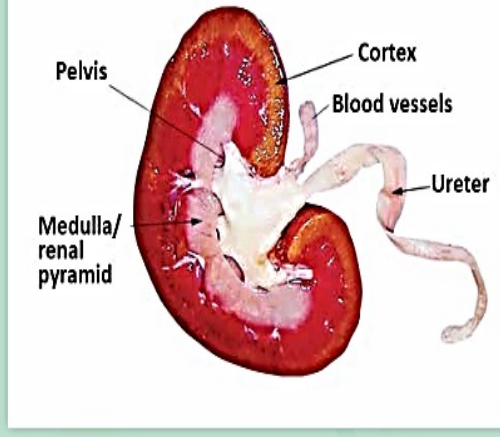
The **renal vein** removes carbon dioxide and has a lower concentration of urea.

The **ureter** transfers urine to the bladder.

Urine is released through the urethra.

Kidney dissection

Risk assessment: scissors and scalpels are sharp and there is a risk of piercing skin. Cut away from yourself and on to a white tile if possible.



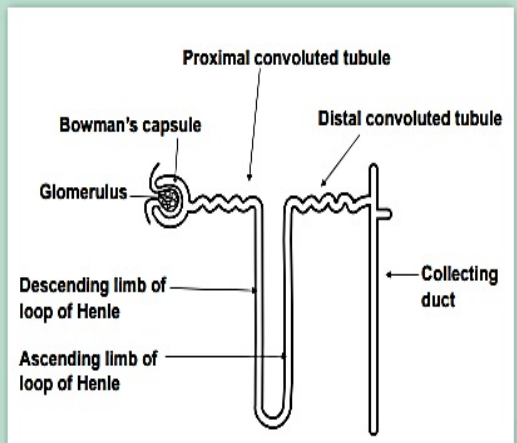
There are three visible regions:

- **Cortex** is the outer region.
- The **medulla** is organised into triangular **renal pyramids**.
- The pyramids drain into the **pelvis**.

The **nephron** is the functional unit of the kidney.

The **glomerulus**, **Bowman's capsule**, **proximal convoluted tubule** and **distal convoluted tubule** are located in the cortex.

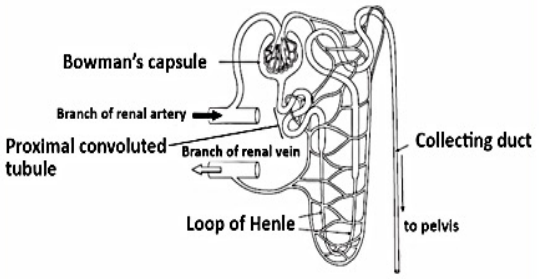
The **loop of Henle** and **collecting duct** are located in the **medulla**.



The **nephron** is where blood is filtered and useful substances, like glucose and water, are reabsorbed back into the blood.

Leave blank to allow students to glue.

Knowledge Organiser: Homeostasis



The collecting duct passes through the concentration gradient of the medulla.

Anti-diuretic hormone (ADH) controls the permeability of the collecting duct to water. When it is **more permeable**, **more water is reabsorbed** to the blood and less water is excreted as urine.

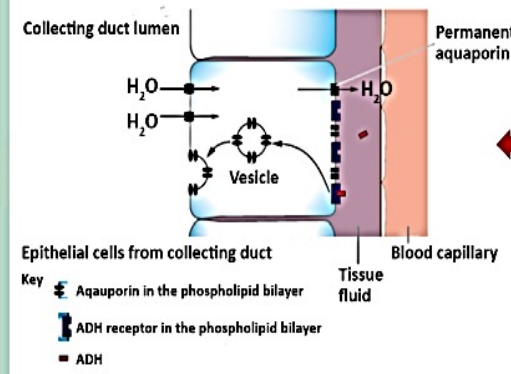
When **blood water potential is lower** than the set point, **osmoreceptors** in the **hypothalamus** detect the change.

The **posterior pituitary gland** releases ADH into the bloodstream.

ADH attaches to **receptors** on the cells of the collecting duct. Aquaporins (vesicles with water channels) fuse with the membrane of the cells next to the lumen of the collecting duct.

Water moves into the cells by osmosis and then passes from the cells into the bloodstream, **raising the water potential** of blood. This is **negative feedback**.

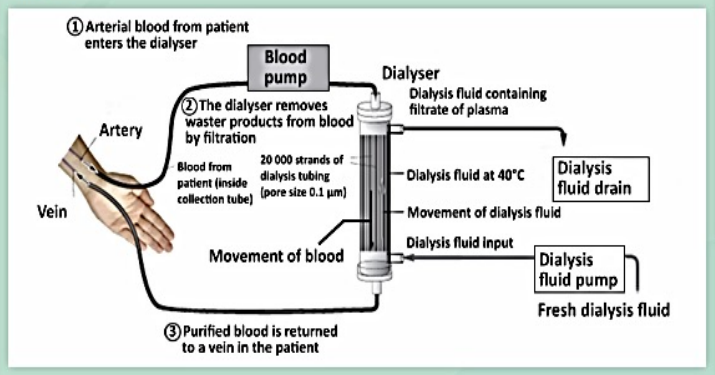
A **low volume of concentrated urine** is produced.



If the kidneys fail, a range of treatments are available:

- Medication can be used to control K^+ and Ca^{2+} levels to help balance fluids.
- A low protein diet reduces the number of excess amino acids and thus the urea made.
- Drugs can be used to lower blood pressure.
- Dialysis, which artificially removes urea from the blood.
- A kidney transplant.

Dialysis



A large number of strands of dialysis tubing increases the surface area where diffusion can take place.

Pores only allow small molecules to leave the blood.

Dialysis fluid has no urea to give a concentration gradient, water leaves by osmosis. There is no concentration gradient for glucose, so it doesn't leave the blood.

Fresh dialysis fluid maintains a concentration gradient.

Counter current flow of blood and fluid maintains a concentration gradient.

Leave blank to allow students to glue.

The role of the loop of Henle is to make an increased **salt concentration gradient** in the medulla.

The **filtrate** passes from the proximal convoluted tubule to the **descending limb** of the loop of Henle, which carries it through the medulla towards the pelvis.

The descending limb is **permeable** to water, so water leaves the filtrate by **osmosis** and is carried away by the vasa recta blood vessel.

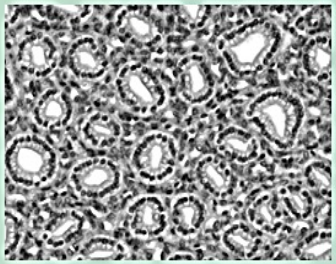
The filtrate gets more concentrated as it descends and the water potential gets lower.

The salt concentration gradient in the medulla means that the water potential is always lower in the medulla than the filtrate.

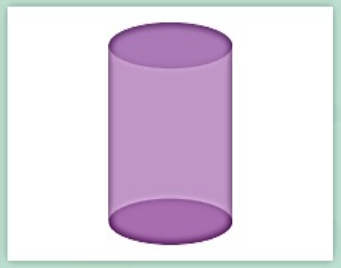
The filtrate passes into the **ascending limb** of the loop of Henle.

The ascending limb is **impermeable** to water.

Salts are **actively transported** into the medulla, creating the salt concentration gradient and raising the water potential of the filtrate.



Micrograph of the medulla



Tubules are cylindrical. They look like circles when cut across and tubes when cut vertically.

The medulla only has tubules – the loop of Henle and collecting duct.

The cortex has the proximal and distal convoluted tubules AND glomeruli and Bowman's capsules.

Adaptations

The loop of Henle is a **counter current multiplier**; the longer the loop the bigger the concentration gradient in the medulla.

This means that more water can be reabsorbed from the descending loop.

Animals adapted to dry environments have longer loops of Henle and reabsorb more water to the blood, e.g. camels. They produce highly concentrated urine and lose less water in excreting it.

Mammals living in fresh water, like otters, have short loops and less concentrated urine.

Adaptations of nitrogenous waste

Amino acids cannot be stored. **Excess amino acids** are converted into nitrogenous waste.

Mammals convert amino acids to **urea** in the **liver**. Urea has a medium toxicity and solubility. Urine can be concentrated or diluted according to the need to conserve or eliminate water.

Fish convert excess amino acids to **ammonia** by deamination only. Ammonia is **highly toxic** and **highly soluble**. Fish live in large volumes of water and ammonia is excreted easily.

Insects, birds and **reptiles** use more ATP than it takes to make urea to make **uric acid**. Uric acid is **insoluble** and requires **little water** to excrete. This makes it light (for flight) and is an adaptation for living in a terrestrial environment. It has a **lower toxicity** than urea so young animals can excrete it at the egg stage of the life cycle.

Knowledge Organiser: Homeostasis

Leave blank to allow students to glue.

Knowledge Organiser: Inheritance

Genetic terminology

Term	Definition
Gene	The physical unit of heredity
Locus	The site on a chromosome occupied by a gene
Allele	Different forms of the same gene
Dominant	A gene always expressed when present
Recessive	A gene only expressed in a homozygous pair
Codominant	Both alleles contribute to the phenotype
Phenotype	The characteristics of an organism
Genotype	The alleles contained in an organism
Homozygous	Alleles are the same e.g. HH or hh
Heterozygous	Alleles are different e.g. Hh
F1	First generation in a genetic cross
F2	The second generation
Autosomes	Pairs 1-22 of the chromosomes
Sex chromosomes	Pair 23 that determines sex (male/female in the human.)

Codominance - Both alleles are expressed in the phenotype.

Eg 1- Blood typing

I^AI^A	A antigen on blood cells
I^BI^B	B antigen on blood cells
I^AI^B	Both A and B antigens on blood cells

Eg 2 – Colouring in cows

Some cows are Red (RR)

Some white (WW)

Offspring can be roan (RW)

	R	R
W	RW Roan	RW Roan
W	RW Roan	RW Roan

Incomplete dominance - A blend of both alleles can be seen in the phenotype.

e.g. Red, white and pink carnations.

A cross between red and white

Carnation produces an all pink F1.

In the F2 -a cross of 2 pink parents

there is a phenotypic ratio of:

1 red:2pink:1white.

F2	R	W
R	RR Red	RW Pink
W	RW Pink	WW White

Mendelian inheritance

Gregor Mendel studied inheritance in pea plants. He chose easy to distinguish characteristics which importantly:

- were controlled by single genes
- on different chromosomes.

Monohybrid crosses - Single gene inheritance.

1. Identify the characteristic and designate a letter to represent the dominant and recessive allele.

Tall plants – T

Dwarf plant - t

2. Give the genotype and phenotype of the parents.

Phenotype: Tall plant x Dwarf plant

Genotype: TT x tt

3. Identify the gametes produced by both parents:

Phenotype: Tall plant x Dwarf plant

Genotype: TT x tt

Gametes: T T x t t

4. Place the gametes in a **Punnet square** and show all 4 possible crosses at fertilisation. Label each new genotype with the phenotype.

F2	T	t
T	TT Tall	Tt Tall
t	Tt Tall	Tt Dwarf

F1	t	t
T	Tt Tall	Tt Tall
T	Tt Tall	Tt Tall

The F2 shows the mendelian phenotype ratio 3:1.

All the offspring in the F1 are tall.

Mendel's 1st law: the law of segregation - The characteristics of an organism are determined by factors (*genes*) which occur in pairs. Only one member of a pair of factors (*genes*) can be represented in a single gamete.

Leave blank to allow students to glue.

Dihybrid inheritance- 2 gene inheritance

Independent assortment

The independent assortment of chromosomes in meiosis explains why unlinked genes (found on different chromosomes) can combine to form all 4 kinds of gametes shown opposite.

Mendel experimented with seeds he knew to have dominant yellow/round characteristics and recessive wrinkled/green traits.

Parental phenotypes	Round/yellow	Wrinkled/green
Parental genotypes	RRYY	rryy
gametes	RY	ry
F1 generation	RrYy	
F1 Phenotype	Round/yellow	
F2 parental genotype	RrYy	RrYy
F2 gametes	RY Ry rY ry	

Female gametes

Male gametes	RY	Ry	rY	ry
RY	RRYY Round yellow	RRYy Round yellow	RrYY Round yellow	RrYy Round yellow
Ry	RRYy Round yellow	RRyy Round green	RrYy Round yellow	Rryy Round green
rY	RrYY Round yellow	RrYy Round yellow	rrYY Wrinkled yellow	rrYy Wrinkled yellow
ry	RrYy Round yellow	Rryy Round green	rrYy Wrinkled yellow	rryy Wrinkled green

Dihybrid cross phenotypic ratio:

9 round yellow: **3** Round green:**3** wrinkled yellow: **1** wrinkled green

Ratios

If you take each characteristic individually in the dihybrid cross above, the monohybrid phenotypic ratio still stands.

Yellow: green seeds = 12: 4 = 3:1

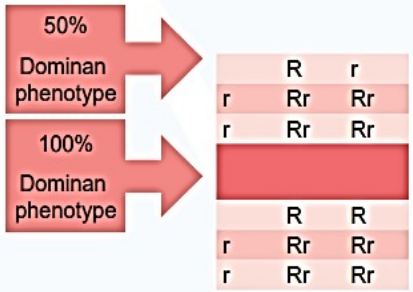
Round: wrinkled seeds =12:4 = 3:1

Mendel's second law of segregation. The law of independent assortment.

Test crosses

Monohybrid - To determine if an organism showing a dominant phenotype is a homozygote or heterozygote. Cross organism with a known pure breed (homozygote) rr.

Dihybrid - cross each genotype with homozygote for both characteristics rryy. If the parent was heterozygous for 1 characteristic, offspring would be produced in a 1:1. If the parent is heterozygous for both a 1:1:1:1 ratio would be seen.



Recognising linkage

The mendelian **9:3:3:1 ratio** is therefore **expected** in any experiment where **genes are not linked.**

Linkage, meaning genes occurring on the same chromosome and therefore being inherited together, can be detected if the **expected ratio is not found** in the offspring.

Small numbers of recombinant phenotypes can still occur due to 'crossing over' in meiosis.

Chi squared

A statistical test used to determine if the numbers and phenotypes of offspring produced in a genetic cross is close enough to the expected Mendelian ratio that any difference is due to chance and not for any other reason.

1. Null hypothesis

A statement e.g. **There is no difference between the observed and expected results of a genetic cross.** If the test shows that the deviation from expected ratios is by chance the hypothesis is **accepted**, if not it is **rejected**.

2. Calculate expected numbers

Calculate of all the offspring produced how many would you expect e.g. if 3744 off spring are produced:

3744/16 = 234 so

9: (9 x 234 =2106) **3:** (3x234= 702) **3:** (3x234= 702) **1:** 234

3. Chi²

$$\chi 2 = \sum \frac{(\text{observed value} - \text{expected value})^2}{\text{expected value}}$$

4. Calculate the degrees of freedom

The number of outcomes -1 e.g. in a 9:3:3:1 there are 4 possible outcomes so the degrees of freedom used would be 3. Use this to find the X^2 critical value at 5%.

5. Accept or reject the null hypothesis

If the calculated value for **χ2** < the critical value for **χ2** then null hypothesis is accepted.

If the calculated value for **χ2** > the critical value for **χ2** then null hypothesis is rejected.

Knowledge Organiser: Inheritance

Leave blank to allow students to glue.

Sex linkage - Genes that are sex linked can be found on the sex chromosomes.

Remember females have XX sex chromosomes and males have XY.

In males, the Y chromosome is smaller than the X chromosome. There are genes on the X chromosome that do not have the homologous locus on the Y chromosome.

Sex linked genes are written as superscript on the chromosome e.g. X^hY.

Haemophilia - a disease caused by a recessive allele for Factor 8 that does not code for the normal blood clotting factor.

In this case the father has the normal gene, but the mother carries the abnormal recessive allele.

Male children born in this cross have a 50% chance of having the disease.

Gametes	X^H	Y
X^H	X^HX^H	x^HY
X^h	x^HX^h	X^hY

A lack of corresponding gene on the Y chromosome means this disease can be inherited by males with only 1 recessive allele. For a female to inherit this disease, both parents need to be carrying the recessive allele.

Duchenne muscular dystrophy

A progressive muscle disease caused by a sex-linked recessive allele that does not code correctly for the protein dystrophin.

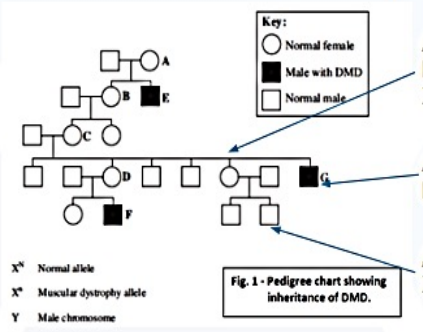


Fig. 1 - Pedigree chart showing inheritance of DMD.

A normal female could have the genotype X^NX^N or X^NX^n

A male with DMD must be X^nY

A normal male must be X^NY

Mutation

A mutation is **a spontaneous, random change in a gene.**

Mutation rates are increased in organisms with short life cycles or frequent cell division.

Occurs mostly during crossing over in prophase 1 and non-disjunction in anaphase I and II.

Advantageous mutations	Disadvantageous mutations
Mutations affect protein synthesis and so change the phenotype of the organism. This leads to variation in species that causes evolution by natural selection.	Some genes called proto-oncogenes can mutate to become oncogenes, which are involved, causing uncontrolled cell division to form a cancer.

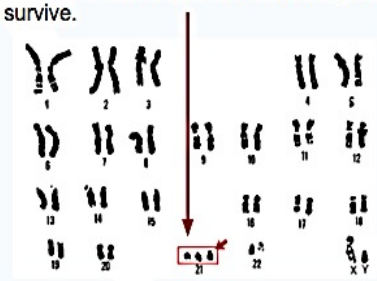
Gene point mutation. E.g. Sickle cell anaemia

- One mutated base in the DNA code for haemoglobin.
- So incorrect amino acid added into a polypeptide chain.
- Red blood cell forms a sickle shape and is less efficient at carrying oxygen.

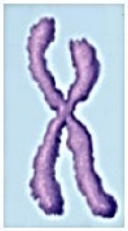
Chromosomal mutations E.g. Down's syndrome

Failure of chromosome 21 to separate from its homologous pair during anaphase I in meiosis forms gametes with 2 copies and at fertilisation the zygote then has 3 copies of chromosome 21.

Normally an extra chromosome would be fatal to an organism but chromosome 21 is small, only a few hundred genes, so the organism can survive.



Epigenetics



Every nucleus in cells of an organism contains a full set of genes, but in specialised cells only some genes are expressed, others are switched off.

Epigenetics is the study of changes in gene expression without any changes to the DNA sequence.

Epigenetic changes result from • Diet • Drugs • Development • Aging.

DNA methylation

DNA bases become methylated which reduces the transcription of the gene and so affects protein synthesis.

Histone modification

Modification of histones means they can coil more tightly, preventing gene expression, or they can coil loosely allowing transcription and protein synthesis.

Epigenetic changes can cause • Cancer • Autoimmune disease • mental disorders • Diabetes.

Knowledge Organiser: Inheritance

Leave blank to allow students to glue.

ABO

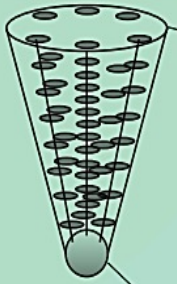
Knowledge Organiser: Photosynthesis

Chloroplasts are transducers - they convert light energy into chemical energy.

Use the 'Unit 2 – Adaptations for gaseous exchange in plants' to study the adaptations of a leaf for photosynthesis.

- Chloroplasts are mainly located in the palisade mesophyll.
- They are able to move and rotate in that layer in order to maximise light absorption.
- Chloroplasts have a large surface area for maximum light absorption.

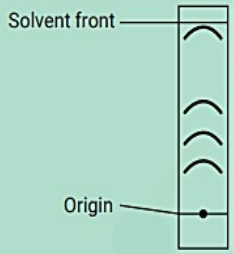
Photosystems - these light capturing complexes are located in the thylakoid membranes and contain different pigments which each absorb different wavelengths of light.



The antennae complex contains chlorophyll *a*, chlorophyll *b*, and the carotenoids xanthophyll and beta carotene. Light energy is absorbed and passed to the reaction centre.

The reaction centre contains 2 molecules of chlorophyll *a*. Electrons in these molecules are excited and raise to a higher energy level.

Chromatography - the different pigments involved in photosynthesis can be observed and identified using chromatography.



A mixture of pigments is extracted from leaves and applied to the origin of the chromatogram.

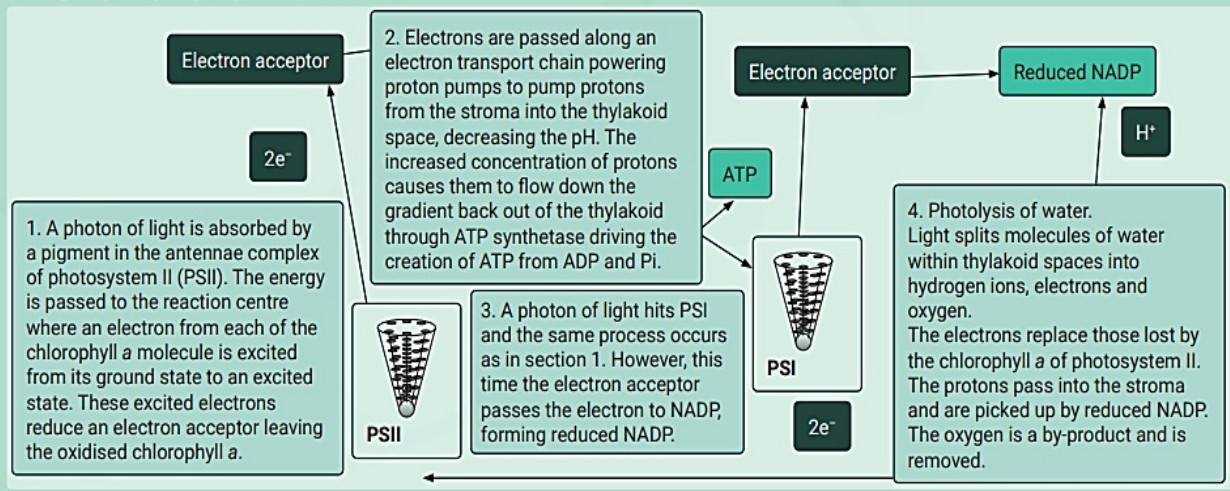
The chromatogram is placed into a solvent and left to run.

Pigments travel up the chromatography paper different distances according to their solubilities.

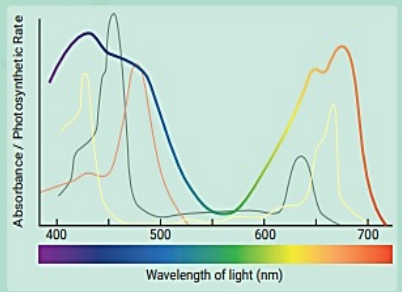
The distance moved by the solvent (the solvent front is marked) and the Rf values can be calculated and compared to known data to identify the different pigments.

$$\text{Rf} = \frac{\text{distance travelled by pigment}}{\text{distance travelled by solvent front}}$$

Light-dependent reaction
Non-cyclic photophosphorylation (the Z scheme)



Absorption and action spectra can give evidence that the light absorbing pigments are responsible for photosynthesis.



The absorbance spectra (faded lines) show the peak absorbances of the different wavelengths of light for each pigment.

The action spectra (overlaid bright line) shows the rate of photosynthesis at different wavelengths of light.

Both lines show peaks in the red and blue regions and a dip in the green region. This supports the theory that red and blue light is absorbed and is used in photosynthesis whereas light in the green region is reflected by the plant and does not contribute to photosynthesis.

Cyclic photophosphorylation

In this case, the electron acceptor that received electrons from PSI passes them back down the electron transport chain to PSI.

Using light (photo) to create the high energy electrons needed to power the electron transport chain to drive ATP synthetase (phosphorylation) gives plants a good source of ATP.

ATP and Reduced NADP will now be used in the stroma for the light independent stage of photosynthesis to create hexose sugars.

Leave blank to allow students to glue.

Knowledge Organiser: Photosynthesis

The light independent reaction - The Calvin cycle

1. In the stroma, the 5C compound ribulose bisphosphate takes up carbon dioxide to form an unstable 6C compound. This reaction is catalysed by the enzyme RUBISCO.

2. The carbon dioxide can be described as 'fixed' as it has been converted from a gas into a solid carbohydrate compound.

3. The unstable 6C compound immediately breaks down into 2x 3C compounds called glycerate-3-phosphate.

4. Glycerate-3-phosphate is reduced by reduced NADP and using energy from ATP (both received from the light dependent cycle) the 2x 3C glycerate-3-phosphate are converted into 2x 3C carbohydrates called triose phosphate.

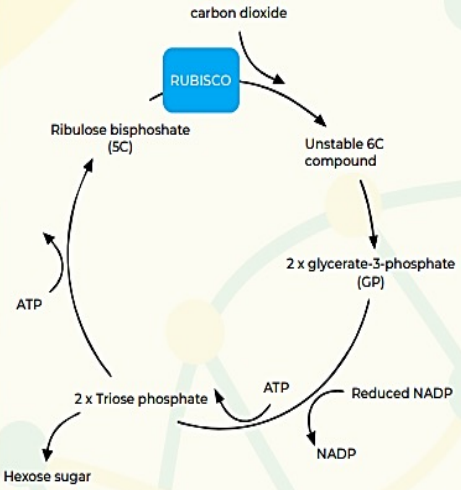
5. 1C from the triose phosphates will be used to create a hexose sugar, the other 5C form ribulose phosphate which is regenerated to ribulose bisphosphate using ATP, and the cycle begins again.

Products of the Calvin cycle

The hexose sugar produced is glucose (actually fructose bisphosphate).

Lipids are also produced from triose phosphate.

Amino acids are produced using nitrogen from nitrates.



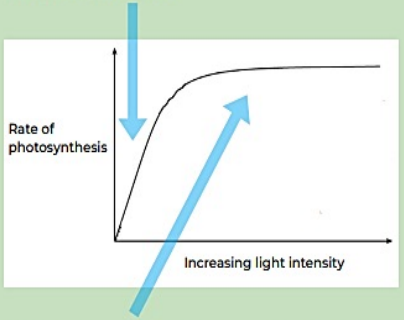
Mineral	Function	Deficiency
Nitrogen	Synthesis of proteins, nucleic acids and chlorophylls	Reduced growth of all organs and yellowing of leaves (chlorosis)
Magnesium	Chlorophyll production	Yellowing of the leaves (chlorosis)

Limiting factors

The rate of a physiological process will be **limited** by the factor in shortest supply.

Light intensity

Light intensity is limiting the rate here as when the light intensity increases, the rate also increases.



Another factor is limiting the rate of photosynthesis as no further increase in light intensity has an effect.

Carbon dioxide

Carbon dioxide can be described as a limiting factor as when in short supply the process of photosynthesis is limited. Any increase in this factor will increase the rate of photosynthesis until a different factor becomes limiting.

Temperature

As there are enzymes involved in the process (ATP synthetase, ATPase, Rubisco) and any increase in temperature leading to an increase in kinetic energy of molecules will lead to increased successful collisions and an increased rate of reaction. Therefore, low temperatures will limit the reaction and increases in temperature above the optimum can cause denaturation of enzymes that similarly limits the rate.

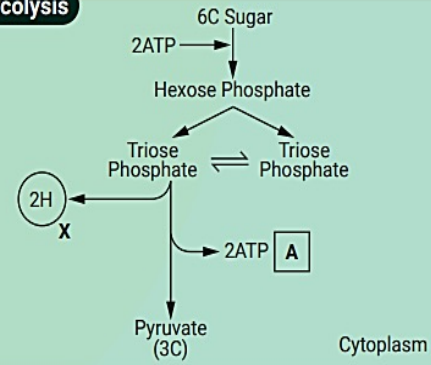
Leave blank to allow students to glue.

Knowledge Organiser: Respiration

Respiration - All living organisms carry out respiration.

- A catabolic, enzyme-controlled reaction inside cells to provide energy.
- Energy rich respiratory substrates, such as glucose or fatty acids, are broken down to release energy.
- High energy bonds, C-C, C-H and C-OH are broken, and lower energy bonds are formed.
- The excess energy released is used to phosphorylate ADP to form ATP or released as heat energy.

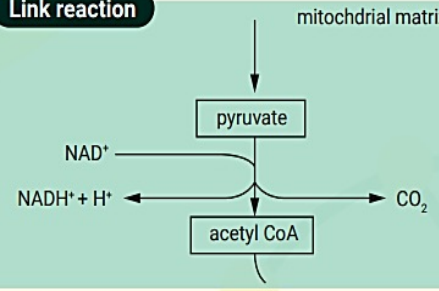
Glycolysis



Glycolysis - in cytoplasm

1. Glucose is phosphorylated using 2ATP into hexose phosphate.
2. The hexose phosphate splits into two triose phosphate molecules.
3. The oxidation of these triose phosphates yields 2ATP by **substrate level phosphorylation**. Dehydrogenation releases 2 Hydrogen that are picked up by NAD. The resulting 2x 3C pyruvates diffuse into the mitochondria.

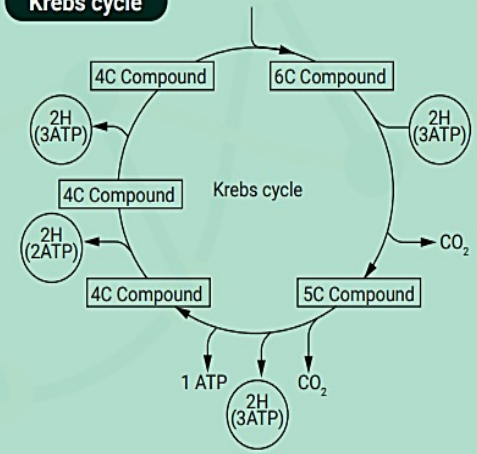
Link reaction



Link reaction - in mitochondrial matrix

4. Oxidative decarboxylation of pyruvate catalysed by decarboxylase releases carbon dioxide.
5. Dehydrogenation catalysed by dehydrogenase releases pairs of hydrogen atoms converting NAD to reduced NAD.
6. The addition of coenzyme A forms acetyl CoA (2C) which enters the Krebs cycle.

Krebs cycle



Krebs cycle - in mitochondrial matrix

7. The acetate from acetyl CoA combines with a 3C compound to form a 6C compound.
8. Decarboxylation forms a 5C compound and dehydrogenation occurs reducing NAD.
9. Decarboxylation forms a 4C compound and dehydrogenation to reduce NAD. There is also substrate level phosphorylation giving 1 ATP.
10. Dehydrogenation forming reduced FAD.
11. Dehydrogenation forming reduced NAD.

Electron transport chain - on inner mitochondrial membrane

12. Reduced NAD and reduced FAD deliver pairs of hydron atoms to the ETC.
13. They are oxidised, delivering protons (H^+) and high energy electrons (e^-) to proton pumps on the inner mitochondrial membrane.
14. Reduced NAD utilises all 3 proton pumps and so 3xATP are released. Reduced FAD utilises only 2 proton pumps and only 2x ATP are released.
15. The method of ATP production can be found on the sheet "The importance of ATP".

Respiratory substrates other than glucose

Lipids

- Glycerol is converted into triose phosphate for use in glycolysis.
- Fatty acids are split into 2C acetate fragments which feed into the Krebs cycle as acetyl CoA.

Proteins

- Amino acids are deaminated in the liver into ammonia and keto acids, one of which is pyruvate that is used in the link reaction and others are fed into the Krebs cycle.

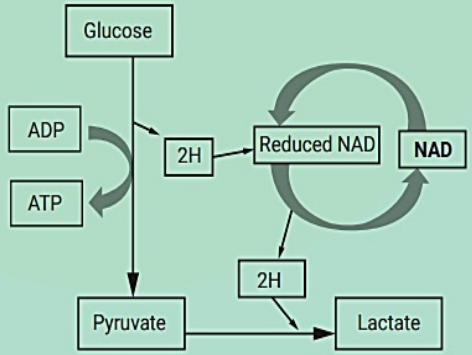
Leave blank to allow students to glue.

Knowledge Organiser: Respiration

Anaerobic respiration in animals

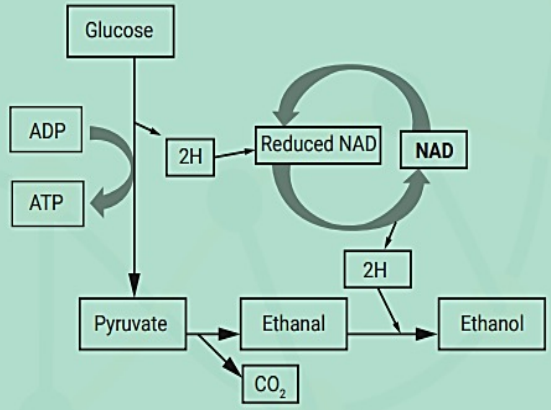
Anaerobic respiration occurs in the absence of oxygen. Without oxygen to act as the final electron acceptor, biochemical reactions inside the mitochondria grind to a halt as any reduced NAD and FAD cannot be reoxidised to pick up more hydrogen.

A mechanism in glycolysis allows reduced NAD to transfer hydrogen to pyruvate, allowing NAD to again accept hydrogen from glucose in a reaction that produces a very small yield of 2 ATP.



1. Glycolysis occurs.
2. Triose phosphate is converted to pyruvate with the release of ATP and reduction of NAD.
3. Reduced NAD reduces the pyruvate, forming lactate.
4. The oxidised NAD can again be reduced during glycolysis. The cycle continues.

Anaerobic respiration in plants



1. Glycolysis occurs.
2. Triose phosphate is converted to pyruvate with the release of ATP and reduction of NAD.
3. Pyruvate is decarboxylated, releasing carbon dioxide and forming ethanal.
4. Reduced NAD reduces the ethanal, forming ethanol.
5. The oxidised NAD can again be reduced during glycolysis. The cycle continues.

Respiration energy budgets

	Glycolysis	Link reaction	Krebs cycle
ATP produced from substrate level phosphorylation	2		2
Reduced NAD produced (will give 3 ATP each)	2	2	6
Reduced FAD produced (will give 2 ATP each)			2
ATP from oxidative phosphorylation of reduced coenzymes NAD or FAD.	6	6	22
Total	8	6	24
Total for aerobic respiration	38		
Total for anaerobic respiration	2		

Leave blank to allow students to glue.

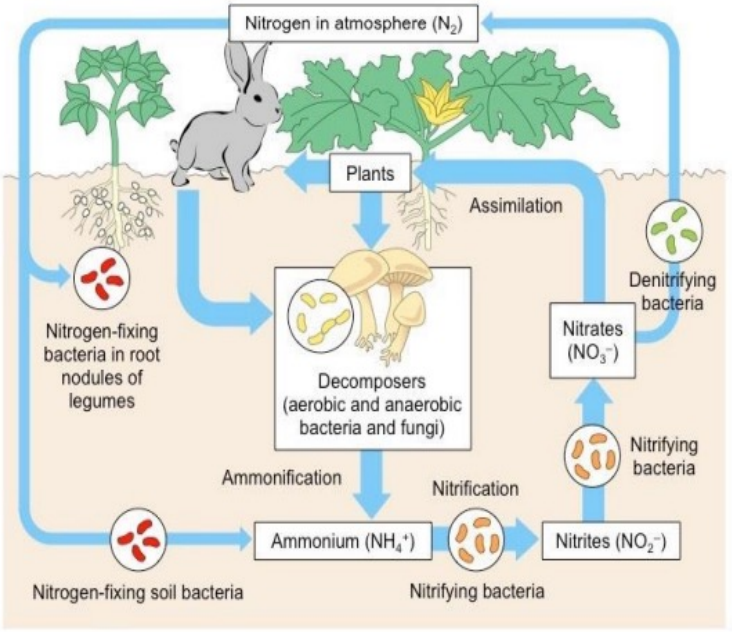
Knowledge Organiser: Energy and Ecosystems

WHAT IS MEANT BY BIOMASS?	Mass of living material
WHAT IS CALORIMETRY?	Measuring amount of chemical energy stored in biomass by heating in calorimeter
WHAT IS GPP?	Gross Primary Production - the chemical energy converted from light energy by plants, in a given area and time
WHAT IS Respiratory loss R?	GPP that is lost to the environment as heat through respiration
WHAT IS NPP?	Net primary production NPP = GPP – R
WHAT IS MEANT BY CONSUMERS NET PRODUCTION? GIVE THE EQUATION FOR IT AND EXPLAIN WHAT EACH PART MEANS	N = I – (F+R) I - Chemical energy in ingested food F - Chemical energy lost in faeces and urine R - energy lost as heat through respiration
WHAT IS MEANT BY TROPHIC LEVEL?	Stage in a food chain
WHAT IS A SAPROBIONT?	Bacteria and fungi – decompose matter by extracellular digestion
WHAT ARE MYCORRHIZAE?	symbiotic relationship between fungi and roots of plants
WHAT ARE HYPHAE?	Fungal strands that form mycorrhizae with plants
DESCRIBE THE PROCESS OF AMMONIFICATION	Saprobionts convert plant/animal nitrogen compounds into ammonia
WHAT ARE *Rhizobium* AN EXAMPLE OF AND WHAT DO THEY DO?	Nitrogen fixing bacteria. They convert atmospheric nitrogen to ammonia ⍰ ammonium ions
WHAT HAPPENS IN THE PROCESS OF NITRIFICATION?	Ammonium ions ⍰ nitrites ⍰ nitrates
WHAT ARE *Nitrosomonas* AND WHAT DO THEY DO?	Nitrifying bacteria that convert Ammonium ions ⍰ nitrites
WHAT ARE *Nitrobacter* AND WHAT DO THEY DO?	Nitrifying bacteria that convert nitrites ⍰ nitrates
WHAT HAPPENS IN THE PROCESS OF DENITRIFICATION?	Conversion of nitrates ⍰ atmospheric nitrogen. Happens in waterlogged soil
WHAT IS GUANO?	Waste produced by sea birds, contains a high concentration of phosphate ions
WHAT IS MEANT BY LEACHING?	When water-soluble compounds are washed out of soil by rain/irrigation systems
WHAT HAPPENS IN EUTROPHICATION?	Too many mineral ions in water causes mega-growth, mega-death and mega-decay

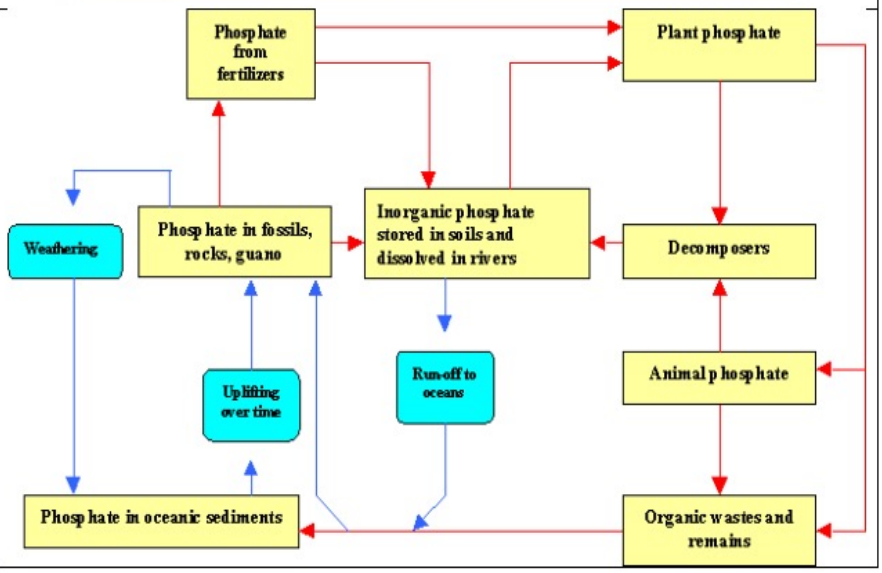
Leave blank to allow students to glue.

Knowledge Organiser: Energy and Ecosystems

DRAW AND LABEL THE NITROGEN CYCLE



DRAW AND LABEL THE PHOSPHOROUS CYCLE



Leave blank to allow students to glue.

Knowledge Organiser: Gene Expression

WHAT IS A MUTATION?	Any change to the base (nucleotide) sequence of DNA
WHAT HAPPENS IN A SUBSTITUTION MUTATION?	One or more bases are swapped for another
WHAT HAPPENS IN A DELETION MUTATION?	One or more bases are removed
WHAT HAPPENS IN A ADDITION MUTATION?	One or more bases are added
WHAT HAPPENS IN A DUPLICATION MUTATION?	One or more bases are repeated
WHAT HAPPENS IN A INVERSION MUTATION?	A sequence of bases is reversed
WHAT HAPPENS IN A TRANSLOCATION MUTATION?	A sequence of bases is moved from one location to another
WHY IS THE GENETIC CODE KNOWN AS DEGENERATE?	DNA code has more than one triplet of bases coding for an amino acid
WHAT IS A FRAMESHIFT?	Mutations that change the number of bases in the DNA code cause frame to shift. Triplet code is read in a different way
WHAT IS A HEREDITARY MUTATION?	Mutation in gamete – always passed onto the offspring
WHAT IS A SILENT MUTATION?	Mutation that has no effect on amino acid primary sequence
WHAT IS MEANT BY A MUTAGENIC AGENT? GIVE EXAMPLES	Something that increases rate of mutations. Eg EV radiation, ionising radiation, chemicals (eg benzene) and viruses
WHAT ARE ACQUIRED MUTATIONS?	Mutations occurring in cells after fertilisation (eg in adulthood
WHAT IS A TUMOUR?	Uncontrollable cell division causing a mass of abnormal cells
WHAT DOES THE TUMOUR SUPPRESSOR GENE CODE FOR?	A gene that causes cell division to slow, by producing proteins stopping them dividing or causing apoptosis
WHAT IS APOPTOSIS?	Programmed cell death by self-destruction
WHAT DO PROTO-ONCOGENES DO?	Stimulate cell division by producing proteins that make cells divide
WHAT IS AN ONCOGENE?	Mutation in proto-oncogene stimulating uncontrollable cell division
WHAT IS THE DIFFERENCE BETWEEN A MALIGNANT AND A BENIGN TUMOUR?	Cancers = malignant tumour. Rapidly dividing cells that invade and destroy surrounding tissue. Cells can break off and spread via blood / lymph to other areas. whereas, benign tumours are not cancerous. Slower growing and covered in fibrous tissue. Often harmless but can cause blockages or put pressure on organs
WHAT IS METHYLATION AND WHAT CAN HAPPEN AS A RESULT?	Addition of methyl ($-CH_3$) group onto DNA. Can switch genes OFF by preventing transcription
WHAT IS HYPERMETHYLATION ?	Too much methylation
WHAT IS HYPOMETHYLATION?	Too little methylation

Leave blank to allow students to glue.

Knowledge Organiser: Gene Expression

HOW IS OESTROGEN LINKED TO SOME CANCERS?	Hormone that stimulate breast cells to divide and replicate. This is because it is lipid soluble and diffuses through the cell membrane. It binds with an oestrogen receptor and then enters the nucleus. These act as a transcriptional factor for the AID gene. THis gene causes hypermutation
WHAT ARE STEM CELLS?	Unspecialised cells that can divide and develop into other types of cell
WHAT IS THE DIFFERENCE BETWEEN TOTIPOTENT, PLURIPOTENT, UNIPOTENT AND MULTIPOTENT STEM CELLS?	TOTIPOTENT: Can mature into any type of cell. Found in early embryos only. PLURIPOTENT: Can specialise into any type of body cell but NOT placental cells UNIPOTENT:Only differentiate into one type of cell, eg epidermal skin cells MULTIPOTENT:Can differentiate into a few different types of cell. Eg bone marrow cells forming red and white blood cells
WHAT ARE CARDIOMYOCYTES?	Heart muscle cells
DESCRIBE SCID	Severe combined immunodeficiency. Genetic disorder affecting immune system
WHAT ARE iPS CELLS?	Induced pluripotent cells – reprogramming adult cells so they become pluripotent.
WHAT IS THE PROMOTOR REGION OF A GENE?	Specific DNA site near start of target genes
WHAT ARE TRANSCRIPTIONAL FACTORS?	Protein molecules controlling transcription of genes
WHAT ARE ACTIVATORS?	Transcriptional factor that stimulates rate of transcription
WHAT ARE REPRESSORS?	Transcriptional factor that inhibits rate of transcription
WHAT IS ?RNAi (siRNA)	Small double-stranded non-coding RNA prevents transcription
DEFINE EPIGENETIC CONTROL	Involves heritable changes in gene function without changing the DNA itself
WHAT IS A HISTONE?	Large protein around which DNA is wound
DESCRIBE THE EFFECT OF ACETYLATION ON TRANSCRIPTION	Acetyl groups ($COCH_3$) is added to histone, causing them to become less tightly wound, switching on transcription by revealing promoter regions.
WHAT DOES THE ENZYME HISTONE DEACETYLASE (HDAC) DO?	Enzyme that removes acetyl groups from histones
WHAT IS THE PROTEOME OF AN ORGANISM?	All the proteins coded for by an organism

Leave blank to allow students to glue.

Knowledge Organiser: Recombinant DNA Technology

WHAT IS MEANT BY AN ORGANISM'S GENOME?	The entire set of DNA, including genes of an organism
WHAT IS MEANT BY PROTEOME?	The entire set of proteins made by an organism
WHAT IS THE SANGER TECHNIQUE USED FOR?	Method of sequencing DNA using gel electrophoresis.
WHAT IS PYROSEQUENCING ?	Faster method of sequencing DNA by synthesising DNA that releases light at every base added
WHAT IS cDNA AND HOW IS IT FORMED?	Complimentary DNA – a copy of DNA synthesised using reverse transcriptase from mRNA
WHAT DOES THE ENZYME REVERSE TRANSCRIPTASE DO?	Enzyme that converts messenger RNA into DNA
WHAT DOES THE ENZYME LIGASE DO?	Enzyme that forms phosphodiester bonds in the sugar-phosphate backbone of DNA
WHAT ARE "STICKY ENDS"?	Single-stranded section at end of DNA where bases are exposed
DESCRIBE A PALLINDROMIC SEQUENCE	Base sequence reads the same in either direction eg GAATTC CTTAAG
WHAT IS IN VIVO CLONING?	Method of amplifying DNA fragments in living cells (eg bacteria)
WHAT IS IN VITRO CLONING?	Method of amplifying DNA fragments using PCR
WHAT IS PCR AND DESCRIBE HOW IT WORKS	Polymerase chain reaction for in vitro cloning You need a strand of DNA, primers, DNA nucleotides and *taq* DNA polymerase. Heat to 90 - to break H bonds and make the DNA single stranded. Cool to 40 - anneals the primers heat to 75 - optimum temp for *taq* DNA polymerase.
WHAT IS A VECTOR?	Something used to transfer DNA from one organism into another (eg a plasmid)
DEFINE LIGATION	Where DNA ligase joins sticky ends from a DNA fragment to sticky ends of the vector DNA
DEFINE RECOMBINANT DNA	New combination of bases in the DNA due to combining the vector DNA to the inserted DNA fragment
WHAT IS MEANT BY A TRANSFORMED CELL?	A host cell that has taken up the vector with recombinant DNA
WHAT IS ELECTROPORATION AND WHY WOULD YOU USE IT?	Use of a small electric shock to increase membrane permeability of the host cell, encouraging it to take up the vector
WHAT IS HEAT SHOCK AND WHY WOULD YOU USE IT?	Use of calcium chloride solution and heat of 42^{0}C encouraging host cell to take up the vector
WHAT ARE MARKER GENES?	Genes on a vector for identifying transformed cells

Leave blank to allow students to glue.

Knowledge Organiser: Recombinant DNA Technology

WHAT IS A PRIMER?	Small sections of single stranded DNA, complimentary to the bases at the start of a DNA fragment
WHY WOULD YOU USE *Taq* DNA polymerase IN PCR?	DNA polymerase from *Thermus aquaticus* – from hot springs so able to withstand high temperatures without denaturing
WHAT IS GENE THERAPY?	Altering defective genes inside cells to treat genetic disorders and cancer
DEFINE GERM-LINE THERAPY	Involves altering genes in sex cells so that every cell in the resulting embryo will contain the altered allele. Currently illegal in humans
DEFINE SOMATIC THERAPY	Involves altering genes in body cells, particularly the cells affected by the disorder, such as lung cells for cystic fibrosis.
WHAT IS A MICROARRAY?	Gene probes that can screen for lots of different genes at the same time
WHAT ARE VNTRs?	Variable number tandem repeats – base sequences appearing next to each other that don't code for anything and can be repeated thousands of times. Inherited from parents and differs from person to person
HOW DOES GEL ELECTROPHORESIS PRODUCE A DNA FINGERPRINT?	By separating DNA fragments according to size. Smaller pieces move fastest through a gel towards the positive plate
HOW WOULD YOU INSERT A GENE FROM ONE ORGANISM AND INSERT IT IN THE GENOME OF ANOTHER?	• Cut the DNA using a restriction enzyme • that cuts at a specific pallindromic sequence • Cut the host DNA using the **same** restriction enzyme • use a vector (eg a plasmid) to carry the foreign DNA into the host cell • use ligase to insert the DNA • to make recombinant DNA • use marker genes to identify transformed cells

Leave blank to allow students to glue.