Overview

Cells, Organ Systems & Ecosystems

Cells and movement across membranes

The Respiratory system in humans

The digestive system in humans

The circulatory system in humans

Photosynthesis

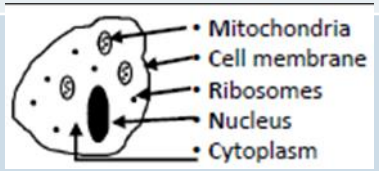
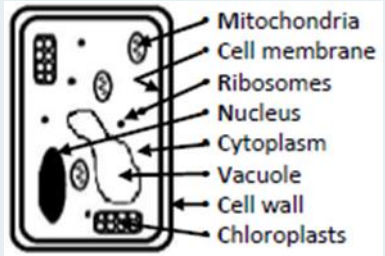
Ecosystems - transferring energy

Ecosystems - Pollution & nutrient cycles

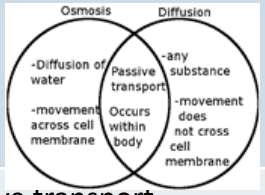
Structure of Plants

Maths Skills for Biology

Key Points to Learn

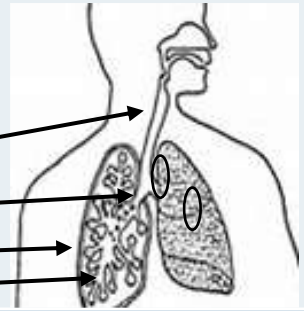
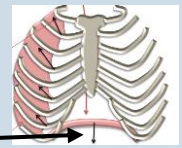
1. Early light microscopes	Use light and lenses. Have magnifications of 100 to 2 000
2. Electron microscope	Modern. Use a beam of electrons. Magnifications of up to 2 000 000
3. Magnification	How much bigger an image appears than the real object e.g. Magnification of 100, image looks 100 times bigger than object $magnification = \frac{size\ of\ image}{size\ of\ object}$
4. Resolving power	Smallest size microscope can show
5. Typical Animal cell	. 
6. Typical Plant cell	
7. Specialised animal cells	e.g Sperm – tail to swim
8. Specialised plant cells	e.g Root hair - absorb water and ions
9. Mitochondria	Perform respiration to release energy
10. Cell membrane	Controls movement in/out of cell
11. Ribosomes	Makes proteins by protein synthesis
12. Nucleus	Controls activities of cell. Genes to build new cells
13. Cytoplasm	Jelly like liquid where most reactions happen

Key Points to Learn

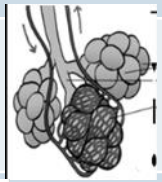
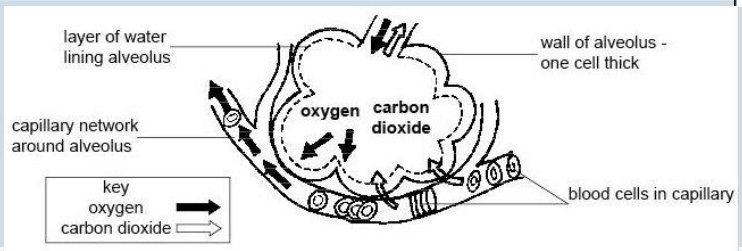
14. Vacuole	Sac filled with sap. Keeps cell rigid
15. Cell wall	Made of cellulose. Supports cell
16. Chloroplasts	Green and full of chlorophyll
17. Chlorophyll	Absorbs light for photosynthesis
18. Eukaryotic cells	Animal cells and plant cells. Have cell membrane, cytoplasm and nucleus
19. Prokaryotic cells	Bacteria. Do not have a nucleus. Genetic material is looped
20. Diffusion	Particles spreading out in gas/liquid Move from high → low concentration. Dissolved substances like O_2 and CO_2 move in/out of cells by diffusion
21. Factors affecting diffusion	1. Difference in concentration (concentration gradient) 2. Temperature 3. Surface area to diffuse through
22. Osmosis	 Diffusion of water through partially permeable membrane (surface that only lets small particles through). Moves from dilute solution → more concentrated solution
23. Active transport	Moves substances from low →high concentration. Needs energy
24. Enzymes	 are involved in all metabolic reactions building large molecules from small ones as well breaking down large molecules into small ones.
25. Lock & Key	stylised diagrams of enzyme/substrate interactions
26. Enzyme Stability	the effect of temperature and pH on enzyme activity including the effect of boiling which denatures most enzymes
27. Structure of enzymes	Different enzymes contain up to 20 different amino acids linked together to form a chain which then folds into the globular enzyme shape.

Cells & movement across membranes

Key Points to Learn

1. Aerobic Respiration	Process by which all living things get energy from glucose and oxygen Glucose + Oxygen → Carbon dioxide + Water $C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O$ Happens continuously in plants an animals. Provides lots of energy Exothermic reaction - gives off heat Occurs within mitochondria in cells
2. ATP - Adenosine triphosphate	chemical that provides energy to drive many processes in living cells. Less ATP broken down in anaerobic compared to aerobic.
3. Anaerobic Respiration - Animals	Glucose → Lactic acid Much less energy provided than aerobic respiration
4. Lactic Acid	Causes muscles to tire and cramp
5. Oxygen Debt	Requires more oxygen after exercise is complete to break down the lactic acid
6. Lung Structure	Organs for gas exchange. Take in O_2 release CO_2 Trachea Bronchi Lung Alveoli 
7. Thoracic muscles	Intercostal muscles between ribs Diaphragm 
8. Breathing	Not the same as respiration. Method of obtaining oxygen from the air
9. Trachea	Pipe from mouth to bronchi

Key Points to Learn

10. Cilia & mucus	Tiny hair-like cells. Produce mucus. Mucus and cilia help protect the respiratory system. Particles and bacteria stick to mucus and cilia move the mucus out of the respiratory system to the back of the throat.
10. Bronchi	Pipe into each lung
11. Bronchioles	Smaller and smaller tubes that end with alveoli
12. Alveoli	Thin sac-like structures within the lungs. Covered in blood vessels to help gas exchange 
13. Gas exchange	
14. Composition of air	

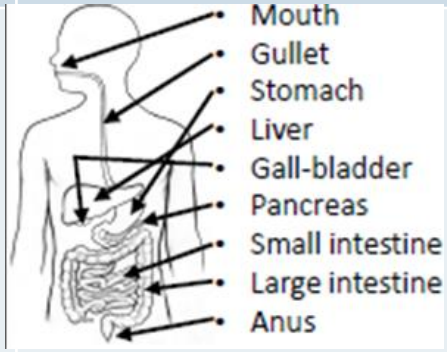
Gas	Inhaled	Exhaled
Oxygen	21%	17%
CO_2	Tiny amount	3%
Nitrogen	79%	79%
Water	Small amount	Large amount

15. Limewater	Turns cloudy when CO_2 goes through it
16. Smoking	chemicals in cigarette smoke paralyse cilia particles clog the mucus which prevents their function Tar = cancer Nicotine = addictive Diseases caused: emphysema, bronchitis, Asthma
17. Lung volume changes	movement of air takes place due to differences in pressure between the lungs and outside the body

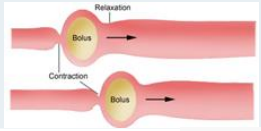
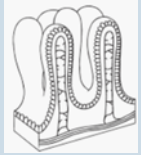
Human respiratory system

Human digestive system

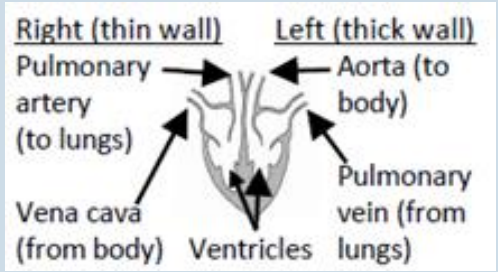
Key Points to Learn

1. Digestion	breakdown of large molecules into smaller molecules so they can be absorbed for use by body cells
2. Human digestive system	
3. Carbohydrate	Types of sugars: glucose, starch, cellulose. Used for energy **Test: Starch turns iodine bluey black** **Test: Glucose: Benedicts + heat turns blue to brick red**
4. Proteins	Made up of amino acids. Used to make enzymes, tissues and cells. Found in meat, fish, pulses, milk **Test: Biuret reagent turns from blue to purple**
5. Starch	(a carbohydrate) made up of a chain of glucose molecules
6. Lipids	Fats made up of fatty acids and glycerol. Used to provide energy
7. Metabolism	The sum of all the reactions in a cell or the body of an organism
8. Carbohydrase	Enzyme that turns starch to glucose.
9. Amylase	Type of carbohydrase enzyme. Breaks down glucose. Made in salivary glands, pancreas, small intestine
10. Protease	Enzyme breaks down protein. Made in stomach, pancreas, small intestine
11. Lipase	Enzyme breaks down lipids. Made in pancreas, small intestine

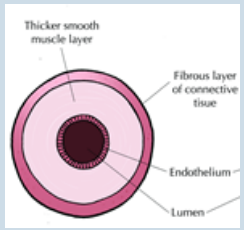
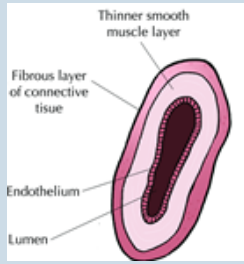
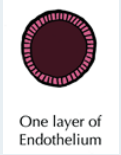
Key Points to Learn

12. Mouth	Chews food. Starch digestion begins by carbohydrase/ amylase in saliva
13. Stomach	Churns food. Partial digestion - secretes protease
14. Liver	Makes bile to be stored in gall bladder
15. Pancreas	Puts lipase, proteases and carbohydrase into the small intestine
16. Small Intestine	Continued digestion of carbohydrates to glucose, proteins to amino acids, fats to fatty acids and glycerol and absorption of digested molecules Majority of digestion occurs here.
17. Large Intestine	Absorption of water
18. Bile	Bile emulsifies large droplets of fat into small droplets to increase the surface area for enzyme action. It also increases the pH in the small intestine to the optimum pH for lipase activity.
19. Peristalsis 	The action of contraction and relaxation of muscles in peristalsis in forcing food through the digestive system.
20. Absorption 	The small intestine has a relatively large surface area, created by villi, which contain blood vessels. It has a rich blood supply which maintains a steep diffusion gradient.
21. Balanced Diet	protein, carbohydrates and fats, minerals (iron),vitamins (vitamin C), fibre and water. Iron is needed for the production of haemoglobin, vitamin C is needed to maintain healthy tissue
22. Excesses	Excess sugar can lead to type 2 diabetes, obesity, tooth decay. Excess fat can lead to obesity, heart disease and circulatory disease. Excess salt (sodium) can lead to high blood pressure.
23. Energy from food	foods have different energy contents and that energy from food, when it is in excess, is stored as fat by the body

Key Points to Learn

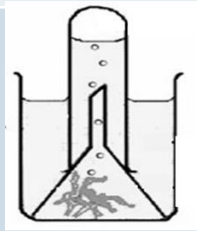
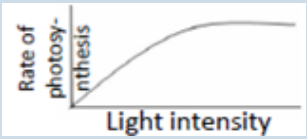
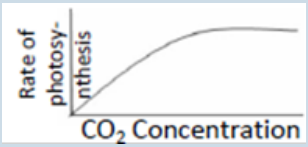
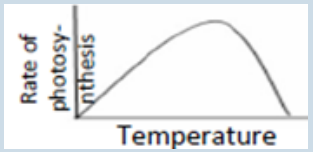
1. Red blood cell	Contain haemoglobin for transport of oxygen • Biconcave • No nucleus • Cell membrane 
2. Phagocyte (white blood cell)	Defence against disease. Cell membrane, cytoplasm & nucleus. 
3. Platelets	Used in clotting, help to form scabs
4. Plasma	Straw coloured liquid part of blood. Used for transport of carbon dioxide, soluble food, urea, hormones and the distribution of heat
5. The Heart	Organ made of muscle that pumps blood in two loops around body: • involving one system for the lungs – pulmonary • and one for the other organs of the body – systemic 
6. Heart Valves	The heart contains valves to prevent the blood flowing backwards: • the right side has a tricuspid valve (a valve with three flaps) • the left side has a bicuspid valve (a valve with two flaps) • Both sides have semilunar valves – at the entrances to the pulmonary artery and aorta
7. Circulatory system	Transports substances to/from body cells. Made up of: • Blood • Blood vessels (arteries, veins and capillaries) • The Heart

Key Points to Learn

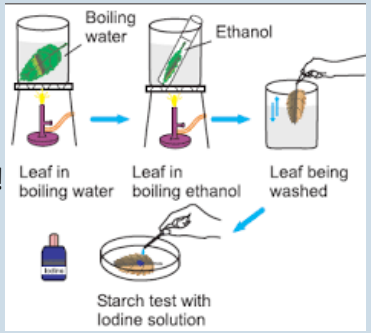
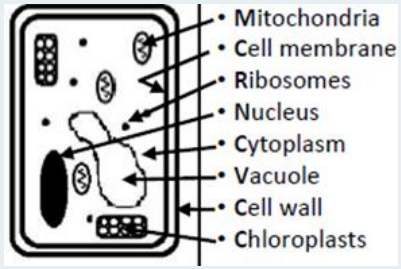
8. Arteries 	Carry blood away from the heart (always oxygenated apart from the pulmonary artery which goes from the heart to the lungs). • Have thick elastic and muscular walls. • Have small passageways for blood (internal lumen). • Contain blood under high pressure
9. Coronary arteries	Blood vessels that supply heart with oxygen
10. Veins 	Carry blood to the heart (always deoxygenated apart from the pulmonary vein which goes from the lungs to the heart). • Have thin, less muscular walls. • Have larger passageways for blood (internal lumen). • Contain blood under low pressure. • Have valves to prevent blood flowing backwards.
11. Capillaries 	Found near every living cell of the body. • Walls are one cell thick, this allows for the diffusion of substances into the cells from the capillaries and out of the cells into the capillaries. • Very low blood pressure.
12. Cardiovascular disease 	Risk Factors: high levels of fat and salt in the diet, high blood pressure, high blood cholesterol, smoking, genetic factors and a lack of exercise. Effects: Atheroma – blockage of vessel. Can cause heart attack
13. Treatment for cardiovascular disease **Describe pros and cons**	Statins – drugs that control cholesterol levels Angioplasty – surgery to remove blockage Lifestyle changes – healthy diet & exercise 

Human circulatory system

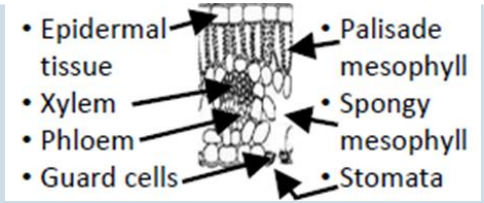
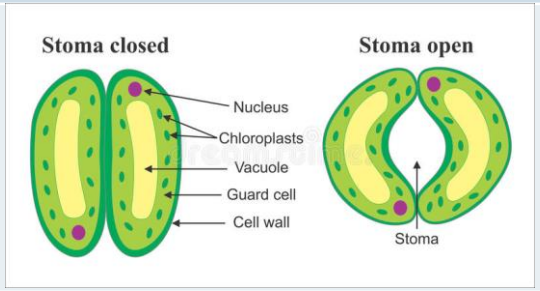
Key Points to Learn

1. Photosynthesis	is the process by which plants make carbohydrates from raw materials, using energy from light. • The reverse of respiration • Endothermic reaction – light energy is absorbed
2. Word Equation	Oxygen is a by product *Absorbs light energy* Carbon + Water → Glucose + Oxygen dioxide
3. Rate of Photosynthesis	Can be measured by using pond weed and counting number of oxygen bubbles released 
4. Calculating light intensity	Light intensity $\propto \frac{1}{\text{Distance}^2}$ The symbol ∝ means 'is proportional to', and distance is measured in meters.
5. Limiting factors	Affected by light intensity  Affected by CO_2 concentration  Affected by Temperature 

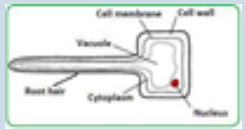
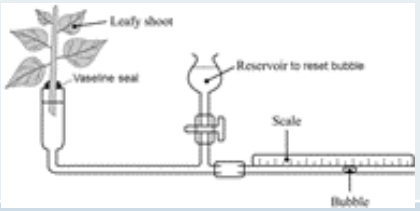
Key Points to Learn

7. Testing leaf for starch	Boil in water → ethanol → wash → iodine Turn Bunsen off before ethanol! 
8. Plant leaf cell	
9. Mitochondria	Perform respiration to release energy
10. Cell membrane	Controls movement in/out of cell
11. Ribosomes	Makes proteins by protein synthesis
12. Nucleus	Controls activities of cell. Contains genes to build new cells
13. Cytoplasm	Liquid where most reactions happen
14. Vacuole	Sack filled with sap. Keeps cell rigid
15. Cell wall	Made of cellulose. Supports cell
16. Chloroplasts	Green and full of chlorophyll
17. Chlorophyll	Absorbs light for photosynthesis

Key Points to Learn

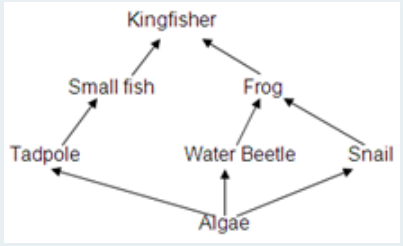
1. Leaf structure cross-section	
2. Plant Organs	Leaf – carries out photosynthesis Stem – supports Roots – take in water and minerals
3. Features of leaves	• Large surface area – To maximise light absorption • Thin - Short distance for carbon dioxide to diffuse into leaf cells • Cuticle - A waxy waterproof layer which reduces water loss, it is transparent to allow light through the leaf
4. Stomata	The stomata control gas exchange in the Each stoma can be open or closed to: • regulate transpiration • allow gas exchange 
5. Diffusion	Of carbon dioxide, oxygen and water vapour into (or out of) the leaf is greatest when the stomata are open, during the day.
6. Xylem	Moves water and ions – from roots upwards by **transpiration** • contain no cytoplasm • are impermeable to water • have tough walls containing a woody material called lignin
7. Phloem	Moves sugars and amino acids – from leaves to rest of plant by **translocation** Contain cytoplasm Sugars move: • from sources in the root to sinks in the leaves in spring time • from sources in the leaves to sinks in the root in the summer

Key Points to Learn

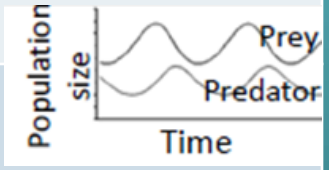
8. Vascular bundles	Xylem – strong & tough – middle of roots to resist pulling up Xylem & Phloem in stems – near edge for wind protection Xylem surrounded by phloem
9. Transpiration	Evaporation from leaf pulls water through plant xylem. Affected by temperature, humidity, wind, light
10. Translocation	Is the movement of materials in plants from sources to other parts of the plant – **Active Transport** Chemicals, such as pesticides, also move through the plant by translocation.
11. Water	• Used in photosynthesis • Transport - transpiration • Fill the vacuoles to support cells
12. Root Hairs	 • Where most water absorption happens • Long, thin, large surface area • Water enters roots by osmosis from soil *concentration gradient* • Active transport of nutrients – root hair cells – carrier proteins move ions <u>against</u> the concentration gradient
13. Potometer	Used to measure the rate of transpiration that's proportional to water uptake. 
14. Plant nutrients	Nitrates N – amino acids, proteins, cell growth Phosphates P – DNA, cell membranes Potassium compounds K – enzymes for respiration & photosynthesis In fertilizers NPK values – relative proportions of minerals
15. Nutrient deficiencies	Nitrate – poor growth, yellow leaves Phosphate – poor root growth, discoloured leaves Potassium – Poor growth fruit & flowers, discoloured leaves

Structure of plants – TRIPLE ONLY

Key Points to Learn

1. Food chains	A food chain shows the flow of energy and materials from one organism to the next in a habitat. It begins with a producer. Producer → Primary consumer → Secondary consumer
2. Food webs	• Interconnected food chains • Shows energy flow in an ecosystem • Interdependence - changes in the population of one species impacts on others in the web 
3. Producer	Green plants or algae. Always first organism in a food chain/web. Produce most of the biomass for life on Earth eg phytoplankton
4. Primary consumers	Eat producers eg snail
5. Secondary consumers	Eat primary consumers eg frog
6. Tertiary consumers	Eat secondary consumers eg kingfisher
7. Types of consumption	Herbivore – plant eater Carnivore – meat eater Omnivore – eats both plants and animals – can inhabit more than one trophic level
8. Decomposer	Microorganisms that feed on dead organisms and waste Release carbon back into atmosphere and minerals ions into soil
9. Trophic Levels	The position occupied by an organism in a food chain is known as its trophic level. Food chains are rarely longer than four trophic levels as energy is used up or lost at each level.

Key Points to Learn

10. Pyramids	Shows the population at each stage in a food chain. Energy is lost up the pyramid due to growth, maintenance, repair, respiration & waste Sometimes the pyramid doesn't look like a pyramid  Producer at the bottom always. Biomass pyramid shows amount of biological mass in the chain – these ALWAYS look like a pyramid
11. Biomass	Amount of biological mass in an organism The percentage efficiency of energy transfer between trophic levels can be calculated: efficiency = $\frac{\text{energy transferred to next level}}{\text{total energy}} \times 100$
12. Distribution	Where things are
13. Abundance	How many there are
14. Predator	Consumers that kill and eat other animals
15. Prey	Consumers that get eaten by predators
16. Predator-prey cycles	Numbers of both rise and fall in cycles  1. Lots of plants means prey numbers increase 2. Lots of prey means predator numbers increase 3. Lots of predators means prey numbers decrease 4. Less prey means predator numbers fall 5. Less predators means prey numbers increase

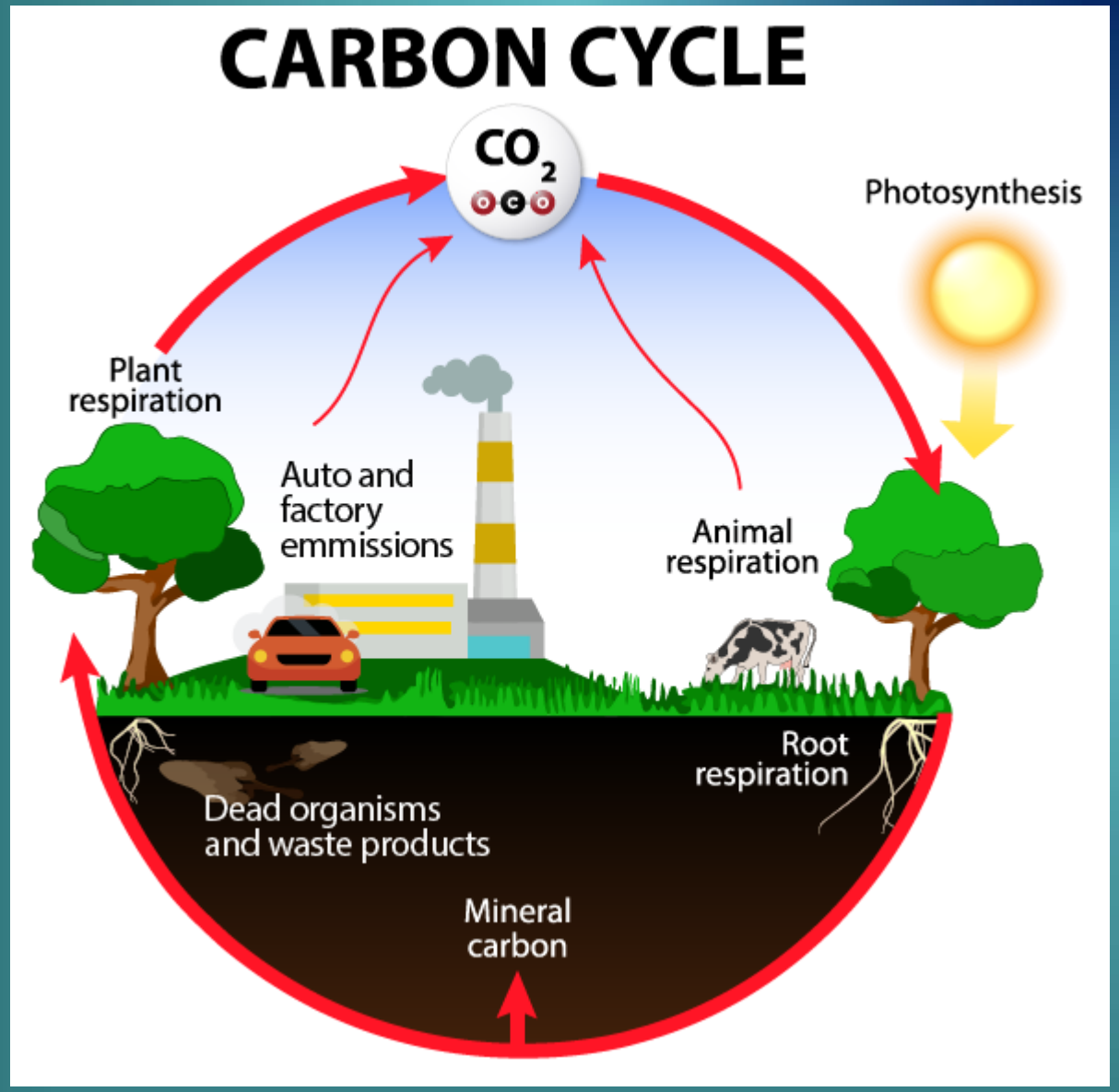
Ecosystems – transferring energy

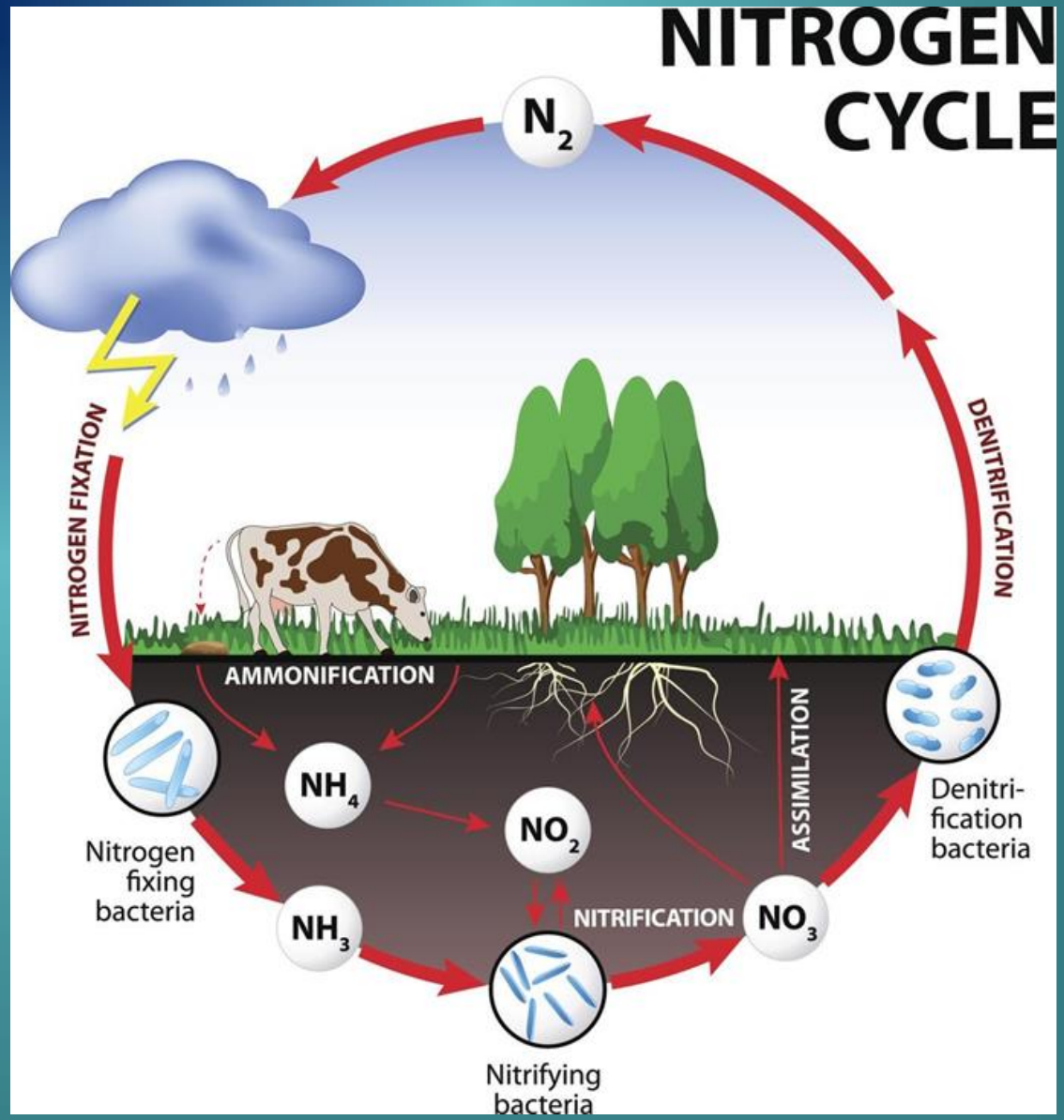
Key Points to Learn

1. Intensive farming	Advantage – increased yield Disadvantage – chemical pollution – run off, animal welfare concerns, antibiotic resistance
2. Human need	The need to balance the human requirements for food and economic development with the needs of wildlife
3. Biodiversity	The variety of all different species in a particular ecosystem
4. Ecosystem	A system that includes all living organisms (biotic) in an area and non-living (abiotic) factors
5. High biodiversity	• Ensures stability of ecosystems by reducing one species dependence on another • Future of human species on Earth relies on high biodiversity
6. Negative human impact on biodiversity	Human actions are reducing biodiversity. Actions such as: • More waste • More land use • Population growth • Using resources
7. Pollution from waste	Pollution kills plants and animals which can reduce biodiversity • In water, from sewage, fertiliser or toxic chemicals • In air, from smoke and acidic gas • On land, from landfill and from toxic chemicals
8. Land use	Humans reduce land available for animals by: • Building • Quarrying • Farming • Dumping waste
9. Destruction of peat bogs	Used for compost. Leads to reduction in size of this habitat. Decay or burning of peat releases carbon dioxide
10. Deforestation	Removal of forests to : • grow cattle and rice fields • grow crops for biofuels

Key Points to Learn

11. Maintaining biodiversity	Actions humans are taking to reduce loss of biodiversity: • Breeding programmes for endangered species • Protection and regeneration of rare habitats • Reintroduction of field margins and hedgerows • Reduce deforestation • Reduce carbon dioxide emissions • Recycling rather than dumping in landfill
12. Indicator Species	An indicator species is an organism whose presence or absence is used by scientists to determine if an area is polluted. e.g. Lichen on Trees, blood worms in waterways Pollution also indicated by pH and oxygen levels.
13. Bioaccumulation	When heavy metals or pesticides, which cannot be broken down in animals tissues, are washed into soils and rivers and pass through food chains. These chemicals reach a toxic level in organisms.
14. Eutrophication	Some pollutants affect the environment by disrupting the equilibrium in food chains. • Sewage • Nitrate leaching
	Triple Only
15. Microorganism and decay	Micro-organisms digest materials from their environment for life processes. These materials are returned to the environment either in waste products or when living things die and decay. When decay is prevented fossil fuels form.
16. Carbon Cycle	Carbon is passed from the atmosphere, as carbon dioxide, to living things. It is then passed from one organism to the next in complex molecules, and returned to the atmosphere as carbon dioxide again.
17. Nitrogen Cycle PTO FOR DIAGRAMS	Nitrogen compounds found in cells include proteins. Nitrogen from the air is converted into soluble ions absorbed by plant roots.. It forms part of nitrogen compounds in the plants, and is then passed from one organism to the next. It is returned to the atmosphere as nitrogen gas. Denitrifying bacteria – anaerobic – farmers try to prevent.


CARBON CYCLE
CO_2
Photosynthesis
Plant respiration
Auto and factory emmissions
Animal respiration
Root respiration
Dead organisms and waste products
Mineral carbon


NITROGEN CYCLE
N_2
NITROGEN FIXATION
DENITRIFICATION
AMMONIFICATION
ASSIMILATION
NH_4
NO_2
NH_3
NITRIFICATION
NO_3
Nitrogen fixing bacteria
Denitri-fication bacteria
Nitrifying bacteria

Maths Skills

Prefix	Meaning	Standard form
Mega (M)	x 1000000	x 10^6
kilo (k)	x 1 000	x 10^3
milli (m)	÷ 1 000	x 10^{-3}
nano (n)	÷ 1 000 000 000	x 10^{-9}

Biology Formulae

$$magnification = \frac{size\ of\ image}{size\ of\ object}$$

$$Light\ intensity \propto \frac{1}{Distance^2}$$

$$efficiency = \frac{energy\ transferred\ to\ next\ level}{total\ energy\ in} \times 100$$

Standard Form

In standard form, a number is always written as:

$A \times 10^n$

A is always between 1 and 10.

n tells us how many places to move the decimal point.

15 000 000 would be 1.5×10^7

Move your decimal point to the LEFT is a POSITIVE number

$0.000467 = 4.67 \times 10^{-4}$

Move your decimal point to the RIGHT is a NEGATIVE number

Adding and subtracting numbers in standard index form

Convert them into ordinary numbers, do the calculation, then change them back if you want the answer in standard form.

$4.5 \times 10^4 + 6.45 \times 10^5$

= 45,000 + 645,000

= 690,000

= 6.9×10^5

Multiplying and dividing numbers in standard form:

Here you can use the rules for multiplying and dividing powers. Remember these rules:

To multiply powers you add, eg, $10^5 \times 10^3 = 10^8$

To divide powers you subtract, eg, $10^5 \div 10^3 = 10^2$