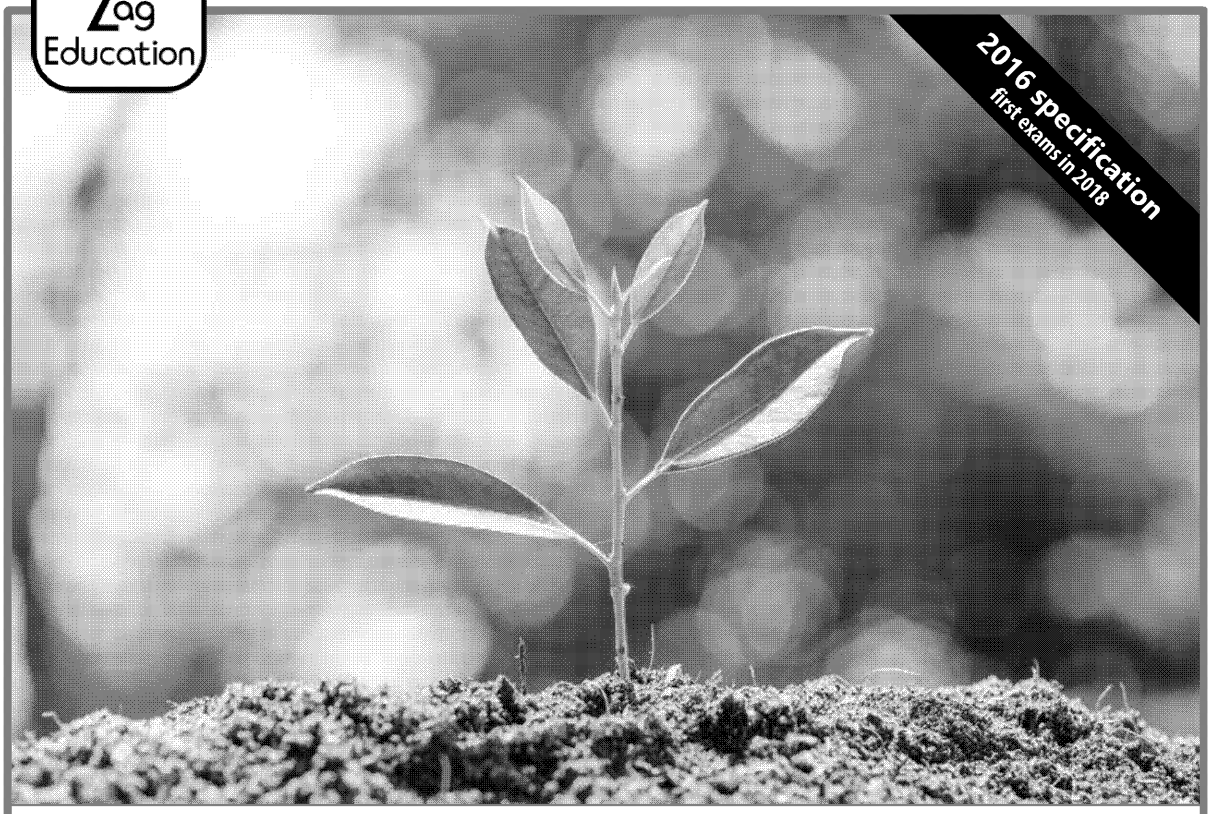
Zig Zag Education

Biology

GCSE (9–1) | WJEC | 3400



Cover Lessons

For GCSE WJEC Biology

zigzageducation.co.uk

POD 8090

Contents

Teacher's Introduction

As a science teacher and Head of Biology for many years, I know the value of a
lessons! This resource is designed as a 'dip-in', with relevant lessons for each t
the list of lessons.

A lot of the time, cover lessons unfortunately come down to a revision guide, a
then answer questions. While revision guides have good diagrammatic inform
depth or include any extension, and students usually know that no one will fin
doing. With this resource, however, the marking and feedback cycle can be co
any additional activities can be set for homework.

Each of the lessons contains the followin
- Links to specification and l
- Instructions for th
- Backs
- Wo
- Exte
- Answers in the answer section for easy reference for cover teachers, and
  desired.

The resource is designed for non-specialist use, but, depending on the cover te
included for variety such as through diagrammatic representations, some YouT
group and peer-marking that could be used for discussion.

I've also tried to tailor the content for use during potential Ofsted inspections
times) by incorporating:
- reference to tiers and full-course-only material
- extension activities
- a range of open and closed questions, and mark schemes with a range of
  well to discussion, and peer- or self-marking, and may be used to set targ
- cross-curricular links to literacy and numeracy
- lots of 'Working Scientifically' content

I hope you find this resource useful!

*A web page containing all the links listed in this resource is conve
Education's website at **zzed.uk/8090***

You may find this helpful for acce websites rather than ty

Free Updates!

Register your email address to receive any future fr
made to this resource or other Biology resources y
has purchased, and details of any promotions for y
** resulting from minor specification changes, suggestions from teach
and peer reviews, or occasional errors reported by customers*

Go to **zzed.uk/freeupdates**

Outline of All Cover Lessons for

Ref.	Lesson ID	Syllabus Refs	Lesson Title and Learning Objectives	Lesson Outline and Suggestions	K
CELLS AND MOVEMENT ACROSS CELL MEMBRANES	1	1.1 a–c	**What's in a cell?** Be able to: • Name the main subcellular structures in eukaryotic cells (plant, animal, fungi) and prokaryotic cells (bacteria) • Explain how they are related to their functions	***Starter – Recap:*** If possible, show the rap and use it (or a textbook) to complete cell labels and matching boxes (Task 1). ***Main:*** Complete the various tasks to learn function of organelles (Task 2) and compare prokaryotic and eukaryotic cells (Task 3), and label the different types of cell using the given info (Tasks 4 and 5). ***Plenary:*** Self- or peer-checking and marking. ***Extension:*** Flow chart task to consolidate knowledge and make students think about classification.	eukaryo prokaryo subcellu DNA, rib wall, chl cellulose cell men plasmid, vacuole, (possibly murein)
	2	1.1 e, 1.3 a	**Size, Scale and Surface Area** Be able to: • Calculate and compare surface area to volume ratios • Use surface area to volume ratios to explain the need for complex exchange surfaces • Recognise and describe some exchange surfaces in the body	***Starter:*** Prompt questions to open discussion and start thinking. ***Main:*** Read the given information and answer the starter questions (Task 1). Apply this to Practical Analysis 5a, a surface area to volume ratio investigation in which students analyse given results and answer discussion questions. ***Plenary:*** Discuss answers in small groups and correct mistakes. ***Extension:*** Use surface area to volume ratio to explain natural phenomena.	unicellul multicel diffusion surface a ratio, ra

Ref.	Lesson ID	Syllabus Refs	Lesson Title and Learning Objectives	Lesson Outline and Suggestions	K
CELLS AND MOVEMENT ACROSS CELL MEMBRANES	3	1.1 f–h	**Active and passive transport** Be able to: • State that substances move into and out of cells by three main processes: a. diffusion b. osmosis c. active transport • Define each process with reference to the movement of named substances, in terms of concentration gradients	***Starter:*** Read background information, and summarise the three types of transport. ***Main:*** Worksheets on practical-based questions on diffusion and osmosis. Practical analyses are independent of each other, and students may complete either or both depending on lesson length. **The effect of temperature on diffusion** consolidates understanding of diffusion and progresses to factors affecting diffusion. **Osmosis in potato cells** – consolidates understanding of osmosis and water potential. ***Extension:*** Questions about hypertonic and hypotonic solutions.	active, p energy, osmosis, active tr concent turgid, fl
	4	1.1 i, l	**Working with enzymes** Be able to: • Use the 'lock and key theory' as a simple model to explain enzyme action • Describe experiments that can be used to investigate enzymatic reactions	***Starter:*** Recap enzyme terminology via the gap-fill exercise (Task 1). ***Main:*** Practical Analysis. Students read the practical instructions then answer the questions. This can work better with a class discussion to check comprehension first, or as individual work, with answers to be discussed at the end of the lesson. ***Plenary:*** Self- or peer-checking and marking. ***Extension:*** Additional questions on the practical consequences of optimum enzyme conditions.	enzyme, active si variable (indepe depende denatur

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RESPIRATION AND THE RESPIRATORY SYSTEM IN HUMANS	5	1.2 a–b	**Aerobic and anaerobic respiration in cells** Be able to: • State the word equation and the symbol equation for aerobic respiration • State the word equation for anaerobic respiration • Compare the processes of aerobic and anaerobic respiration with regard to - the need for oxygen - the differing products - the relative amounts of energy released	***Starter:*** Read and review diagram and information, and write the equations for aerobic respiration (Task 1). ***Main:*** Students can work independently to extract the key points from the information in order to answer a range of questions (Task 2), followed by an exam-style question (Task 3). ***Plenary:*** Self- or peer-checking and marking. ***Extension:*** Applying anaerobic respiration knowledge to a case study of a long-distance athlete.	aerobic, energy, process
CIRCULATORY SYSTEM IN HUMANS	6	1.4 c, e–f, h–j	**The heart and circulation** Be able to: • Describe the human circulatory system • Explain how the structures of the heart and blood vessels are adapted to their functions	***Starter:*** If possible, show the video clip on the history of understanding heart structure. Otherwise, read information and take notes, and discuss Task 1 in pairs. ***Main:*** If possible, display this animation of the heart beating, then students work through all parts of Task 2, answering questions based on the background and their textbooks. ***Plenary:*** Self- or peer-checking and marking. ***Extension:*** Draw table/diagram to summarise, and additional question to extend knowledge	pulmona aorta, ar capillary atrium (ventricle

Ref.	Lesson ID	Syllabus Refs	Lesson Title and Learning Objectives	Lesson Outline and Suggestions	K
PLANTS AND PHOTOSYNTHESIS	7	1.5 a, d–e	**The process of photosynthesis** Be able to: • State the word and symbol equations for photosynthesis • Describe the process of photosynthesis	***Starter:*** Watch or listen to the rap if possible. Write an equation using the given diagram (recap). ***Main:*** Label the section of a leaf, using a textbook (Task 1). Determine the symbol equation for photosynthesis (Task 2). Application of respiration and photosynthesis interdependence (Task 3). Complete mind map of plant products (Task 4). ***Plenary:*** Complete word search with clues to consolidate knowledge. ***Extension:*** Challenge question.	endothe reactant carbon d chloroph chloropl
	8	1.5 b–c	**Controlling photosynthesis** Be able to: • Name some factors that limit photosynthesis • Explain their effect on the rate of photosynthesis • **HT** – Explain and interpret graphs of limiting factors	***Starter:*** Students discuss which factors affect photosynthesis, and how, as a recap. ***Main:*** Read brief background information and answer problem-solving question on the conditions required for an optimal rate of photosynthesis (Q6 is HT only). Practical analysis on the effect of light intensity on the rate of photosynthesis. ***Plenary:*** Students to swap and feed back on each other's analysis. ***Extension:*** Contained within Practical Analysis.	limiting concent optimun
	9	1.5 g–h	**Measuring mineral uptake in plants** Be able to: • Explain the difference between active and passive transport, with some examples • Understand that active transport requires energy	***Starter:*** Read background information. **Tracking active uptake of minerals** – practical analysis develops understanding of active transport as a process reliant on energy, for which respiration is needed. ***Extension:*** Modifying method to assess levels of oxygen needed to maximise mineral uptake.	mineral, sulfate i phospha concent active tr

Ref.	Lesson ID	Syllabus Refs	Lesson Title and Learning Objectives	Lesson Outline and Suggestions	K
ECOSYSTEMS, NUTRIENT CYCLES AND HUMAN IMPACT ON THE ENVIRONMENT	10	1.6 e–g	**Cycles in biology** Be able to: • Explain the role of microorganisms in the cycling of materials through an ecosystem • *Bio – explain the effect of abiotic factors on the rate of decomposition*	***Starter:*** A food web showing some simple ways in which nutrient recycling benefits organisms with questions (Task 1). ***Main:*** Recycling questions with a diagram (Task 2); analysing carbon cycle (Task 3) and predicting the impact of removing specific microorganisms (Task 4). ***Plenary:*** Discussion of Task 4 predictions; self-/peer-marking. ***Extension:*** Connect abiotic factors with cycles in biology.	decomp detritivo bacteria
	11	1.6 k	**Investigating Ecosystems** Be able to: • Explain what biotic and abiotic factors are • Describe the effect of these factors on a community by interpreting the given data	***Starter:*** Read the information page and glossary. ***Main:*** Match up key terms (Task 1) plus quick check on interdependence and biotic/abiotic factors (Tasks 2 and 3). Graphical analysis on the effect of pollution on a community of indicator species (Task 4). ***Plenary:*** Go over / discuss answers with a focus on data analysis. ***Extension***: Apply knowledge of limiting factors to an introduced species.	biotic, a commur ecosyste limiting
CLASSIFICATION AND BIODIVERSITY	12	2.1 d	**How Species Interact** Be able to: • State some factors that organisms compete for • Describe the impact of competition in a community	***Starter:*** Pictures of some plants to annotate with adaptations and what they are competing for (Task 1); this could be completed as a class. ***Main:*** Read information and complete food web analysis (Task 1). Answer questions on cyclic fluctuations (Task 2), followed by crossword clue writing (Task 3). ***Plenary:*** Peer-marking of work. ***Extension:*** Student chooses an ecosystem to show examples of types of competition.	competi commur adaptati interdep cyclic flu predato relation

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CLASSIFICATION AND BIODIVERSITY	13	2.1 e–g	**What is biodiversity?** Be able to: • Explain what 'biodiversity' is • Describe how biodiversity can be measured • Describe some benefits of maintaining biodiversity	***Starter:*** Ideally, show the video clip (3 mins); otherwise, read background information. ***Main 1:*** Read biodiversity handout and analyse human impacts and responses to biodiversity loss, using the information sheet (Task 1). Sampling exercise (Task 2) and comparing data collection methods. Work through worksheets. ***Plenary:*** Class discussion: the benefits of small numbers of many species (greater biodiversity) vs many individuals of a small range of species. Task 3: Write a speech to world leaders on protecting biodiversity. ***Extension:*** Reflection and opinion on a quote.	biodiver variatio quadrat
CELL DIVISION AND STEM CELLS	14	2.2 e–f	**Stem cells** Be able to: • understand what makes stem cells unique, and compare types of stem cell • provide arguments for and against the use of stem cells	***Starter:*** Students read a passage on stem cells and the difference between different types of stem cells and their uses in cloning. ***Main:*** Analyse diagrams of the differentiation potential of embryonic stem cells vs adult stem cells via questions. Arguments for/against therapeutic cloning via a speech written on their personal view. Students write a short speech explaining own views. ***Plenary:*** Self- or peer-marking for Task 1, questions 1–8. ***Extension:*** Swap speeches and discuss.	embryo, differen undiffer therape reprodu
DNA AND INHERITANCE	15	2.3 a–b, 2.4 c–d	**From DNA to proteins** Be able to: • Describe how DNA codes for different amino acids • Explain, simply, how the structure of DNA affects the protein made	***Starter:*** Read information, and T/F quiz to recap DNA structure (Task 1). ***Main:*** Activities for students to work through – completing a glossary of terms (Task 2) as well as considering the role of mutations in cystic fibrosis (Task 3). Task 4 is HT only – reading the DNA code. Finally, students must read section on Human Genome Project and produce a short newspaper article. ***Plenary:*** Self-/peer-marking. ***Extension:*** Consider practical applications of vertebrate genomic research.	protein amino a sugar ph nucleoti (see glos

Ref.	Lesson ID	Syllabus Refs	Lesson Title and Learning Objectives	Lesson Outline and Suggestions	K
VARIATION AND EVOLUTION	16	2.4 e–g	**The theory of evolution by natural selection** Be able to: • Describe some adaptations that allow organisms to survive and succeed in their natural environment • Explain how evolution by natural selection occurs over time	***Starter:*** If access to ICT and projector, start with the 'adaptations rap' for students to watch then discuss. Otherwise, read background and highlight relevant information. ***Main:*** Produce quick notes (Task 1); sequence the statements into two flow charts to explain how and why organisms change over time, in an 'evolutionary arms race' (Task 2). Then, apply knowledge of natural selection to how horses have changed over time (Task 3). ***Plenary:*** Peer-marking and discussion. ***Extension:*** Scenario-based written exercise – to use ideas of natural selection to propose ideas about scorpion/meerkat co-evolution.	natural s evolutio competi reprodu
VARIATION AND EVOLUTION	17	2.4 h	**Evolution – assessing the evidence** Be able to: • Describe evolution as a gradual change in inherited characteristics over time that may result in a new species • Describe the evidence for evolution with reference to antibiotic resistance	***Starter: Antibiotic resistance clip*** *www.youtube.com/watch?v=znnp-lvj2ek* ***Main:*** Consider the information in an antibiotic resistance leaflet and answer questions on how we can prevent antibiotic resistance through a storyboard (Task 1) – could revisit 'bacteria on a pizza' from Lesson 9. Consider the pentadactyl limb and evidence from embryology to draw conclusions about evolution (Tasks 2 and 3). ***Plenary:*** Self- or peer-marking. ***Extension:*** Convergent evolution – explaining and providing examples.	MRSA, n resistanc natural s evidence
RESPONSE AND REGULATION	18	2.5 b–d	**The nervous system** Be able to: • Describe the structure of the nervous system • Describe the stages of a reflex arc • Explain the role of the nervous system in a coordinated response	***Starter:*** Read through background then complete senses quiz (Task 1). ***Main:*** The reflex arc – diagrams and questions to complete using the given information (Task 2), then creative writing exercise (Task 3). ***Plenary:*** Self- or peer-checking and marking. ***Extension:*** 'A nervy problem' scenario-based written exercise (exam-style extended writing).	reflex ar receptor sensory relay ne motor n respons

Ref.	Lesson ID	Syllabus Refs	Lesson Title and Learning Objectives	Lesson Outline and Suggestions	K
RESPONSE AND REGULATION	19	2.5 e	**The eye, accommodation and focusing** Be able to: • Name the parts of the eye • Relate each part to its function • Explain how the eye focuses on near or distant objects	***Starter:*** (Recap and progression) – consider the role of the brain in vision (via the occipital lobe). ***Main:*** Information to read through and use to label a diagram of the eye (Task 1). Complete table to describe different structures, and explain how the structures accommodate and adapt to light (Task 2). Apply knowledge to actual eye problems (Task 3). ***Plenary:*** Complete word search to consolidate terms. ***Extension***: Apply knowledge to explain an eye disorder (myopia) and suggest treatments.	cornea, optic ne body, su ligamen accomm adaptati
	20	2.5 f–i, l	**Homeostasis and control** Be able to: • Explain what homeostasis is with reference to the internal and external environment • Describe some examples of homeostasis in the body • Explain how insulin controls blood sugar levels	***Starter:*** Scenario-based table for students to complete. Using the given information, they consider the impact of the external environment, and what we drink/eat, on the internal environment (Task 1). ***Main:*** Summary of control systems in the body (Task 2) then context-based questions on blood sugar control and negative feedback (Task 3). ***Plenary:*** Answers and feedback. ***Extension:*** Consolidation via graph analysis.	receptor effector, glucagor liver, gly
	21	2.5 j–k	**Temperature control by the skin** Be able to: • Describe the function of the skin in controlling body temperature • Explain how this is coordinated by the brain	***Starter:*** Scenario-based questions. ***Main:*** Read given information and use to complete sequencing activity (Task 1) then essay task (Task 2). ***Plenary:*** Consolidation via crossword on key terms with clues.	thermor hypotha sweatin vasocon vasodila hypothe

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MICRO-ORGANISMS AND THEIR APPLICATIONS	22	2.7 a–c	**Culturing microbes using aseptic techniques** Be able to: • Describe and explain how to culture bacteria using aseptic techniques	***Starter:*** If possible, watch video showing bacteria dividing. Otherwise, read information and begin tasks. ***Main:*** Complete doubling and graph activity (Task 1) to introduce the idea of exponential growth. Then complete Practical Analysis on the use of aseptic techniques, risk assessment and questions analysing the procedure. ***Plenary***: Discuss and compare answers in pairs. ***Extension:*** Alternative method planning.	aseptic, dish, aut flaming, incubati loop, co
DISEASE, DEFENCE AND TREATMENT	23	2.8 e–f	**Fighting pathogens – immunity and defence** Be able to: • Describe how the body defends against infection using the words 'non-specific' and 'specific' • Explain the role of the immune system in defence	***Starter:*** If possible, students watch the introduction video (8 mins) and summarise key points via annotation around a diagram of the human body (Task 2), including key terms. Alternatively, use the provided information. ***Main:*** Read through information on the components of blood and their functions, then complete Tasks 1 and 2 (and Task 3 if not already completed) before going on to the comprehension questions in Task 4. Finish with recap exercise (Task 5). ***Extension*:** Applied knowledge question on monoclonal antibodies.	white bl non-spe immunit antibod pathoge lymphoc
	24	2.8 g–i	**The how and why of vaccination!** Be able to: • Explain how vaccines work inside the body to prevent illness • Explain how vaccination programmes prevent the spread of disease	***Starter:*** If possible, watch the cartoon clip and make notes on what a vaccine contains. ***Main:*** Read through the extracts, and use textbooks and background information to work through the sentence rearrangement and comprehension questions on vaccination methods and programmes (Tasks 1 and 2). Mind map showing vaccination challenges (Task 3). ***Plenary:*** Self- or peer-checking and marking. ***Extension:*** Students explain vaccination in the context of a virus, then evaluate an aspect of public policy on vaccines.	vaccine, immunit antigen, herd imr memory lymphoc

Framework for Lessons in the Order of Teaching as Set ou

WJEC lessons by syllabus		
Lesson ID	WJEC Ref	Lesson Tit
1	1.1 a–c	What's in a
2	1.1 e, 1.3 a	Size, Scale and Su
3	1.1 f–h	Active and Passive
4	1.1 i, l	Working with E
5	1.2 a–b	Aerobic and Anaerobic R
6	[illegible]	The Heart and Ci
[illegible]	1.5 a, d–e	The Process of Pho
8	1.5 b–c	Controlling Photo
9	1.5 g–h	Measuring Mineral U
10	1.6 e–g	Cycles in Bio
11	1.6 k	Investigating Eco
12	2.1 d	How Species I
13	2.1 e–g	What is Biodiv
14	2.2 e–f	Stem Cel
15	2.3 a–b, 2.4 c–d	From DNA to P
16	2.4 e–g	The Theory of Evolution b
17	2.4 h	Evolution – Assessing
18	2.5 b–d	The Nervous S
19	2.5 e	The Eye, Focussing and
20	2.5 f–i, l	Homeostasis an
21	2.5 j–k	Temperature Contro
22	[illegible]	Culturing Microbes using A
[illegible]	2.8 e–f	Fighting Pathogens – Imm
[illegible]	2.8 g–i	The How and Why of

1: What's in a Cell

Learning Objectives

By the end of this lesson, you should be able to:

- ✓ name the main subcellular structures in eukaryotic cells (plant, animal, fungi) and pr
- ✓ explain how they are related to their functions

Background

All living things are made of cells. Cells are not all exactly the same, how are made up of) depends on their function (what their job is). In Key Stage learnt about plant and animal cells and their basic structure, what they ha different between them.

All living things fall into two groups – prokaryotes (bacteria) and eukaryot protists), the cells of organisms in each group have different charact some of the features of eukaryotic cells, including mitochondria (which po glucose), ribosomes (which make proteins), the cell membrane (controls w nucleus (the cell's control centre).

Prokaryotic cells do not have a nucleus, but they do have circular DNA in t molecule. Additionally, prokaryotic cells often contain smaller rings of DN swapped between cells.

Prokaryotic cells have a **cell wall**. Some eukaryotic cells, such as plant an but this is made from **cellulose** in plants and **chitin** in fungi, while prokary (also known as peptidoglycan). Many prokaryotes also have a protective o

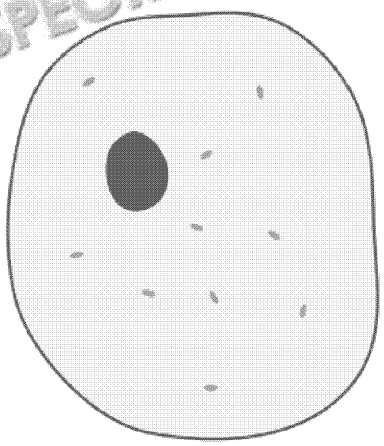
Some prokaryotic cells have a **flagellum**, which is used like a tail to move Prokaryotic cells don't have complex subcellular structures with membran mitochondria. However, both prokaryotic and eukaryotic cells have tiny st help the cells to build the proteins they need.

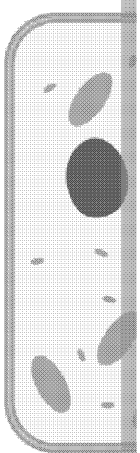
Task 1 – Inside the cell

Use your previous knowledge to label these cells using the terms from the used on one or both diagrams.

Keyword box:

Plant cell	Cell membrane	Animal cell	Cellulose cell
Mitochondrion	Cytoplasm	Permanent vacuole	





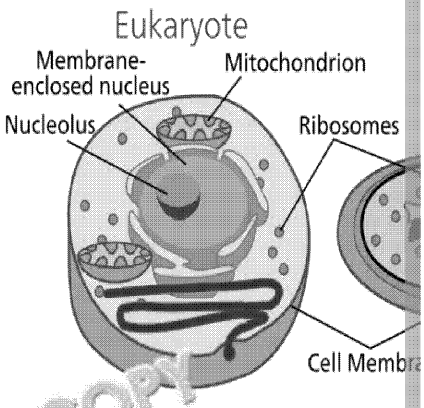
Task 2 – Form and Function

Cut out the shapes below. Join the shapes together in pairs to match each correct description.

Chloroplast	This fluid fills the cell, and is mad various molecules. Reactions happ
Cell wall	The control centre of animal and p
Cell membrane	Contains chlorophyll, a molecule v photosynthesis.
Cytoplasm	This thin layer controls which subs
Vacuole	The factory of the cell, where gluc respiration to produce energy.
Nucleus	This is a permanent storage organ sap.
Mitochondrion	The outermost structure of a plant pathogens and stops it from bursti

Task 3 – Comparing cells

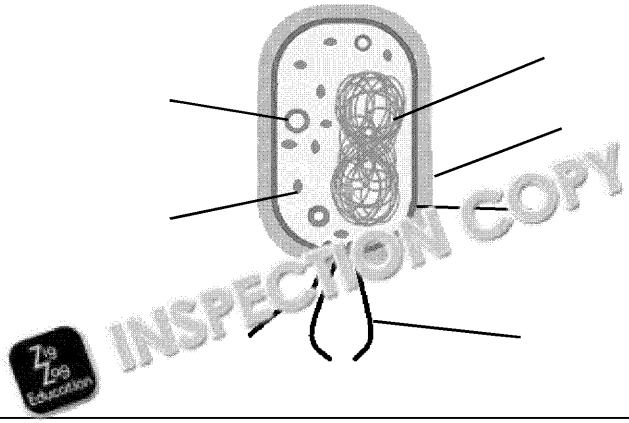
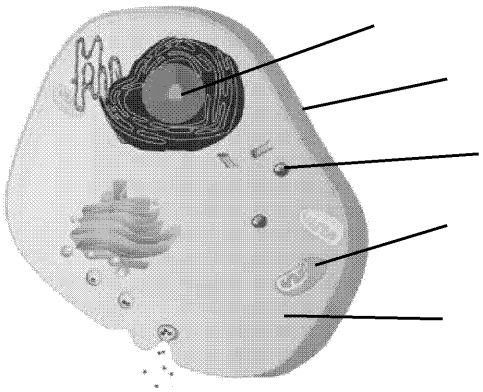
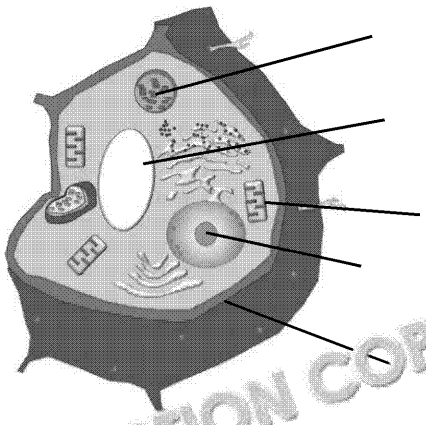
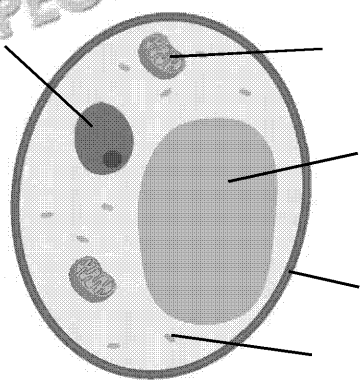
In the background information, you read about prokaryotic cells (bacteria) and eukaryotic cells (plants, animals, fungi and others). Using the information you read, and these diagrams, complete the table of similarities and differences.



Similarities	

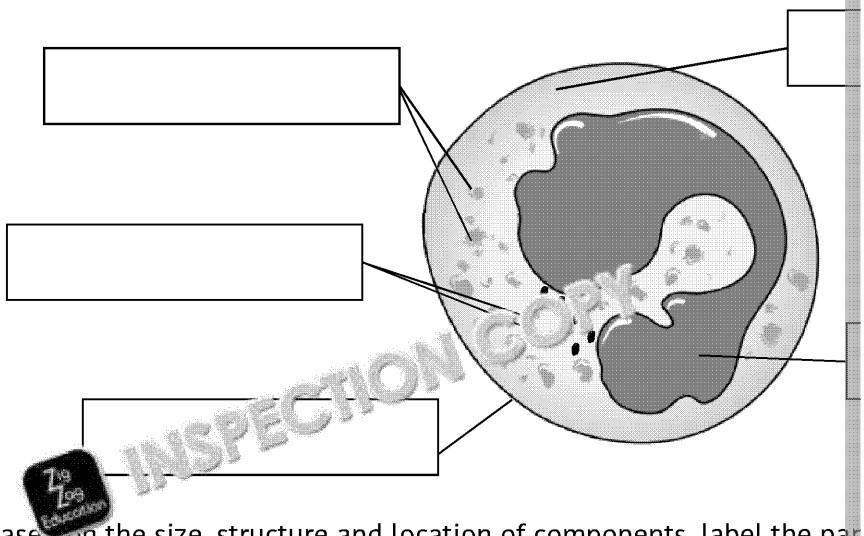
Task 4 – The variety of living cells

Label the following cell diagrams and complete the table by filling in the

Label the main subcellular structures and state their functions





Task 5 – Cell structure

The diagram below shows a white blood cell.



a) Based on the size, structure and location of components, label the par
spelling).

b) Suggest how the different parts of the cell help it to fight infection / c

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c) Describe how this cell differs from (i) a plant cell, and (ii) a fungal cell

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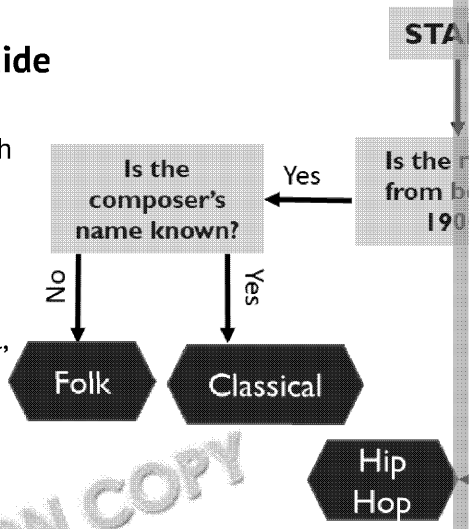
Extension: A cell-spotter's guide

The diagram to the right shows an example of a simple flow chart, which helps a record shop employee to classify music.



Draw a flow chart to help somebody classify a cell as either an animal cell, a plant cell, a fungal cell or a prokaryotic cell.

(Hint: your flow chart might have to be more precise than the one above!)

2: Size, Scale and Surfac

Learning Objectives

By the end of this lesson, you should be able to:

- ✓ Calculate and compare surface area to volume ratios
- ✓ Use surface area to volume ratios to explain the need for complex exchange surfaces
- ✓ Recognise and describe some exchange surfaces in the body

Starter questions

1. What is a unicellular organism?
2. What is a multicellular or[illegible]?
3. Can you name e[illegible] each?
4. How [illegible]y [illegible]oms of living things are there?
5. Whi[illegible]he kingdoms contain unicellular organisms, and which contain multicellular organisms?

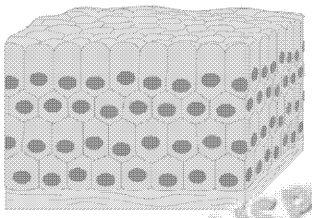
Figure 1:

Background

All organisms require water and nutrients to survive. Aerobes need oxyge can respire without it. Remember **MRS GREN** (movement, respiration, sens excretion and nutrition)?

Unicellular organisms have to live in a liquid medium which supplies them **Bacteria** and the amoeba in Figure 1 are examples of unicellular organism cell, which means their ability to move away from their immediate environ microscopic, and that is the secret to their success; the smaller an organis **volume ratio**. This means they can obtain what they need by the simple pr **membrane**. This amoeba absorbs food molecules through the cell membra stored in simple **vesicles** (storage 'bags') inside – it doesn't have, or need, diffuses through the cell membrane into the surrounding liquid.

Multicellular organisms such as plants and animals have a small surface ar harder to reach the centre of the organism through diffusion alone. They t



system consisting of specialised tubes to suppl and nutrients, and, just as importantly, to carry furthest from the or[illegible]n outer surface wou For vertebrat[illegible]s [illegible]uch [illegible] humans, these tubes ar plant[illegible] av[illegible]ferent tubes – xylem, which tra[illegible]ar[illegible]sports sugars and other substances.

Basicall[illegible] c[illegible]es down to the **diffusion distance** – how far the cells ar are diffu[illegible]n from. Imagine standing at the end of a buffet queue: will t it gets to your turn? Similarly, if oxygen has to diffuse through thousands layer, will there be any left for those cells?

Also, **multicellular** organisms need more energy than unicellular organism active – this is why multicellular organisms need a **circulatory system** or o supply all of their cells quickly and efficiently. They also need an **exchang** example) across which essential substances can be absorbed.

Task 1 – A question of scale

1. Based on the information you have read, write a paragraph to suggest amoeba doesn't.

2. Write a paragraph to suggest why plants with deep root networks, suc large, but mosses (which don't have root systems) are generally small.

3. Blood vessels are where important gases and other substances vital fo and waste products are removed.

   Suggest why some areas of the body have a very dense network of tin substances, and predict at least one area of the body which will have

TASK 2 – PRACTICAL ANAL
EFFECT OF SIZE ON UPTAKE BY

Read the practical description below and answer the analysis and conclusi

Background and recap

Diffusion is the 'spreading out' of a substance from an area of high concen
concentration. It happens both inside and outside of living organisms. In
diffusion by using cubes of **agar jelly**.

Agar is a good material to study diffusion in f t vo asons: firstly, it has la
to diffuse through it. Secondly, it is t ee through so you can observe t

This experiment us n a entoric acid, which will diffuse through the aga
substan he a jelly, which changes colour when it comes into cont
differen will be used.

Aim

To find out how the size of an agar cube affects how quickly acid will diffu

Apparatus

- Boiling tubes (×3) and rack
- Paper towel
- Forceps
- Stop clock / stopwatch
- Hydrochloric acid, 0.1 mol
- Tile
- Ruler
- Scalpel
- Agar jelly, with phenolphthalei

Method

- Using a tile as a surface, cut three cubes from the agar jelly with the s
length of 0.5 cm, Cube 2 should have a side length of 1 cm, and Cube
1.5 cm.
- Pour approximately 5 ml of HCl into three boiling tubes in a rack.
- Use the forceps to place one cube of agar into each boiling tube, and
- Record how long it takes for each agar cube to turn from pink to colou

Analysis

Complete the calculations in the table below, and u ur results and cal
area to volume ratio affects diffusion.

A Length of side of ag be (c	**B** = 6 × A T face rea of cube (cm^2)	**C** = A^3 Volume of cube (cm^3)	**D** = B/C Surface area to volume ratio	T
0.5				
1.0				
1.5				

Questions

1. Suggest two improvements to the method described on the previous p

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2. Calculate the increase in surface area, from the smallest cube to the la a percentage.

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3. How many times larger is the volume of the middle cube, compared to cube?

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4. Describe the relationship between side length and surface area to volu

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5. How does the surface area to volume ratio of the agar cubes affect the

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6. Give two other factors that could affect the rate of diffusion of a subst each factor affects diffusion rate.

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7. Use your answers to questions 4 and 5 to explain why large organisms specialised systems, such as the heart and blood vessels, to transport

(Hint: think about the surface area to volume ratio of a human. Are we la

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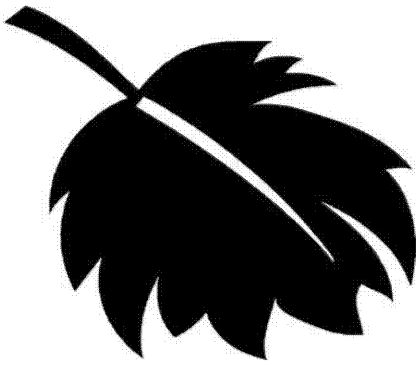
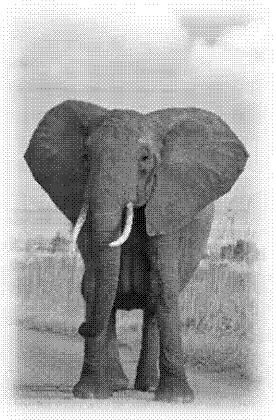
Extension

Describe how issues of surface area and volume affect the following things

- The shape of leaves.
- The size of an African elephant's ears.
- The size of root networks in plants.





3: Active and Passive Tr

Learning Objectives

By the end of this lesson, you should be able to:

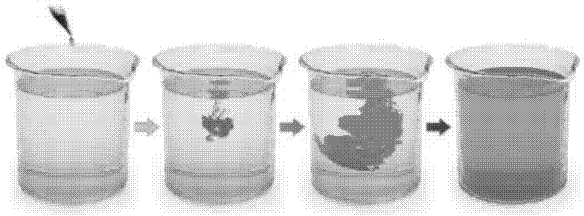
- ✓ compare and contrast three processes for moving substances in and out of cells: dif
  active transport
- ✓ define each process, with reference to energy and concentration gradients

Background

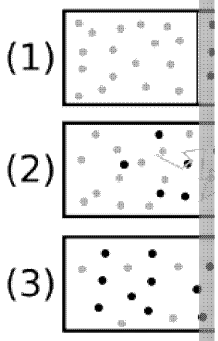
In order for life processes to occur efficientl , m l cules need to move fro
useful molecules are needed insid , and waste products need to b

Movement across th membrane can be **passive** or **active**. **Passive tra**
molecul m a area of high concentrat
example ssive transport.

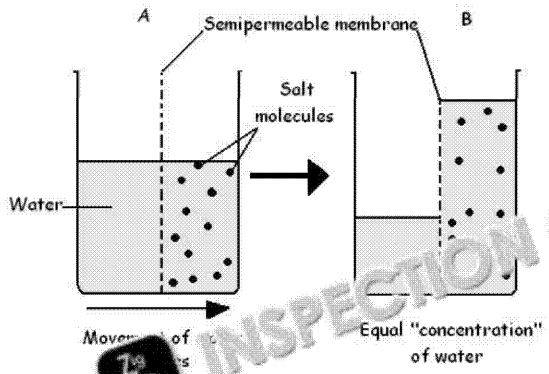
Diffusion occurs in gases and liquids, and involves the random movement
concentration until equilibrium is achieved. This may be seen in the diagr
through water, or the movement of molecules (such as perfume from one
barrier) is opened) until equilibrium is achieved. Some barriers are **perme**
means that they have holes in them that allow certain substances through
no NET movement, as the concentration of molecules is approximately equ



We can use coloured substances like food dyes to observe diffusion in water.



This diagram shows h between fluids is rem become evenly di



Osm ppens when a semipermeable membrane separates two solutions.

Osmosis is the movement of
high **wat** concentration to a
th ou a partially **permeable**
achieved – as shown in the d
may be called 'solute molecu
it forms a 'solution' (recap fro

Osmosis takes place in lots o
using salt to dry meat, or the
hair cell.

Active transport moves substances across the cell membrane from an area
of **high** concentration. This process requires **energy** in the form of ATP, as
move substances **against** the concentration gradient. If you imagine swim
help you to understand why energy is required to do this. Active transport
waste from inside a cell, or to collect useful substances inside it, such as g
minerals loaded into a root from the soil.

Task 1 – Summarise the three types of cel

Using the information you have read, decide what type of transport is bein
below. Choose from **DIFFUSION**, **OSMOSIS** or **ACTIVE TRANSPORT**, then state wh

Scenario or Example	Type of Transp
1. Movement of molecules from an area of low concentration to an area of high concentration	
2. Involves the movement of water through a partially permeable membrane	
3. Molecules moving f[illegible] high to low conc[illegible] may not involve a membrane	
4. Requires energy (ATP) to move molecules	
5. How water enters the roots of a plant	
6. Movement of gases into and out of a leaf	
7. Solutes moving from the small intestine into the blood	
8. Sugar molecules moving from the stem into a developing fruit	

TASK 2 – PRACTICAL ANAL
INVESTIGATING THE EFFECT OF TEMPERAT

Read the practical description below and answer the analysis and conclusi

Background and recap

Diffusion is affected by several different factors. For example, a substance a greater distance. Diffusion across a surface will happen more quickly wh Temperature also has an effect on the rate of diffusion.

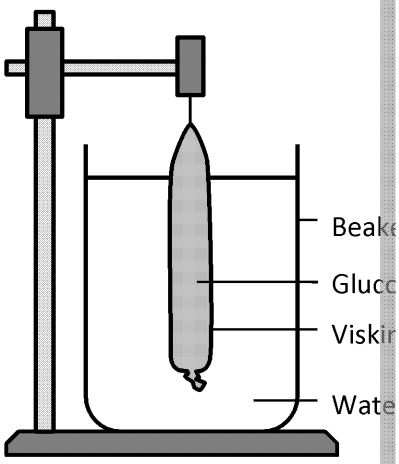
This experiment uses glucose solution, water an **ict's solution** to m affected by temperature. Glucose is a re ar, which means that w Benedict's solution will change is useful property means that we into water.

Aim

To under and the relationship between temperature and diffusion rate.

Apparatus

- Water bath
- Test tubes (× 11)
- Benedict's solution
- Pipette
- Clamp stand
- Beaker
- Length of Visking tubing
- Glucose solution (5 %)
- Distilled water
- Stopwatch



Method

Set-up:

- Set up a hot water bath ready to carry out the Benedict's tests.
- Label 11 test tubes 0 minutes to 10 minutes at one-minute intervals (
- The clamp stand, beaker of distilled water (at room temperature – 20 set up as shown above. The Visking tubing should contain 5 % glucos

Procedure:

- Use a pipette to remove 5 ml of water f th beaker, and add it to a Benedict's solution.
- Start the stopwatch (th *min*)
- Place the test the hot water bath and leave for 10 minutes.
- Aft m , repeat this process, taking 5 ml more water from the test with 1 ml of Benedict's solution. Then, place this test tube in
- Keep repeating this process at one-minute intervals until all your test water bath.

Observations:

- After each of the test tubes has been in the hot water for 10 minutes,

Changing the temperature:

- Set up exactly the same experiment, using the same steps. However, that has been heated to 60 °C, instead of water at room temperature.

Prediction

How will the time interval affect the colour of Benedict's solution? Explai

.....

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Benedict's colour reference chart (to indicate sugar concentration):

Blue B	Mint M	Green G	Yellow Y	Oran O

Sample results

Table 1: At room temperature (assumed to be 20							
Time (mins)	0	1	2	3	4	5	6
Colour	**B**	**B**	**M**	**M**	**M**	**G**	**G**

Table 2: At 60 °C							
Time (mins)	0	1	2	3	4	5	6
Colour	**B**	**M**	**G**	**G**	**Y**	**O**	**O**

Analysis

1. In this experiment where was the net movement of sugar molecules fr

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2. Explain your answer to 1, using what you know about diffusion.

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3. State the dependent and independent variables in this investigation.

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4. What changes could be made to make the results of this experiment m

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5. What do the results show? Use data to support your answer.

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6. The experiment is repeated at 40 °C. Suggest what the results will lo

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7. Sug ow you could modify this experiment to study the effect of s

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TASK 3 – PRACTICAL ANAL
OBSERVING OSMOSIS IN POTAT

Read the practical description below and answer the analysis and conclusi

Background and recap

Osmosis is the movement of water across a semipermeable membrane, fro
concentration is higher (there are fewer **solute molecules**), to an area wher
solute molecules). Solutes are substances which are dissolved in water.

In plant cells, the membrane is the cell membra[illegible]d the solutes include
glucose and other nutrients. We can use so[illegible]or salt to study osmosis
chunk of potato.

Aim

To study [illegible]olute concentration affects osmosis.

Apparatus

- 1 large potato
- Ruler
- 3 boiling tubes and rack
- Distilled water
- Salt solution (two concentrations: strong and weak)
- Potato peeler
- Tile
- Kitchen knife / scalpel
- Paper towels
- Electronic weighing scales

Method

1. A potato peeler is used to peel the potato.
2. A scalpel / kitchen knife is used to cut three roughly equal-shaped chu
   (approximately 1 cm × 1 cm × 3 cm).
3. The potato chunks are placed on a tile and trimmed until they have si
4. Each potato chunk is weighed and its mass is recorded.
5. Each boiling tube is filled up to an appropriate depth with either conc
   solution or distilled (pure) water. The boiling tubes are labelled A, B a
6. The three potato chunks are placed into test tubes A, B and C – the m
   tube is recorded.
7. The tubes are left for 30 minutes to allow osmosis to happen.
8. Each potato chunk is removed from its boiling [illegible]. A paper towel is
   chunks to absorb any surface water.
9. Weigh each cube, and record the results in a table.

Analysing and [illegible]ning your results

Tube	Potato in	Starting mass (g)	Ending mass (g)	Diff[illegible]
A	Concentrated salt solution	3.2	2.5	
B	Dilute salt solution	3.4	3.3	
C	Distilled water	3.1	3.7	

Results

1. Explain why it is important that the potato chunks have roughly the sa

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2. a) Using the sample results, complete the table by:
   i) calculating the change in mass shown by each potato chunk
   ii) calculating each difference as a perce[illegible]e change in the ma

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   b) Suggest the purpose of giving each answer as a percentage, rather t

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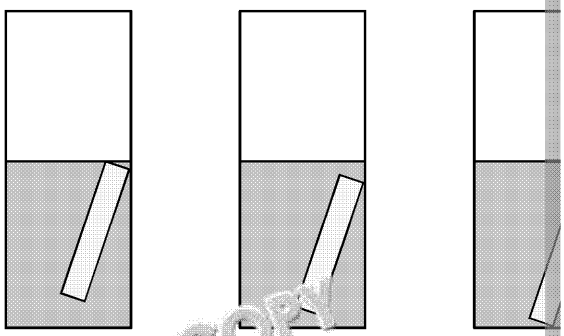
3. For each boiling tube sketched below, draw arrows to show the net m



A – Conc[illegible]d salt[illegible]on

B – Dilute salt solution

C – Plain

4. Exp[illegible]hy the mass and firmness of two of the potato chunks chang

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5. In the sample results, one of the potatoes did not change mass signifi
us about the potato chunk and the solution.

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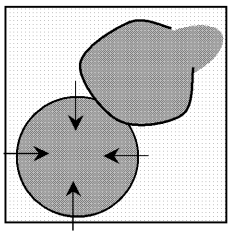
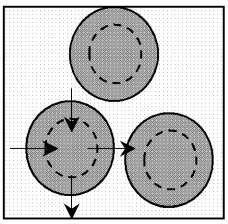
Extension

Keywords:

Hypertonic – a solution that is more concentrated than the cel
Isotonic – a solution that has the same concentration as the ce
Hypotonic – a solution that is less concentrated than the cell c

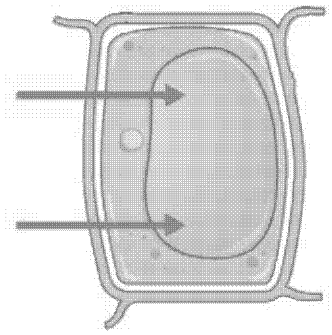
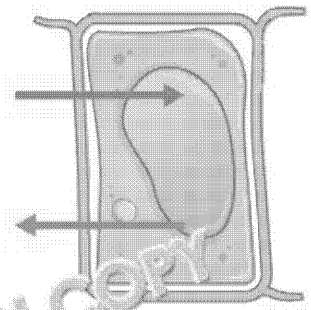
The effect of solute concentration on red blood cells

Hypotonic	Isotonic	
		

For each of the situations above, complete the table to explain what is hap

Type of solution	What is happening	
Hypertonic		
Isotonic		
Hypoto		

The effect of different solutions on plant cells

Hypotonic	Isotonic	
		

For each of the situations above, complete the table to explain what is happening.

Type of solution	What is happening	
Hypertonic		
Isotonic		
Hypotonic		

From your answers, suggest why cell walls are useful for algae, which live

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4: Working with Enzy

Learning Objectives

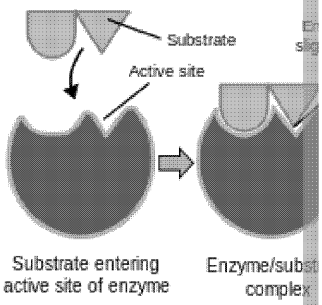
By the end of this lesson, you should be able to:

- ✓ use the 'lock and key theory' as a simple model to explain enzyme action
- ✓ describe experiments that can be used to investigate enzymatic reactions

Background

Enzymes are proteins which speed up reactions in the body. All living thin
most biological reactions don't happen fast enough without enzymes; in fa
happen at all.

Enzymes may be 'makers' or 'breakers' – some build larger molecules out o
break down large molecules. Each type of enzyme works best in certain co
conditions. If conditions are above or below the optimum, the enzyme may stop working efficiently, or it may stop working completely.



Enzymes can be isolated and studied under different conditions; in the laboratory, it's easy to manipulate temperature, pH and substrate/enzyme concentration to see which conditions are best for enzyme function.

A quick reca

Task 1 – Explaining enzymes

Based on the background information and your own knowledge, fill in the
Use the words from the keyword box; you may need to use some words mo

Enzymes are proteins. They are biological _____. This mea
chemical reactions without being _____ up in the reaction.
_____ reaction as the _____ has a _____ sh
substrate.

Groups of enzymes have specific function, digestive enzymes are respo
_____ molecules into _____ ones, while in cells
_____ molecules by joining together smaller ones.

Enzymes can be _____ by extremes of _____ an
enzyme is said to be _____. This means it cannot bind with

Keyword box:

damaged	large	temperature	ca
pH	specific	small	su
used	active site	denatured	sp

TASK 2 – PRACTICAL ANALYSIS: BREAKD HYDROGEN PEROXIDE (H_2O_2) BY THE ENZ

Read the practical description below and answer the analysis and conclusi

Background and recap

In this experiment, the enzyme **catalase** is used to break down its substrat Liver, celery and potato purée will all contain different amounts of catalas used as a source of the substrate.

Aim

Determine the optimum conditions for catalase to break down the substrat

Method

- Cut ver into small, equally sized cubes, about 2 cm long.
- Lab test tubes with the numbers 1–6, so they can be clearly iden
- Put approximately 2 cm^3 of hydrogen peroxide into each of the test tu
- Keep test tube 1 at room temperature (20 °C), and add a cube of liver.
- Gently shake the test tube, to mix the enzyme with its substrate.
- Leave the test tube for one minute, and then record the height of the

Changing the temperature

- Set three water baths to temperatures of 35 °C, 50 °C and 65 °C. Plac 4) into the water baths, one at each temperature.
- Once the test tubes have reached the correct temperature, add a piece measurements as in test 1.

Changing the pH

- For test tube 5, add 1 cm^3 of acid. Shake the test tube, add the liver, a again. Leave the test tube for one minute, and then record the height
- For test tube 6, add 1 cm^3 of alkali. Shake the test tube, add the liver, Leave the test tube for one minute, and then record the height of the

Sample results are shown below:

Tube no.	Independent variable	Temp °C	pH	heigh
1	Temperature	20	7	
2	Temperature	35	7	
3	Temperature	50	7	
4	Temperature	65	7	
5	pH	20	4	
6	pH	20	10	

Analysis

1. Hydrogen peroxide (H_2O_2) can be harmful to the human body. The enz
hydrogen peroxide into water and oxygen. Suggest why it does this.

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2. At least two pieces of equipment which you would need for this practi
method. Suggest additional equipment which you would need.

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3. In this experiment, identify:

i) a variable which is controlled .....

ii) a variable which is not controlled .....

Explain your answers for i) and ii).

i) .....

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ii) .....

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4. You are writing a risk assessment for this experiment. Suggest two sa
assessment should include.

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5. This method has some flaws which make its results less valid. Sugges could be improved to make the results more valid and accurate.

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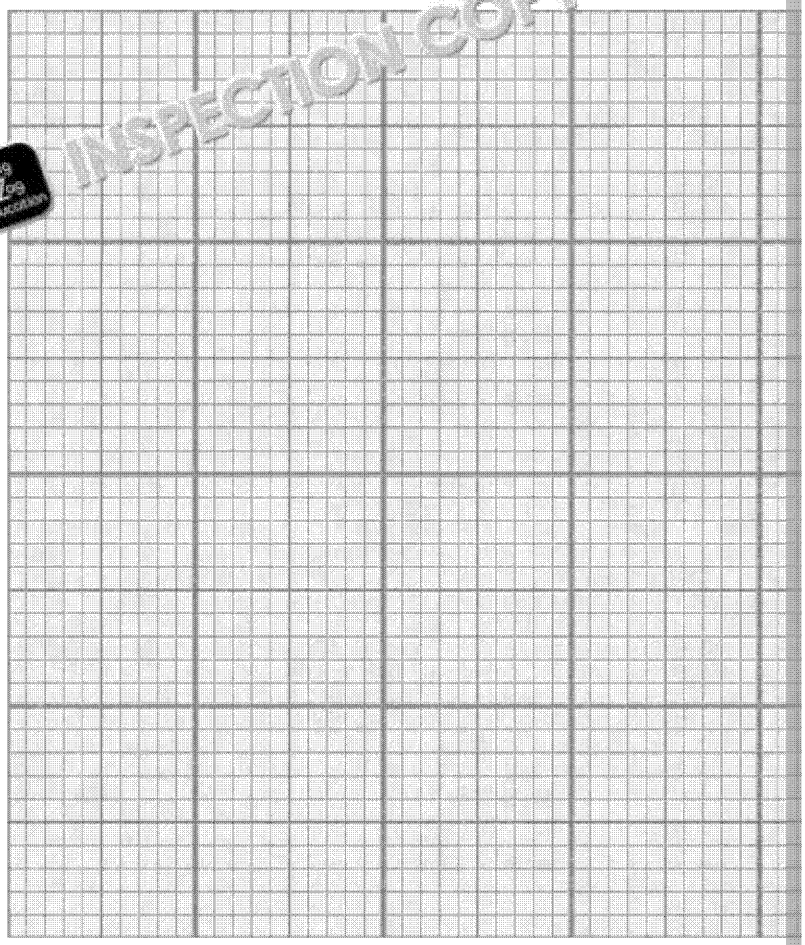
6. Draw a graph to show the results of experiments 1–4.



Conclusions

7. Describe the patterns shown by the results of experiments 1–6.

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8. Which conditions were closest to the optimum conditions for catalase

.....

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9. Why is no foam produced in test tube 4?

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10. The experiment [illegible] a rough idea of the optimum conditions for
met[illegible]ou[illegible]changed so that the optimum conditions can be mea

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Extension

All enzymes have certain optimum conditions, and many enzymes only fun
conditions. With this in mind, suggest why:

- the body carefully controls the composition of the blood
- some bacteria are able to live in thermal vents at 80 °C, while most or

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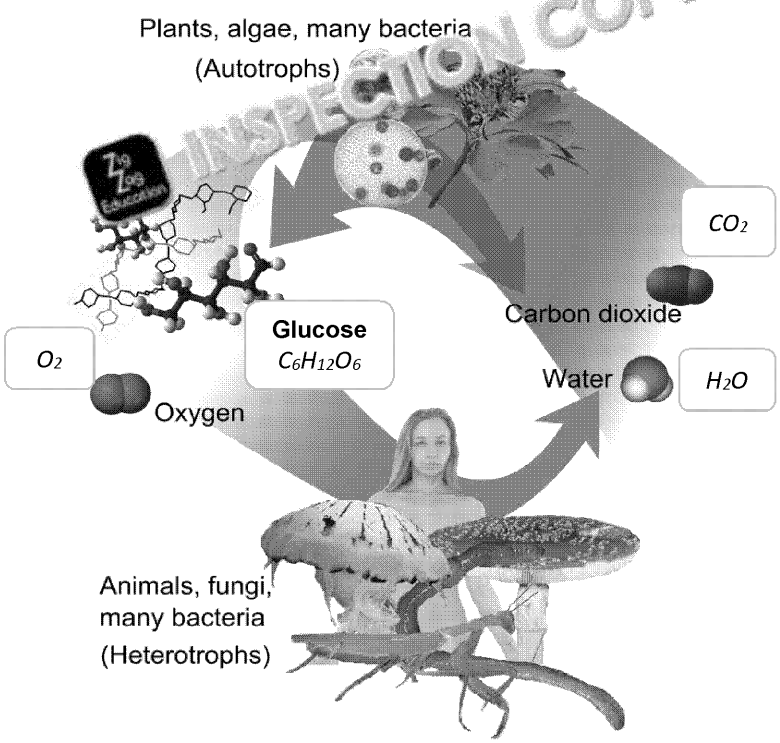
5: Aerobic and Anaerobic Respi

Learning Objectives

By the end of this lesson, you should be able to:

- ✓ state the word equation and the symbol equation for **aerobic respiration**
- ✓ state the word equation for **anaerobic respiration**
- ✓ **compare** the processes of aerobic and anaerobic respiration

Background



A
respir

The dia
transfer
glucose
respirati

In the d
left sho
bacteria
glucose
carbon
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process
left-to-
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aerobic respiration – glucose and oxygen (the **reactants**) – and make tw
dioxide (plus energy). The energy is produced in the form of a molecul

KEY LEARNING POINT 2

Anaerobic respiration is not as efficient as aerobic respi

Anaerobic respiration

Anaerobic respiratio **incomplete breakdown of glucose, without oxy**
plants a also by animals for energy 'backup' when oxygen leve
Anaerob iration releases **only two molecules of ATP** energy per mole
respiration produces 38 molecules of ATP), so it cannot sustain large, activ

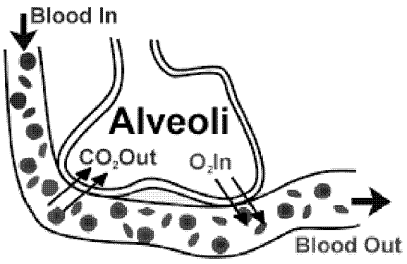
There are two types of anaerobic respiration that you need to know about:

a) Anaerobic respiration in the muscle cells of animals, where glucose is
*(NOTE: this can cause muscle cramps; however, if oxygen levels rise, it is
dioxide and water.)*

b) Anaerobic respiration in the cells of some fungi (such as yeast) in whi
ethanol (alcohol) and carbon dioxide.

KEY LEARNING POINT 3

Breathing is NOT the same as respiration!



Respiration takes place **inside th**
Lesson 1), and should not be con
which takes place in the lungs, a
takes place in the **alveoli**. It's tr
gaseous exchange you would di
respiration to take place!

Breathing allows the all-important molecule o[illegible]ygen to get into the bloodstream and get carried to cells (where the energy release is happening), while allowing the toxic waste – carbon dioxide – to be removed from the [illegible] and breathed out.

Glucose and oxygen **diffuse** into cells, and react together inside the **mitochondria**, releasing **energy (as ATP)** into the cell, together with the waste products water and carbon dioxide. This is why mitochondria are sometimes called the 'powerhouse' of the cell.

Task 1 – Respiration equations

The text above describes the process of aerobic respiration in living organi

1. Write a word equation to describe the process of aerobic respiration.

   ..... + ... ➞ ..... + ...

2. In the space below, write a balanced symbol equation for aerobic resp formulae shown on the diagram, and the following information:

   One molecule of glucose reacts with six molecules of oxygen to produ dioxide, six molecules of water, and energy (which is temporarily store ATP).

   ..... + ... ➞ ..... + ...

3. Write word equations to show the reactants and products of anaerobic

   a) muscle cells: ..... ➞ ..... + ...

   b) yeast cells: ..... ➞ ..... + ...

Task 2 – Quick-fire questions

1. Which type of respiration requires oxygen? .....

2. Which type of respiration is more efficient? .....

3. How many molecules of ATP are produced by:

   a) aerobic respiration? .....

   b) anaerobic respiration? .....

4. Name a commercially useful product of anaerobic respiration in plants

   .....

5. How humans use this substance?

   .....

6. Bread is made using live yeast, which is added to flour with sugar and kneaded, to make a dough. Using the word equations in Task 1, q3, a

   a) Which product makes the bread rise? .....

   b) Why is sugar added?

   .....

   .....

   c) Why is warm water better than cold water?

   .....

   .....

   d) Is the yeast respiring aerobically or anaerobically? .....

   e) Explain your reasoning for (d) above:

   .....

   .....

   .....

7. **Wh**ght oxygen levels be particularly low in muscle cells?

   .....

   .....

   .....

8. Suggest **why** oxygen levels might fall in muscle cells, making us need

.....

.....

9. Some microorganisms live in the deep mud at the bottom of lakes; do aerobically or anaerobically? Explain your answer.

.....

.....

.....

10. What assumptions can you make about the energy needs of organisms

a) [illegible] .....

.....

b) anaerobically? .....

.....

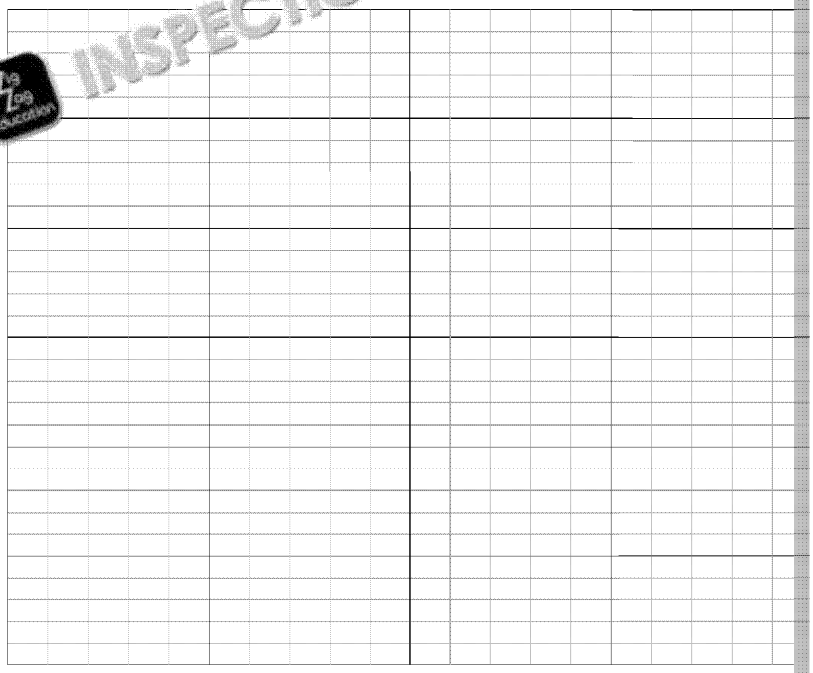
Task 3 – Exam-style question: breathing a

1. A student, Tovah, is given a device to measure her breathing rate. Aft measurement, she is asked to walk on a treadmill while her breathing to start running, and then slow down to a walk again. Finally, Tovah i

   However, the students accidentally do not record the times at which t slow down and stop exercising. The data collected by the breathing n

Time (minutes)	0	1	2	3	4	5	6
Breathing rate (breaths/min)	12	14	13	23	34	40	30

a) Draw a graph of these resu



b) Using the graph, determine when Tovah:
   i) started running. Explain your answer.

   .....

   .....

   ii) stopped walking. Explain your answer.

   .....

   .....

c) Why does exercise have an effect on Tovah's breathing rate?

   .....

   .....

   .....

d) Tovah only ran for a few minutes in the class's experiment. In an
run for 40 minutes.

i) Suggest what impact this would have on the student's oxyge

.....

.....

ii) How could anaerobic respiration help the student exercise fo

.....

.....

.....

.....

iii) What effects would the student feel if they continued to resp

.....

.....

iv) Explain why the student would feel this way, and how they w

.....

.....

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Extension

When athletes exercise intensively for long periods of time, lactic acid bui
lactic acid diffuses into the blood. Glucose supplies are also depleted. Wi
the physical challenges faced by a cyclist undertaking a long-distance race

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6: The Heart and Circu

Learning Objectives

By the end of this lesson, you should be able to:

- ✓ describe the human circulatory system
- ✓ explain how the structures of the heart and blood vessels are adapted to their functi

Background

Blood circulation in vertebrates is described as d[illegible] and **closed** (in blood vessels).

The heart is a vital organ in most multicellular organisms, pumping blood (and the substances dissolved in it) around the whole body. Most vertebrates (reptiles, amphibians, birds and mammals) have a '**double circulatory system**' which means that blood enters the heart twice for each full circuit of the body. The **pulmonary artery** and **pulmonary vein** take blood to and from the lungs to be oxygenated. Once the blood gets back to the heart the **aorta** pumps it to the rest of the body, and the **vena cava** brings it back.

Vena cava

Right atrium

Valves

Figures 1 and 2 show the heart both by itself, and in the broader double circulatory system, together with the names of the arteries and veins leading into and out of the heart. Using this diagram, you should be able to work out which vessels carry blood into the heart, which vessels carry blood away, and which vessels have higher and lower pressure.

Fig

Blood is enclosed in vessels, and, in this way, blood is directed to specific parts of the body. There are three main types of blood vessel – **arteries**, **veins** and **capillaries**.

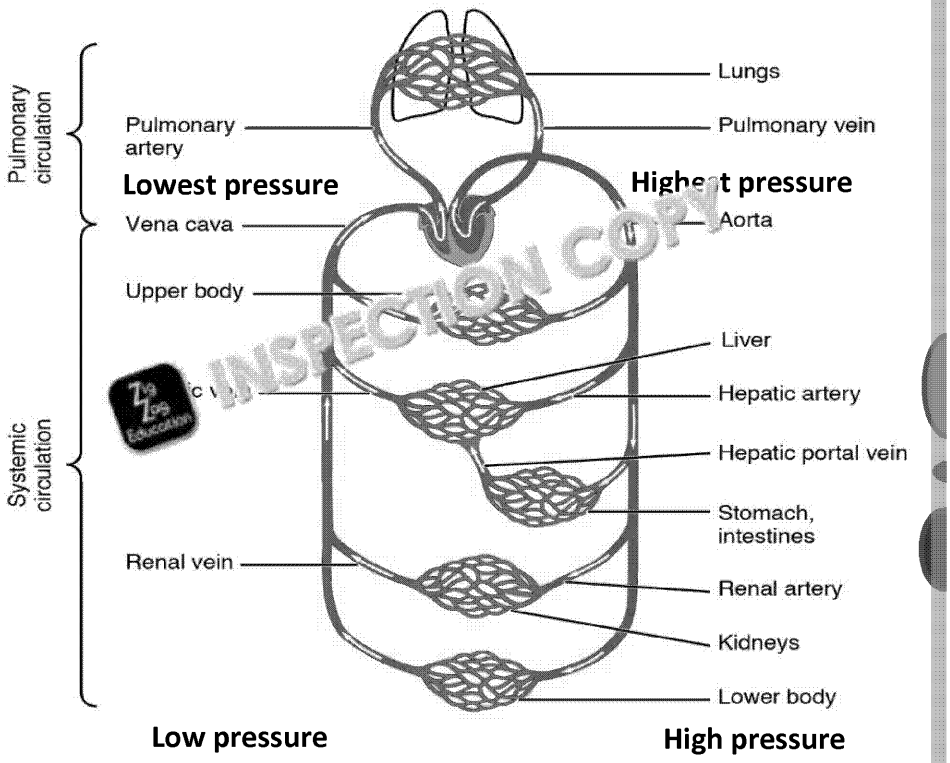


Figure 2: The double circulatory system

Task 1 – The shape of blood vessels

Based on what you have read and your existing knowledge, suggest answe

1. Why is there more elastic tissue in the artery than the vein?

   .....

   .....

2. Why are the capillary walls so thin?

   .....

   .....

3. Why is blood moved through the heart twice during each cycle of the

   .....

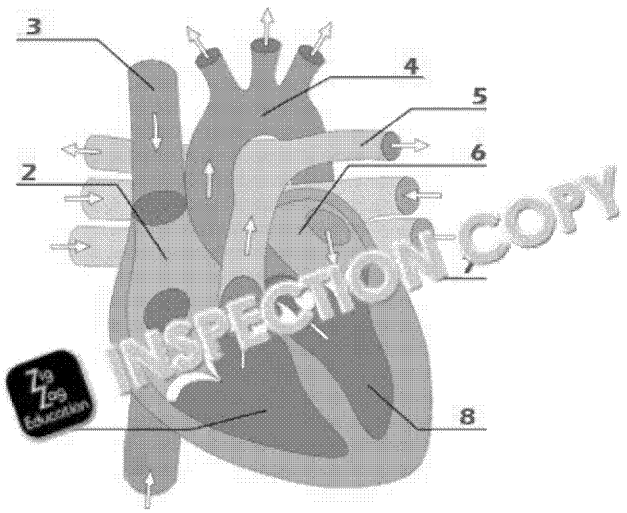
   .....

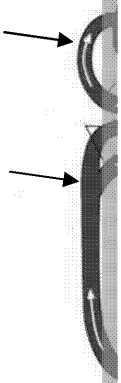
Task 2 – The heart and circulation – diagr

1. Label the diagrams below to show your understanding of the passage
   body, using the words in the box. You will need to use some words m

Keyword box:			
Left atrium	Right atrium	Left ventricle	Right ventricle
Pulmonary vein	Vena cava	Aorta	

Once you have filled in as much as you can, check the previous page.



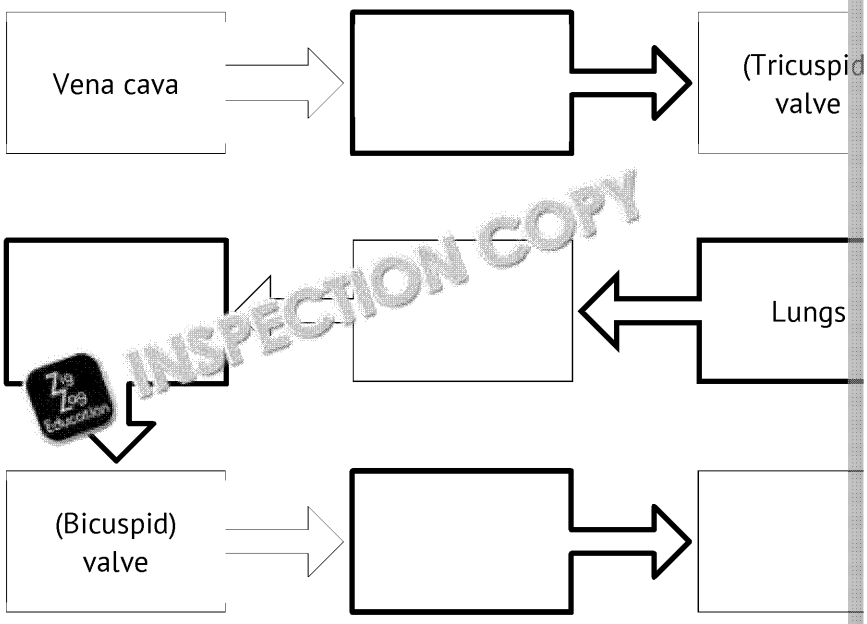


2. Using your answers from question 1), fill in the answer boxes with eit
the letter T (true) or F (false) which matches the statement.

	Statement	Answer		State
a	The heart chamber with the thickest walls.		**g**	The heart ch thinnest wal
b	The heart chamber which pumps oxygen-poor blood into the pulmonar		**h**	The heart is as a 'double True (T) or f
c	large vein which returns deoxygenated blood from the body to the heart.		**i**	The pulmon
d	The vessel with thick, elastic walls which takes blood to the body.		**j**	Blood in the higher in O_2 the left vent True (T) or f
e	The vessel which returns oxygenated blood from the lungs to the heart.		**k**	The right ve
f	The ventricle which pumps oxygenated blood from the heart to the rest of the body.		**l**	The left atri

Task 3 – Heart anatomy checkpoint

1. Complete the following flow chart tracing the passage of blood throu
for chambers of the heart, while the boxes with narrower borders are
involved. If you have access to coloured pens or pencils, you could ad
boxes showing oxygenated or deoxygenated blood.



2. a) Which chamber receives deoxygenated blood? .....

   b) Where has this blood travelled from? .....

3. a) Which chamber receives oxygenated blood? .....

   b) Where has this blood travelled from? .....

4. Which vessels carry blood into the heart? .....

5. Which vessels carry blood away from the heart? .....

6. Which chambers contract to force blood out of the heart? .....

7. Which chamber forces blood into the pulmonary artery? .....

8. Which ventricular walls are thicker – th ht or the left? Why? .....

   .....

   .....

9. Whic hamber forces blood into the aorta? .....

10. a) Which vessels carry blood under the greatest pressure? .....

    b) How are these vessels adapted to **withstand** high pressure withou

       .....

       .....

11. Why is it important that the heart forces blood out under pressure?

.....

.....

.....

12. Explain how blood pressure within vessels:

    a) is affected by the structure of arteries and veins.

.....

.....

.....

.....

    b) affects the structure of the aorta and pulmonary artery.

.....

.....

.....

.....

Extension

A) The pulmonary vein has a different structure from most other veins. S
is likely to be different from other veins, and why. *(Hint: where is the p*

B) In the space below, draw a summary table or diagram that will help yo
function of arteries, veins and capillaries (relating the structure to pres

7: The Process of Photos

Learning Objectives

By the end of this lesson, you should be able to:

- ✓ state the word and symbol equations for photosynthesis
- ✓ describe the process of photosynthesis

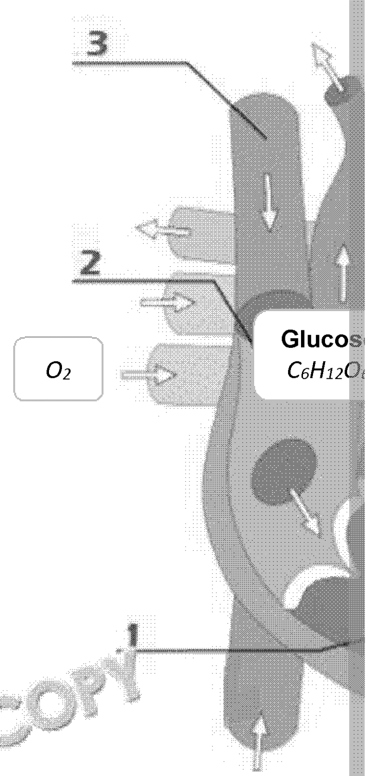
https://www.youtube.com/watch?v=x-tOsGyjfto – a rap!

Background

Plants are essential to all life; they are called 'producers' as they produce t food chain. Plants provide food for herbivores (animals that eat plants) an are eaten by carnivores. When plants die, they are broken down by decom

We eat plants; we eat herbivores; we use plants for furniture, building mat fuels, rubber and many other materials that we cannot live without. For th the conditions required for plants to thrive and, subsequently, support life

Plants absorb light energy from the sun, through chloroplasts in their cells. Chloroplasts contain chlorophyll, a pigment which gives plants their green colour, and they are concentrated in the leaves and stems of plants. When light falls on the leaves, a chemical reaction takes place that converts the carbon dioxide and water into glucose (a carbohydrate) and oxygen, which is released as a waste product. Plants are known as 'autotrophs' which means they can make their own food.



The diagram to the right shows how photosynthesis and respiration use each other's products. Glucose produced by photosynthesis can be respired to produce carbon dioxide, water and energy. Plants and photosynthetic bacteria can do this, and so can the organisms which consume them.

Star

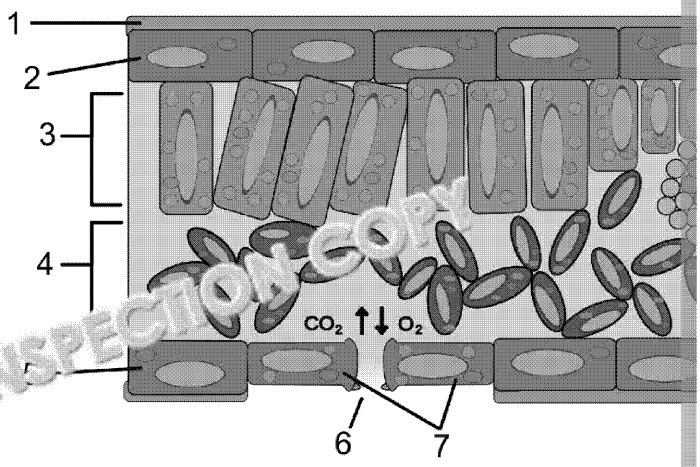
You should have learnt the word equation for photosynthesis in Key Stage remember! Using the diagram above, write the reactants and products as

.... + ... ⟶ ....

(We often indicate that light and chlorophyll are required for the process b near the arrow.)

Task 1 – Tissues of a leaf

1. Use a textbook to label the layers and structures in the leaf with the f
spongy mesophyll, xylem, waxy cuticle, guard cell, palisade mesophyll, u
bundle, lower epidermis, stoma *(plural stomata)*.



2. Explain the functions of the guard cells, stomata, xylem and phloem.

Structure	Function
Guard cells	
Stomata	
Xylem	
Phloem	

Task 2 – An equation for photosynthesis

1. In the space below, write a balanced symbol equation for photosynthe
in the background information, and the foll wi g i formation:
Six molecules of carbon dioxide re t it. i molecules of water to prod
molecules of oxygen, usin . r gy.

..... + ... ⟶ .....
Light energy

2. How is this process similar to, and different from, respiration?

Similarities: .....

.....

Differences: .....

.....

3. Find out what the term 'endothermic' means, and explain why photosy

.....

.....

.....

.....

Task 3 – Bottled life

These bottles are never opened, yet the plants survive – how?

hese are called 'bottle some small plants, soil sealed, the bottles are place, the plants will su

The fragments below c description of how bott knowledge of the equa photosynthesis to help together. Then, write t following page.

up to the leaves. Carbon dioxide diffuses into the leaves,	light energy is available.	
can react in the mitochondria via aerobic respiration, producing	Water is absorbed into the roots, and travels	
and oxygen are produced in this reaction. These molecules	through the leaves back into the bottle. Excess glucose can be stored	

.....

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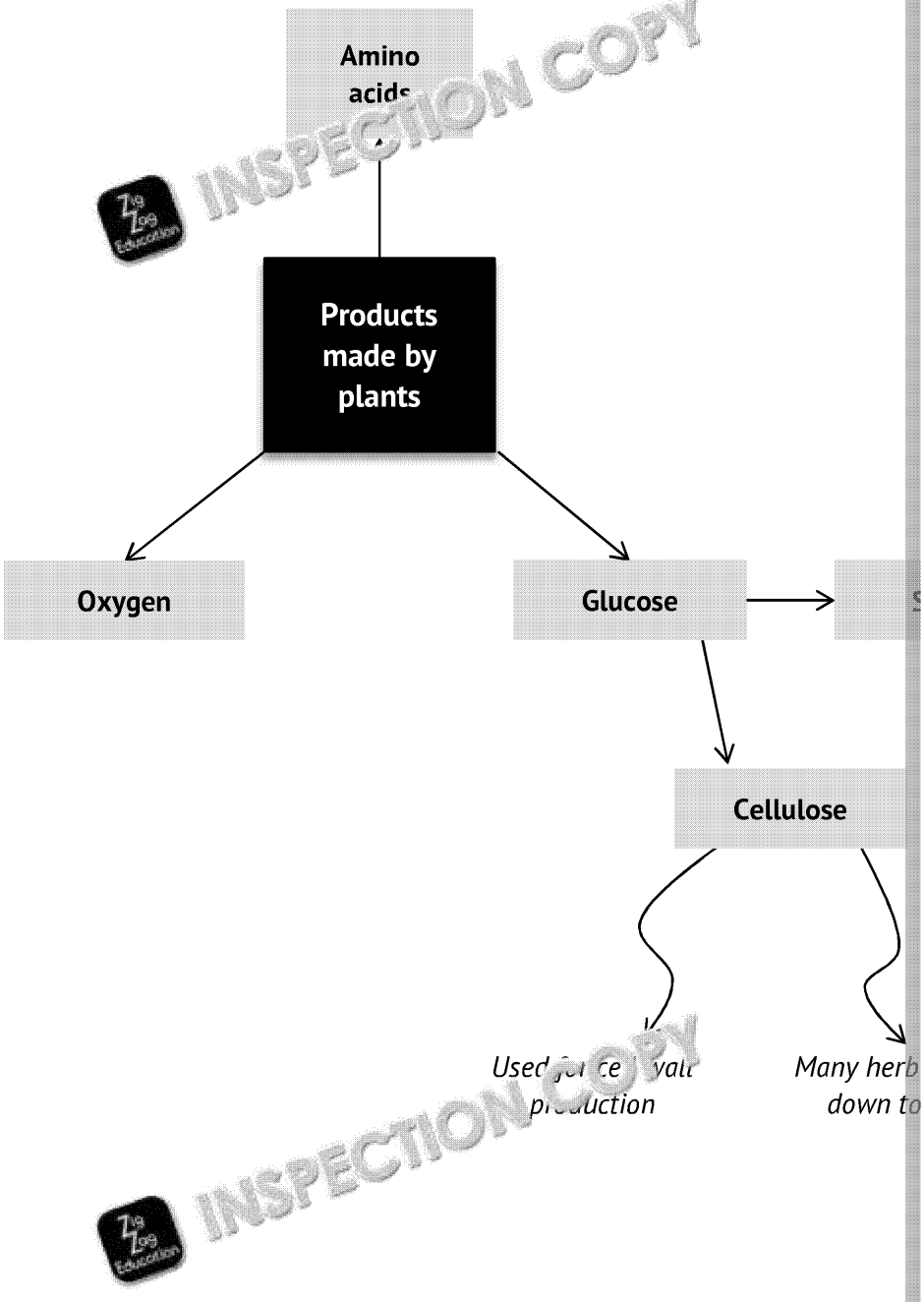
Task 4 – Plant products

Add to the mind map to show different molecules made by plants, and ho
to each part of your mind map to make it more visually memorable.



Task 5 – Photosynthesis word search

The word search below includes lots of words relating to photosynthesis. the hidden words are. Then, find the words in the word search!

H O X Y G E N G S R O E Y I
R R O O T S E R V E P W I N
M E T M L X E K P T X I R S
C Z S D E C I H B A S E A R
M K L P U L L F R W W N H I
H R Z D I O Y Z N O X U F Q
A P O V E R Q X I C L X M U
P R L M D E I H C R A T S
P V I B T L C C A N G
T Z G L E W I O N H V S
C H H T Q M A C C O B V I P
A S T S O A E B N I N D A S
Y B H Z D O K U K B P P D P
C A R B O N D I O X I D E W

1. The process with an equation which is photosynthesis in r
2. Vessel with end plates which shifts sugars around the pla
3. Life-giving substance which is also needed for photosynth
4. Gas which is a waste product in animals, and essential for
5. Gas which plants produce, that all organisms use for respi
6. Plant organ which produces pollen and egg cells (6)
7. Hollow tubes which transport water (5)
8. The energy that drives photosynthesis, and makes life on E
9. Plant organ which absorbs nutrients and stabilises the pla
10. Plant molecule made up of lots of glucose units joined tog
11. The name given to organisms which make their own nutri

Extension

Explain why photosynthesis is described as an **endo**[illegible]**mic** process but res
and why this is important. You should refer to energy in your answer.

.....

.....

.....

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.....

.....

8: Controlling Photosyn

Learning Objectives

By the end of this lesson, you should be able to:

- ✓ name and describe some factors that affect the rate of photosynthesis
- ✓ explain the importance of these factors
- ✓ HIGHER TIER: interpret graphs of limiting factors

Background

Market gardeners need a fast-growing crop that produces lots of large, tasty fruit and vegetables in the shortest possible time, in order to make a good profit. The faster the rate of photosynthesis, the faster plants grow, so gardeners must control and monitor the conditions in their greenhouses so that they are not spending more than they need to on heating and other factors that will affect their profit!

This strawberry polytunnel (a long, tunnel-shaped greenhouse) is designed to grow lots of strawberries quickly, by controlling the environment.

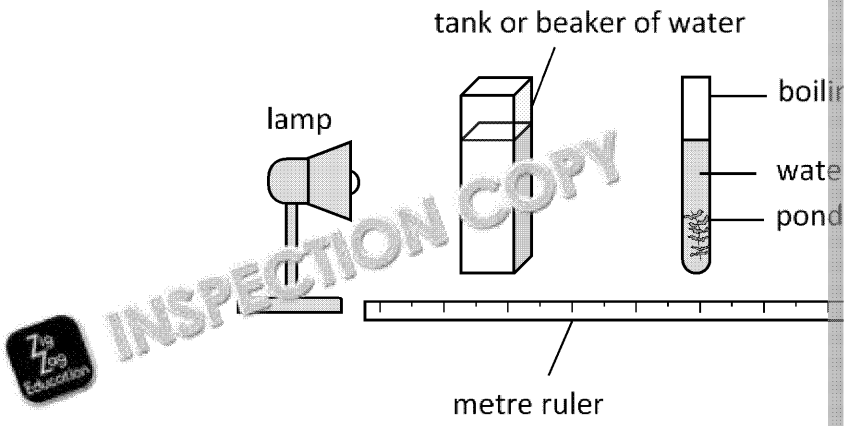
Task 1 – Factors in photosynthesis quiz

1. List as many factors as you can think of that could affect the rate of ph
   (2 = good, 4 = excellent, 6 = amazing!)

   .....

   .....

   .....



2. This practical equipment has been set up to measure the rate of photo
   number of bubbles of gas produced in a fixed period of time (30 secon
   factors can be changed to measure the effect they have on the rate of

   Which gas is being produced in photosynthesis?

   .....

3. The experiment described in question 2 was carried out. The tables (b
was collected. On graph paper, draw a graph to show the effect of ea
a curve of best fit for each.

Things to remember: *choose a sensible scale before you start drawing e
on the axes? Are your axes clearly labelled? Have you included units?*

4. Describe the pattern shown in:

a) the light intensity graph.

.....

.....

.....

.....

b) mperature graph.

.....

.....

.....

.....

c) the carbon dioxide concentration graph.

.....

.....

.....

.....

Light intensity (%)
0
15
25
50
70
80

Temperature (^{0}C)
0
20
30
40
50

CO_2 level (%)
0
10
20
25
30
35

5. What is the optimum level for each factor?

a) Light intensity: .....

b) Temperature: .....

c) Carbon dioxide concentration: .....

6. How do you know that this is the optimum?

.....

.....

Higher tier only

7. Complete the following sentences:

a) A limiting factor is: .....

.....

.....

b) For plants growing in the shade of trees in a tropical rainforest, a

photosynthesis is likely to be .....

c) In cold, wet moorlands, the limiting factor for photosynthesis is m

TASK 2 – PRACTICAL ANAL
LIGHT INTENSITY AND PHOTOS

Read the description of the experiment below, and answer the questions a

Aim: to investigate different factors which a
rate of photosynthesis in *Elodea* (pondw

Background

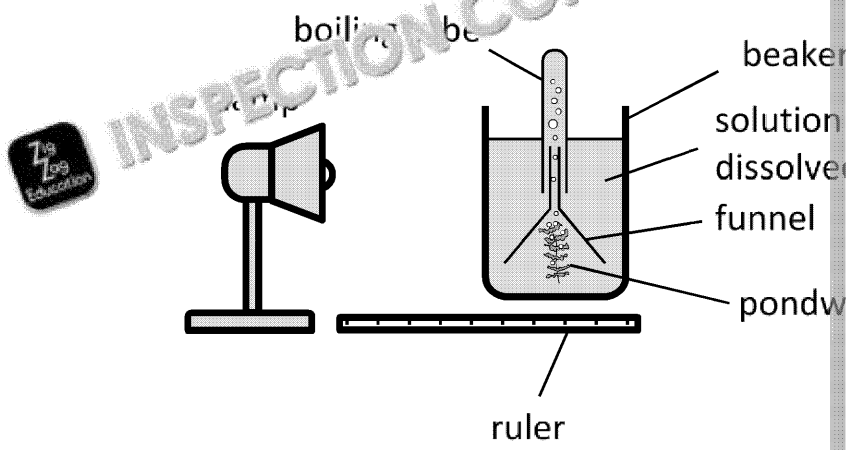
During photosynthesis, carbon dioxide, water and energy from sunlight are
($C_6H_{12}O_6$) – a sugar that can be used in respiration or used to produce othe
also produced as a waste product of photosynthesis. The whole process ha
organelles called chloroplasts. A chemical equation for photosynthesis ca

$$6CO_2 + 6H_2O \rightarrow C_6H_{12}O_6 + 6O_2$$

light energy

Several factors have some effect on the rate of photosynthesis; for exampl
essentially a factor in all chemical reactions. Other factors which may affe
include carbon dioxide concentration and light intensity.

Apparatus



Procedure

1. Cut a section of pondweed, cutting diagonally across the stem using s
   carrying out this stage).
2. Set up the experiment as shown in the previous diagram. If possible,
   with the blinds/curtains drawn.
3. Place the lamp 5 cm away from the beaker.
4. Bubbles should be observed rising from the funnel into the test tube.
5. Count the number of bubbles in one minute. Repeat this process for a
   third minute.
6. Move the lamp until it is 10 cm away from the beaker, and repeat stag
   15 cm distance, and 30 cm distance.

Sample results

	Distance from lamp		
	5 cm	**10 cm**	1
Bubbles (1st repeat)	58	24	
Bubbles (2nd repeat)	51	21	
Bubbles (3rd repeat)	57	10	
Mean			

Questions

1. State:
   a) the dependent variable in this experiment.

      .....

   b) two variables that should be controlled in this experiment.

      .....

      .....

2. During the third repeat at 10 cm t[illegible] la[illegible] is turned so that it doesn't
   Should this result be inc[illegible] when calculating the means? Explain y

   .....

   .....

3. Fill in the table above by calculating the mean number of bubbles pro
   each mean to the nearest whole number.

4. What gas is assumed to be inside the bubbles?

   .....

5. Based on what you know about photosynthesis, explain the results. T
such as the names of parts of the plant and names of chemicals in yo

.....

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.....

6. Suggest one problem with the experim ntal design, and a way in whi

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7. Suggest a piece of equipment which is missing from the diagram of th

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Extension

Suggest how you would alter the experimental set-up to investigate how a
of photosynthesis.

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.....

.....

Write an equipment list for yo r a ive experiment.

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9: Measuring Mineral Uptak

Learning Objectives

By the end of this lesson, you should be able to:

- ✓ Explain the difference between active and passive transport, with some examples
- ✓ Understand that active transport requires energy

Background

Passive processes like **diffusion** and **osmosis** are [illegible] for organisms to absorb substances. For example, plant roots can absorb water by simple osmosis – the water in the soil usually has a high concentration of water, while the roots have a lower concentration of water; therefore, water enters the roots by osmosis.

However, all organisms sometimes need to absorb substances that aren't as easily available. For example, plant roots need to absorb mineral ions such as **nitrates** (NO_3^-), **sulfates** (SO_4^{2-}) and **phosphates** (PO_4^{3-}) from the soil, but these ions aren't always common in the soil. In addition, other plants are **competing** to take up as much of these substances as they can. In order to take up enough, root hair cells have to use **active transport**.

In photosynthesis, plants absorb sunlight energy and CO_2, and use them to make glucose; they then break down glucose by respiration, releasing **energy**. Some of this energy is used to move mineral ions across the cell membrane and into the cell by active transport against a **concentration gradient**.

TASK 1 – PRACTICAL ANAL
MEASURING MINERAL UPTAKE

Aim: to study how the roots of plants take up mineral ions

Read the practical description below and answer the analysis and conclusi

Background and recap

Plants take up mineral **ions** by active transport, in order to absorb as much as of the ions taken up by plant roots is sulfate (SO_4^{2-}), which is needed for esse

Mineral ions are generally absorbed by active transport. However, scientis substances are absorbed by diffusion, and which are absorbed by active tra

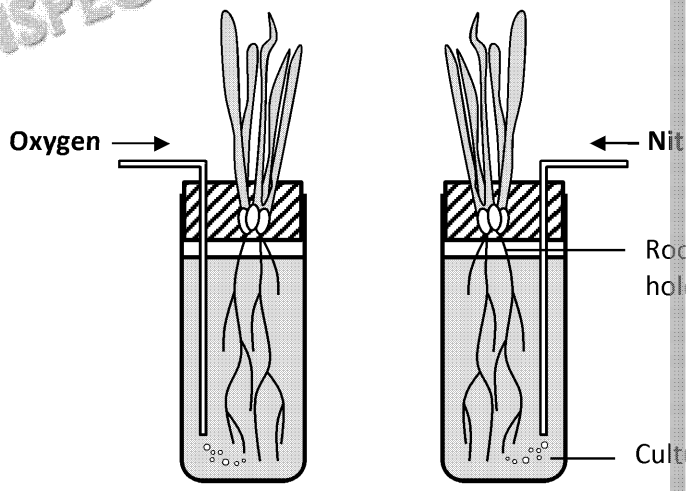
A significant experiment was carried out by scientists using barley seedlin sulfate ions, which have three more neutrons than other sulfate atoms and

The experiment involved growing plants in two nutrient solutions, which c needed for growth. The solutions were identical, except that the first solu it, and the second solution had nitrogen bubbled through it. The second e **anaerobic** conditions.

Method

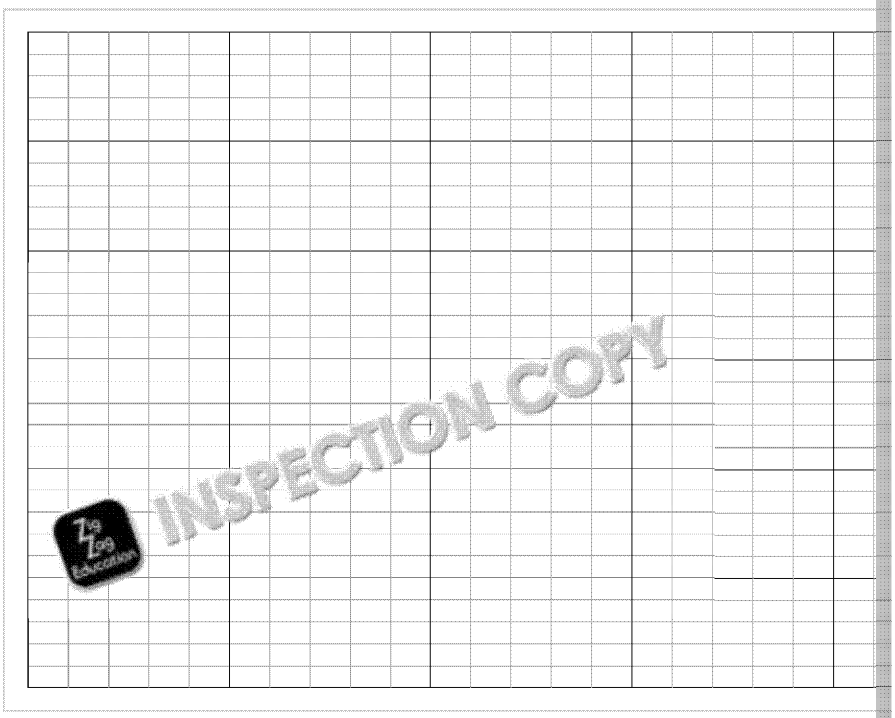
- Two groups of seedlings are grown in nutrient solutions A and B, cont
  (see equipment set-up).
- The sulfate ions are 'labelled' with radioactive (^{35}S) sulfur atoms.
- Solution A has oxygen bubbled through it using a length of tubing, w
  bubbled through it.
- The concentration of these ions is detected using a specialist device w
  radioactivity.
- The concentration of radioactive sulfate ions in each nutrient solution
  for three hours.
- As the number of ions in each solution decreases, it is assumed that th
  up by each plant is equivalent to the nu[illegible] ions lost from the solu

Equipment set-up



Time (minutes)	Sulfate ions absorbed (arbitr	
	With oxygen (O_2)	Wit
0	0	
15	20	
30	45	
45	70	
60	90	
75	[illegible]	
90	145	
[illegible]	180	
120	205	
135	225	
150	250	
165	270	
180	295	

1. Plot a graph of these results, with time (in minutes) on the horizontal
two lines – one for the oxygen experiment and one for the nitrogen e



2. State:
   a) the independent variable in this experiment.

   .....

   b) two variables that should be controlled in this experiment.

   .....

   .....

3. Give a short definition of each of these words, used in the background
radioactive, **anaerobic**.
(If you don't know what a word means, use a dictionary to look it up, but t

.....

.....

.....

.....

.....

.....

4. In which solution did the seedlings take up more sulfate ions?

.....

5. Which major metabolic process in a root cell requires oxygen?

.....

6. Based on what you know about active transport, explain the results of

.....

.....

.....

.....

7. A student says 'this experiment proves mineral ion uptake is more effe
you agree or disagree with the student? Explain your answer.

.....

.....

.....

.....

8. A researcher is looking at the results of the experiment. She wants to
oxygen affect the plant's rate of mineral ion uptake, so she designs a
current experiment.

a) What would be the independent and dependent variables of the

.....

.....

b) Suggest two things which the researcher would keep the same.

.....

.....

Extension

Based on the answers you have given to question 8, write a method for the

.....

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10: Cycles in Biolo

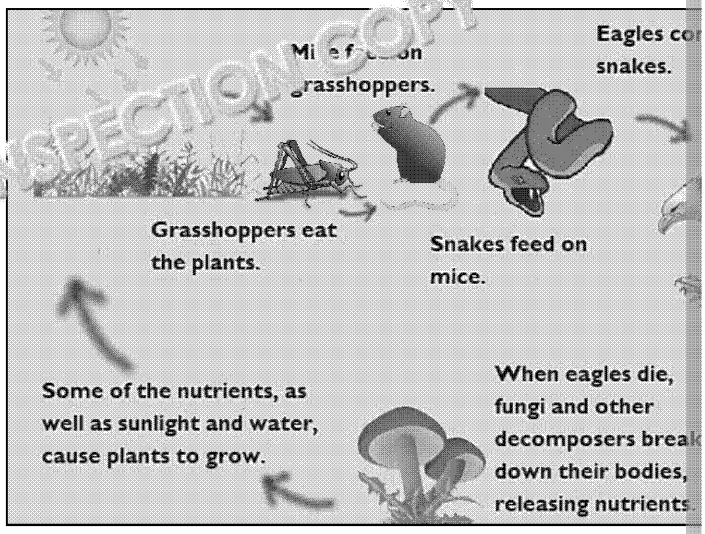
Learning Objectives

By the end of this lesson, you should be able to:

- ✓ explain the role of microorganisms in the cycling of materials through an ecosystem
- ✓ describe the impact of competition in a community

Background:

This is an example of a food web:



Task 1 – Decomposers in the food web

Look at the food web above, and the words and sentence fragments in the
the sentences by writing one word or sentence fragment in each gap.

prey	urine	dead cells
dead animals (and plants), releasing nutrients into the soil.		plant growt cou
nutrients would be released from dead organisms extremely slowly.		sugars and

In this ecosystem, the eagles are ..... of the snakes, while th
the snakes.

Decomposers such as fungi break down .....

If decomposers were not present in this food web, ...

.....

The nutrients released by decomposition include .....

.....

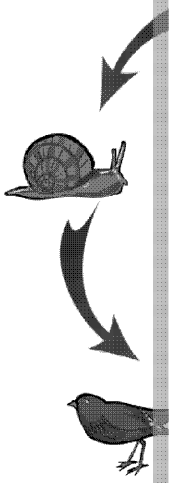
If there were no decomposers present, ...

.....

Other microorganisms help to recycle nutrients by breaking down the prod
....., or by decomposing ..... .

Task 2 – Nutrient recycling

1. Label the diagram with the following words (you may label the same organism more than once): **producer, consumer, decomposer, carnivore, herbivore**.



2. The role of the decomposer in the food chain is not fully explained by this diagram. Draw additional arrows on the diagram to better show the role of the decomposer.

3. The temperature of an ecosystem affects how quickly decomposition happens. Suggest why.

.....

.....

.....

.....

.....

4. Suggest what would happen if all of the decomposers disappeared fro

.....

.....

.....

Task 3 – Carbon cycle

Below are written statements that explain stages in the carbon cycle.

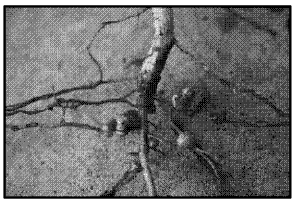
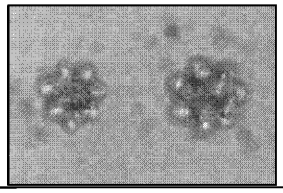
a) Decide which processes store carbon dioxide, and which processes rel the words 'store' or 'release' in the box next to them.

Process	
A dormant volcano suddenly erupts.	
Animals respire aerobically.	
A tree photosynthesises, producing oxygen.	
Sea organisms die and form sediment on the seabed.	
A factory burns coal to produce steam.	

b) Draw a labelled diagram to show the carbon cycle occurring in a parti
include the processes in part a) and others from your textbook or your

Task 4 – Marvellous microorganisms

Each of the situations below relies on microorganisms. Read the informati
important, and complete it to say what would happen without microorgani

Microorganism	What it does	If
Rhizobium 	Lives in the roots of certain plants and 'fixes' nitrogen from the atmosphere, using it to make amino acids which the plant can absorb.	
Coelastrum 	Lives in lakes and gets its nutrients by photosynthesis, releasing oxygen as a waste product.	
Lactobacillus 	Bre[illegible]yn milk to form lactic acid, lowering the pH during yoghurt production. This denatures enzymes from the milk.	
Ruminococcus 	Breaks down cellulose in the gut of a cow.	

Extension

Reminder: abiotic factors are **non-living** factors that affect an ecosystem.

Unscramble each of the words, and suggest how it can affect any of the cy
tasks.

Complete the following table:

Abiotic factor	How it affects differen
reepartutem	
roistur	
dicyiat	
enyxog velsel	

11: Investigating Ecosy

Learning Objectives

By the end of this lesson, you should be able to:

- ✓ explain what biotic and abiotic factors are
- ✓ describe the effect of these factors on a community by interpreting the given data

Background

What is ecology?

- A study of habitats
- A study of interactions betw[illegible] organisms
- A study of Earth thr[illegible] the structure and function of nature

Why is [illegible]d[illegible]?

1. To d[illegible]ver how complex ecosystems work
2. So that humans can use the ecosystems for human benefit without ha
3. To help us understand the consequences of human interference with

Some terms and definitions to learn!

Organism: any living creature (plant, animal, bacterium, etc.)

Biodiversity: the variety of life – the range of living organisms in an ecosy

Ecosystem: the organisms of a particular habitat, together with the physica

Habitat: where an organism lives

Abiotic environment: an organism's surroundings including light intensity, availability, etc.

Biotic environment: other living things in the organism's environment such food, parasites, competitors

Niche: an organism's role in its ecosystem (e.g. as a predator, prey or decor

Population: a group of organisms of the same species that live in the same

Community: all organisms of different species living in a given habitat (e.g

Key facts

- A population will undergo continued growth (shown by the top line in the graph) in an environment in which there is a surplus of food, space, shelter, and suitable **biotic** and **abiotic** conditions.
- Continued growth of the population will [illegible]or [illegible]be slowed or stopped (shown by the bottom two lines) [illegible]something **limits** its growth; this means that something the organisms (as a group) need, starts to run out. These are called **limiting factors** as they limit the size of the population.
- Environmental conditions are broken down into two categories:
  - Abiotic conditions are <u>living</u> factors, such as food (plants or animals), predators in the area, and other populations that may c
  - Abiotic conditions are <u>non-living</u> factors such as space, temperatu water, light intensity, temperature, minerals, water availability or
- We can use biotic factors to help us check that the abiotic environment lichens which grow on stone walls, or certain invertebrate species i pollutants in the environment.

Task 1 – Ecology keyword match-up

Draw a line to match each term with the corresponding description.

Population	An organism's r
Community	Communities of organis env
Environment	Coexisting species tryin
Ecosystem	Non-li
Abiotic	A group of organisms of the place at the same
Ha	The physical area s
Biotic	Populations of different sp
Niche	The livin
Competition	Where an orga

Task 2 – Factorise!

For each factor, write whether you think it is biotic or abiotic.

	Check: Biotic or Abiotic?
pH	
Rainfall	
Predators	
Temperature	
Moisture levels	
Food	
[illegible]	
Oxygen levels	
Light	
Parasites	
Competition	
Space	

Task 3 – Tipping the balance

Briefly, explain whether the population of herbivores would be likely to st

1. Oxygen levels in water fall too low (aquatic herbivores)

.....

.....

2. Food runs out

.....

.....

3. A new predator arrives to the area

.....

.....

4. There's too much food!

.....

.....

5. A virus hits the herbivore's main predator population

.....

.....

6. Another population of a different herbivore species migrates into the

.....

.....

Explain whether the weight of ground plants in a field would be likely to i

7. It hasn't rained for weeks

.....

.....

8. Rab ove to the area

.....

.....

9. Trees are very tall

.....

.....

10. Trees get cut down

.....

.....

11. A natural predator of rabbits is introduced by humans

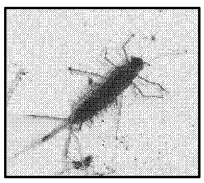
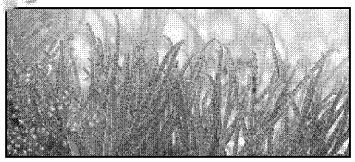
.....

.....

Task 4 – The use of invertebrates as indica pollution (data analysis)

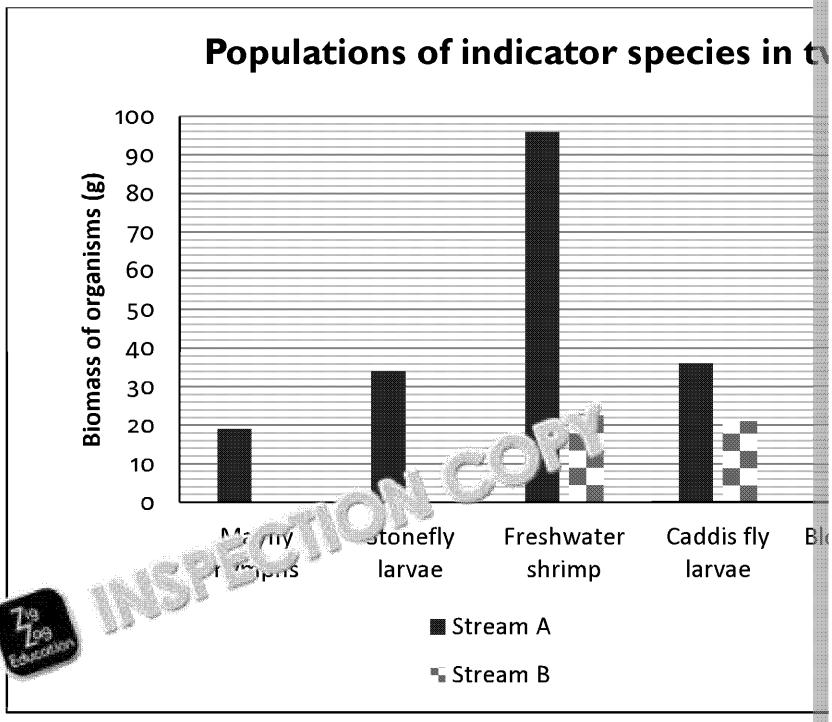
Aim: To analyse data from two streams and draw conclusions on the level invertebrates as indicators.

Indicator species in streams and rivers

State of water	Organisms found	Example
Clean	Mayfly nymphs Stonefly larvae	 Mayfly nymph
Some pollution	Caddis fly larvae Freshwater shrimp	 Freshwater shrimp
Pollut	Bloodworms Sludge worms	 Sludge worms (in fish tank)

Sample

Invert
Mayfly n
Stonefly
Freshwa shrimp
Caddis fl
Bloodwo
Sludge w



1. Describe the data shown in the graph.

2. Use the information about where indicator organisms are found, and t explanations for the numbers of each organism in the two streams.

Extension

A small population of 40 water voles is released in a river valley on a remote Pacific island. The voles thrive in the new environment, and their population initially doubles every three years.

a) According to this rule, how many voles will [illegible] after nine years?

.....

.....

b) How [illegible] voles will there be after 18 years?

.....

.....

c) If this rate of increase continues, how many voles would there be 36 y
introduction?

.....

.....

d) Suggest three or more reasons why, in practice, the number of voles m

.....

.....

.....

.....

.....

.....

12: How Species Inte

Learning Objectives

By the end of this lesson, you should be able to:

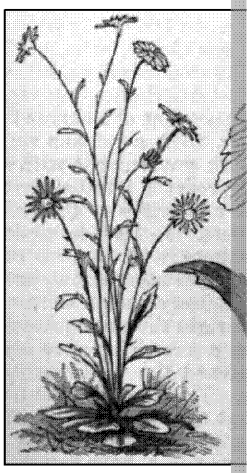
- ✓ state some factors that organisms compete for
- ✓ describe the impact of competition in a community

Starter

a) State at least three things for which these plants are competing.

b) Label the adaptations that enable each plant to be a successful compe
(Hint: how do they get what they need away from other plants? How do they continue as a species?)

Dandelion



Dai

Background

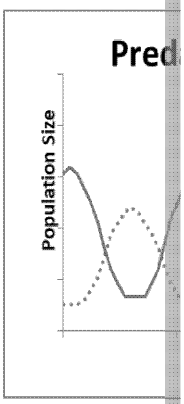
Organisms compete with each other

Organisms constantly need to get resources in order to survive, including f minerals. However, the substances needed for life are **finite**, meaning that them; therefore, organisms must compete for them. Organisms also comp reproduce and pass on their genes.

Organisms develop **adaptations** to allow them to compete effectively; for e bigger leaves to absorb more sunlight. A herbivore such as a cow has spec chew tough plant matter, and a stomach with several chambers to help it most possible nutrients.

Populations

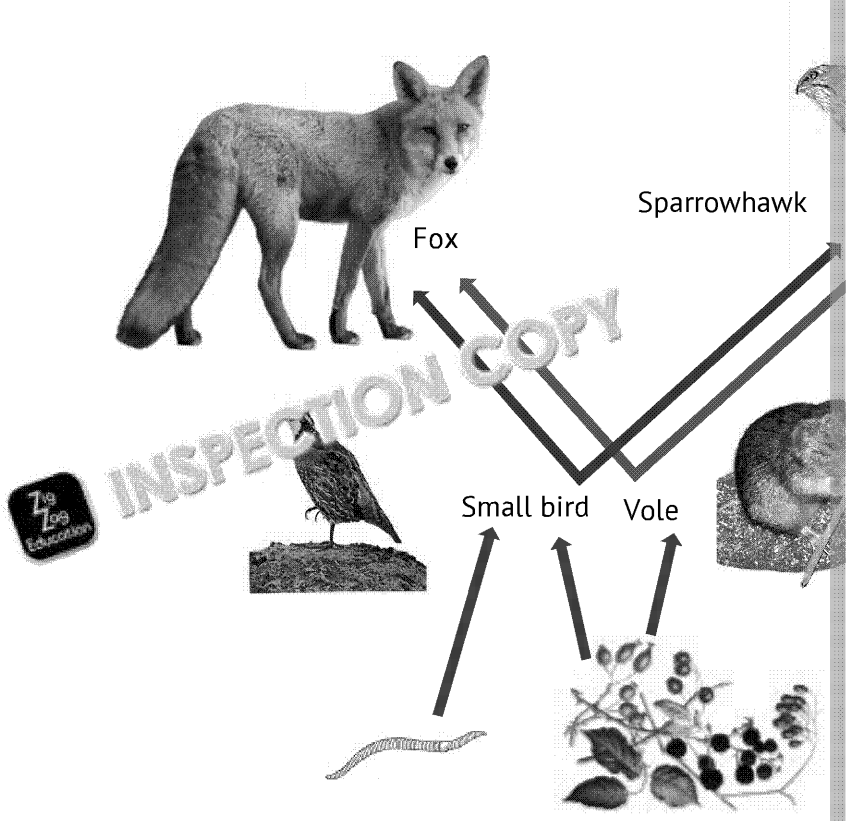
Interdependence is a broad term used to describe how different populations of organisms 'depend' on each other in a community; for example, predator populations rely on enough prey to be available in their habitat range or they will die or have to migrate. Plants rely on animals to spread their seeds; they also rely on worms to create air pockets in the soil.



There are many examples of interdependence, but the relationship betwee quite close, so each population is greatly affected by fluctuations in the ot

Task 1 – Competition within species

A simple food web containing a few organisms is shown below.



a) The animals in this food web are competing with other animals of the species for many different things. List as many as you can.
(2 = good, 4 = excellent, 6 = amazing!)

.....

.....

.....

.....

b) Label the organisms with the following words: predator, prey, produce

c) Label at least three adaptations that enable a named organism to fight for survival.

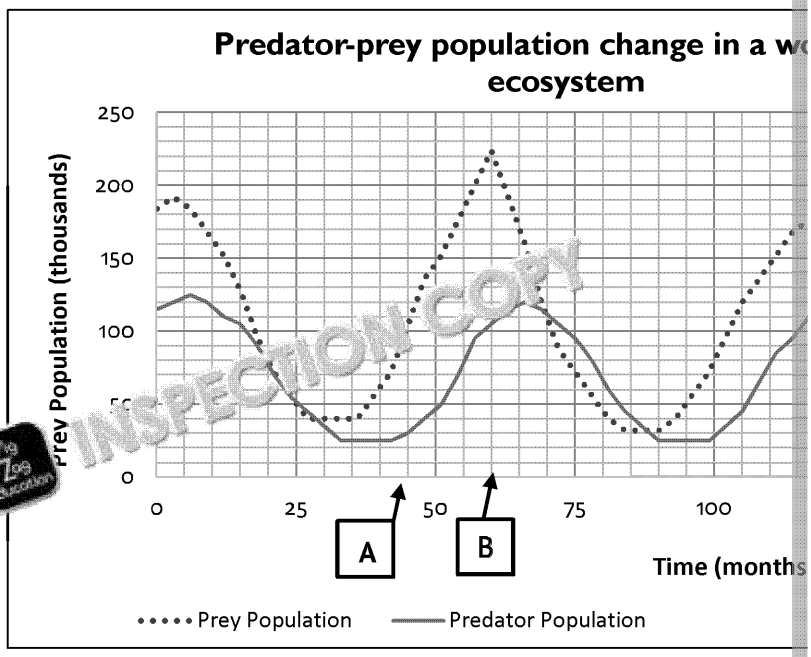
d) Name one thing that animals only compete for with animals of the same answer.

.....

.....

Task 2 – Interdependence and competitio

The graph below shows predator–prey population change over time, for tw
questions below (try not to focus too much on the numbers, but instead loo



1. In terms of predator and prey population change, suggest what is hap

Point A:

.....

.....

.....

Point B:

.....

.....

.....

Point C:

.....

.....

.....

Point D:

.....

.....

.....

2. Try to explain what the term 'cyclic fluctuation' means, using this gra

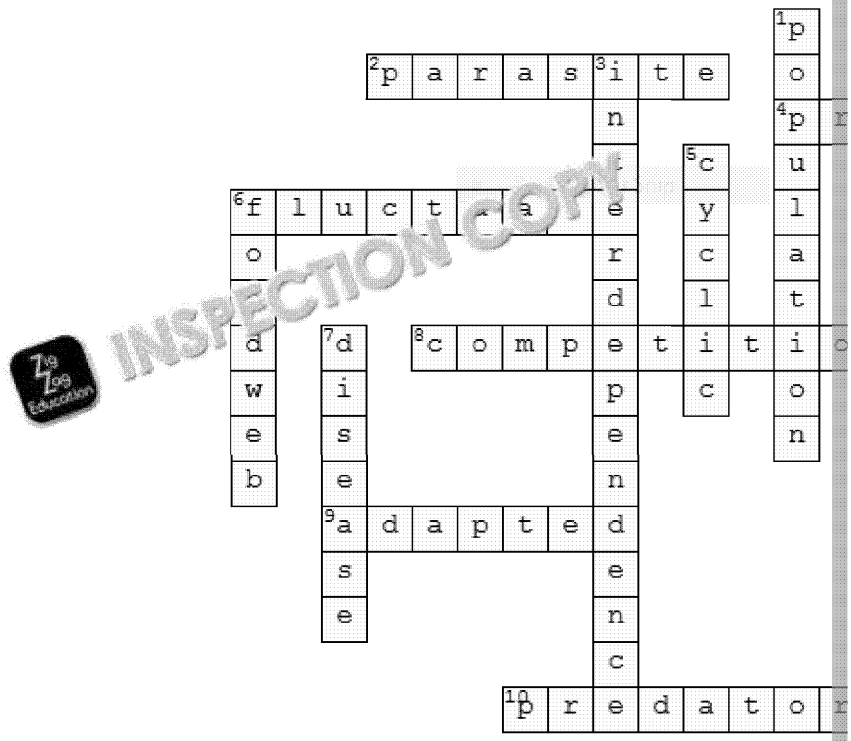
.....

.....

Task 3 – Interactions reverse crossword

The crossword below has already been completed, but the clues have beer
the crossword.

*(**Tip:** some of the words have other meanings outside of biology, but you must
the word in the clue!)*



Write clues for each of the numbered words below.

Across

Down

Extension

Write a description of a specific ecosystem and the types of competition yo

- a **forest in a mild climate**, with trees that lose their leaves seasonally (or the Appalachian forests in the USA, as an example for research).
- a **hot desert**, where rainfall is less than 200 mm per year (you could us Sonoran Desert for research).
- a **rainforest**, where rainfall is very high and temperatures are warm all Rainforest or Borneo as an example for research).
- another ecosystem of your choice.

You can use your own knowledge or your textbook to get ideas for the kin found in the ecosystem, as well as the Internet if you have access to it. Us chosen, give examples of how organisms and species compete with each o

Try to write three or four paragraphs. Ideally, your description should inclu

- what conditions in the ecosystem are like (climate and other abiotic fa
- which types of plant grow in these conditions
- different resources which are competed for by plants and animals in th
- competition within and between species
- predator–prey relationships in the ecosystem

13: What is Biodiver

Learning Objectives

By the end of this lesson, you should be able to:

- ✓ explain what 'biodiversity' is
- ✓ describe how biodiversity can be measured
- ✓ describe some benefits of maintaining biodiversity

Background

'Bio' means 'life', and 'diversity' is another word fa[illegible]ety, so biodiversity is '

Much variety exists within nature. Th[illegible]ty is visible just by looking at the by travelling around the wo[illegible]. It [illegible]omes more obvious that millions of simil environments. Each [illegible] is adapted to its environment and to its role wit example[illegible]h [illegible]ersity – they are all birds but they all have slightly differe foods an[illegible]irectly compete with each other – and starve.

In a selfish way, we need biodiversity as we need to maintain genetic variatio populations can survive – particularly those that we eat (crops and farmed ani (usually plant species, but also fungi and protists).

The human population is increasing rapidly and this is a problem as space is li the more resources will be required (building materials, food (plants and anim disposal areas and housing), but there is increasingly less land available. How ecosystems can have terrible consequences for human societies.

One of the greatest challenges that humanity faces in the twenty-first century sustainably with a still-growing global population. Living sustainably means u destroying them for future generations. The article on the next page (Our susta about sustainability and threats to biodiversity; read the article carefully before

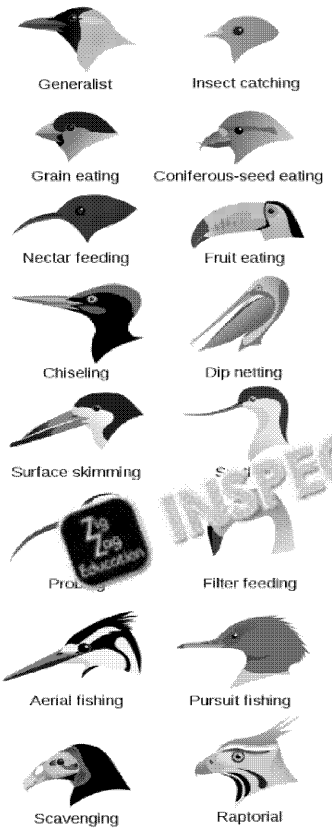
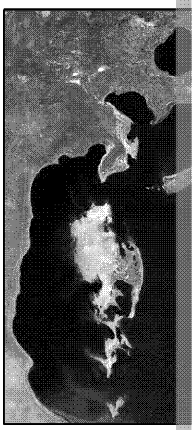


Figure 1: Bird beak shapes and their functions

The shrinking Aral Sea in Kazakhstan and Uzbekistan, which now contains almost no life due to pollution and damaging irrigation projects.



Our sustainable planet?

Sustainable development – the use of natural resources (water, soil, etc.) in a way that improves the lives of people living now, without destroying those resources for future people.

What do people want?

Earth's population reached 7.6 billion in 2017, and an expanding population needs to produce more food to survive and thrive. I for everyone, forests are cut down and dry grasslands are irrigated to make Forests are also cut down to provide timber for buildi s, furniture and fue (building and expanding cities) also damage s e **the habitats** of mar

In addition, most people in th w d vant the same living standards as th as the UK, USA, Sing e a Japan. However, developed countries consu etc.) per n, p oduce more waste, which we need to dispose of.

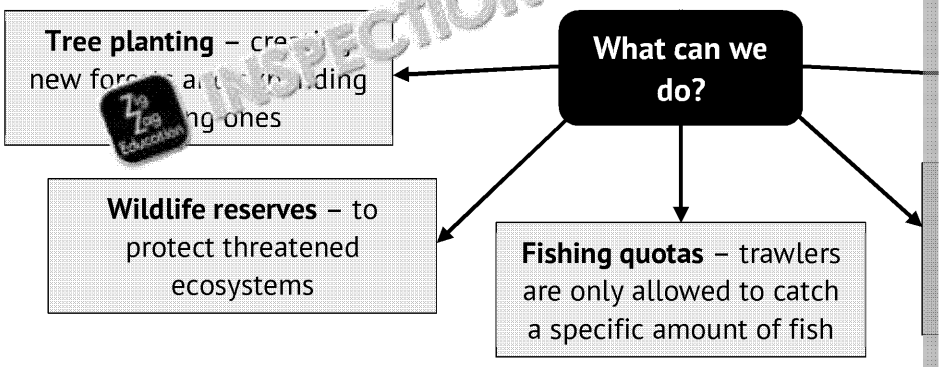
We can protect ecosystems and ban hunting of **endangered species** around th have homes or a way to make money, they will be unwilling or unable to obey

How big is the problem?

- In the UK, we have lost 97 % of our flower-rich meadows since 1900; since 1800, we've lost 99 % of our lowland bogs due to agriculture and urbanisation.
- Worldwide, thousands of species are at risk, including all rhinoceros and tiger species.
- Throughout our long history, humans have destroyed four-fifths of the world's forests.
- Humans appear to be increasing the natural rate of species **extinction** by 100–1,000 times.
- In 2016, the Bramble Cay melomys (a type of rodent) was reported extinct because its island habitat was destroyed by rising sea levels.

What's at stake?

Plant species are the original source of 90 % of our medicines.
If pollinators such as bees die out, so could most of our crops.
If a species becomes extinct, it can send shock waves t rough an ecosystem, threatening other species.



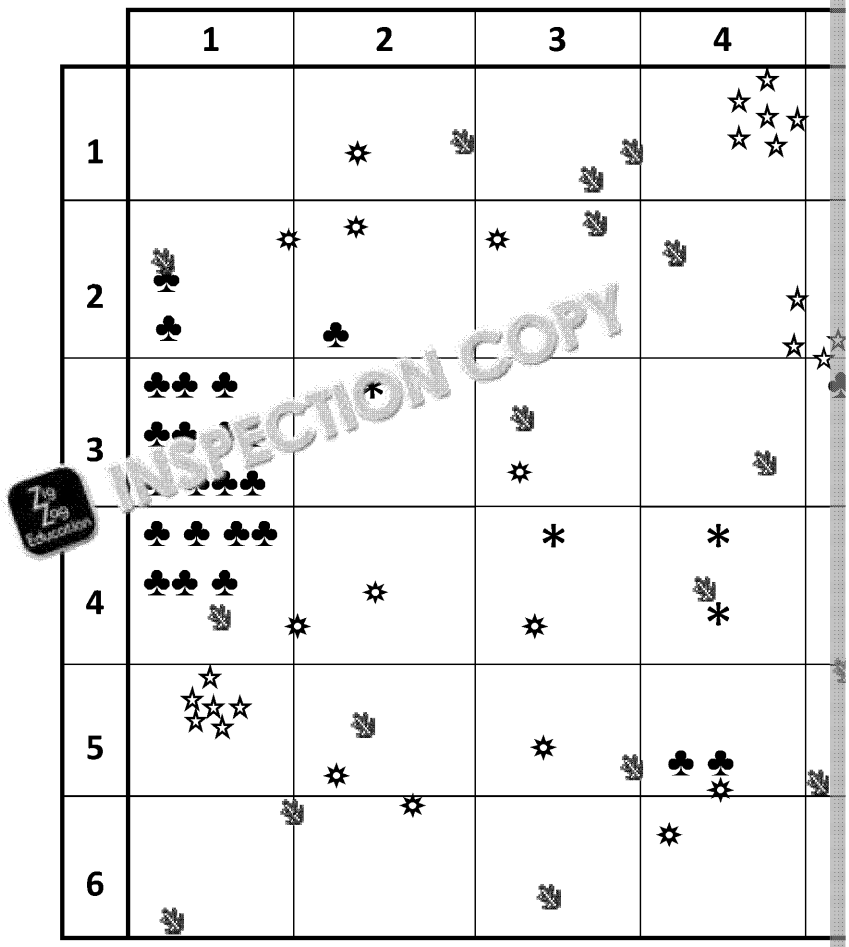
Task 1 – Biodiversity blitz

Answer the questions below. For some you can rely on your own knowled
to use the handout.

Question	Brief Answ
1. Why has the human population increased so much over the last 300 years?	• • • • •
2. Give three ways in which humans use land.	....
3. Give three practical problems caused by an increasing human population.	• • •
4. Give three consequences of an increasing global temperature.	• • •
5. What proportion of rhinoceros species are currently vulnerable to extinction?	.....
6. What are the main problems caused by deforestation?	....
7. W o we mean by 'sustainable development'?	....
8. How are we trying to maintain biodiversity?	• • •

Task 2 – In the field

Quadrats may be used to assess the biodiversity in a field.



The 6 × 6 grid above represents a small plot of land. Each square represen
the field, and, therefore, can be sampled using a 1 m^2 **quadrat**.

There are plans to build on the land. You are required to assess **how man**
flowering plant species and **how many individuals of each named species** t
the whole area. Counting all of them takes a long time, and would take ev
the field was any bigger. You are going to carry out a random sampling pr

PART 1

- Roll a dice to generate a number between 1 and 6 (or close your eyes
  between 1 and 6). This will be your 'across' co ate. Do this again
  you can have the same number twice. For ple, you might end up
- You should count the number flowering plant you find in this
  data in the table on the next page.
- Repeat until you have recorded data for four <u>different</u> squares.
- Ad e number of organisms of each species in the **squares that y**
  it by to estimate the number of each species in the full area.

PART 2

Repeat the method from Part 1, but this time close your eyes and point to
and enter it in the table. Do this nine times. Multiply by four to estimate t
whole area (there are 9 × 4 = 36 squares).

PART 3

You now need to count the total number of each species in the whole 6 ×
third table.

Data

Coordinates	Part 1: Number of			
	plantain	daisy	dandelion	
TOTAL				
AVERAGE PER SQ				
ESTIMA NO. IN FIELD				

Coordinates	Part 2: Number of			
	plantain	daisy	dandelion	
TOTAL				
AVERAGE PER SQ				
ESTIMA NO. IN FIELD				

Part 3: Number of			
plantain	daisy	dandelion	buttercup

1. When everyone has completed this part, compare your data for parts 1
are your estimates different?

.....

.....

.....

.....

2. Which estimate (Part 1 or Part 2) was closest to the real value?

.....

3. Which method (Part 1, Part 2 or Part 3) took the least time?

.....

4. Bas[illegible]he information above and your own knowledge, explain wh
carefully about the size of random samples, and methods of sampling.

.....

.....

.....

.....

.....

.....

Task 3 – An address to the world

Write a speech to be presented in front of world leaders on why we should
the world's biodiversity, and why it is not enough for one country to addre

You should aim to write about 200–300 words. Your speech should includ

- an introduction (introduce yourself and the topic)
- a brief explanation of why we need to conserve biodiversity
- an explanation of why countries need to work together
- some practical suggestions for things world leaders and other people
- a brief conclusion

***TIPS**: Use your knowl[illegible]hemistry and Geography lessons as*
If you have [illegible]e internet, you can search for this informatio
[illegible]be aware of practical issues and the other side of the a

.....

.....

.....

.....

When the last tree is cut, the last fish is caught, and the last river is poi
air is sickening, you will realize, too late, that wealth is not in bank acc
eat money.

Alanis Obomsawin, 1972, from *Who is*
(Possibly adapt

Extension

What do you think this quote means? Do you agree with it?

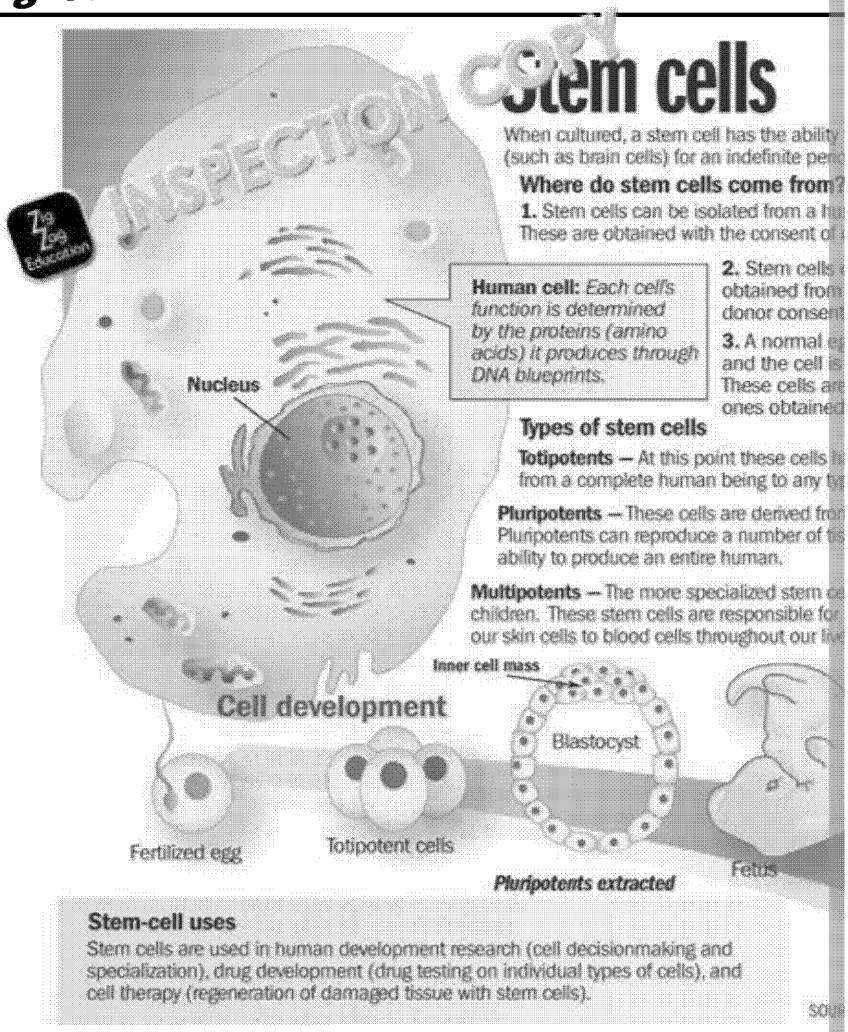
14: Stem Cells

Learning Objectives

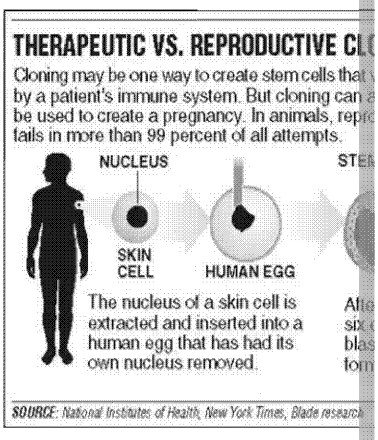
By the end of this lesson, you should be able to:

- ✓ understand what makes stem cells unique, and compare types of stem cell
- ✓ provide arguments for and against the use of stem cells

Background



Stem cells are **undifferentiated** cells. This means that they have not yet **di** **specialised** into a certain type of cell. Potentially these cells can be collec form different types of tissue. There are different types of stem cell, but w **adult stem cells** and **embryonic stem cells**. We all have '**multipotent**' adult stem cells, but these only differentiate into a very few different types of cell, such as bone, blood, liver and muscle cells. However, embryonic stem cells are '**pluripotent**', meaning they can differentiate into many different types of cell, while the earliest embryonic stem cells are **totipotent**, meaning they can turn into any type of cell. Both pluripotent cells and totipotent cells can be used in cloning.



Task 1 – Stem cell research – the debate

Christopher Reeve was a film actor who achieved fame for several roles, particularly playing Superman several times in the 1970s and 1980s. In 1995 he became partially paralysed because of a horse-riding accident, losing his ability to walk.

Reeve was a strong supporter of stem cell technology, because he believed that the technology would improve the lives of people with disabilities. He argued that the technology could 'provide hope to millions'.

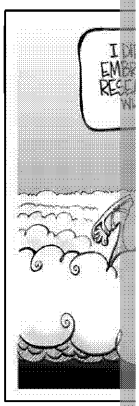
This is an extract from Christopher R[illegible] speech to the UN in October 2[illegible] Conference for the United N[illegible] *Published on YouTube, 18 March 2013*

> 'Ever[illegible] kn[illegible] … opposes the cloning of babies and the pursuit of leadi[illegible]ntist seeking cures calls for stem cell research to advance th as somatic cell nuclear transfer, that offers real hope. The research is st much promise, and not to encourage the ethical pursuit of this researc suffering, and destroy the hope of those afflicted with Parkinson's, Alzh a host of other conditions for which no cure is yet known.
>
> Countries around the world are grappling with this issue, and deciding government is to do the greatest good for the greatest number of peop reproductive cloning and still live up to their obligation to provide the b citizens. I have a real concern that a great medical advance might be l United Nations recommend a treaty that would prohibit this research. S I hope that you'll make the right decision – a decision based on secular scientific knowledge that will provide hope to millions.'

If you have the opportunity, follow this link to listen to Christopher Reeve speak:

Go to **zzed.uk/8090**

https://www.youtube.com/watch?v=pVUKP2-T1rs



Think about the following questions, then answer them.

1. What is the difference between **adult** stem cells and **embryonic** stem cells?

.....

.....

.....

.....

.....

.....

.....

Traumatic brai
Learning
Alzheimer's
Parkinson's

Missing

Wound healing

Bone marrow
transplantation
(currently establish

Spinal cord injury

Osteoarthritis
Rheumatoid a

2. Which are easier to use? Why?

.....

.....

.....

.....

3. What is the difference between **reproductive cloning** and **therapeutic**

.....

.....

.....

4. Sug hy many scientists are opposed to reproductive cloning?

.....

.....

.....

.....

.....

5. Which conditions could be treated with therapeutic cloning?

.....

.....

.....

6. Which stem cells (adult or embryonic) should be used for therapeutic

.....

.....

.....

7. Suggest HOW therapeutic cloning is used to treat some of the conditi
which types of cell would need to be cloned, and what is done with these

.....

.....

.....

.....

8. Using the table below, write down arguments **for** and **against** therape

For	

9. Write a short speech to explain your views on therapeutic cloning.

Extension

If you have time, swap your speech with someone else's and discuss the si your views. Why do you agree or disagree?

15: From DNA to Prot

Learning Objectives

By the end of this lesson, you should be able to:

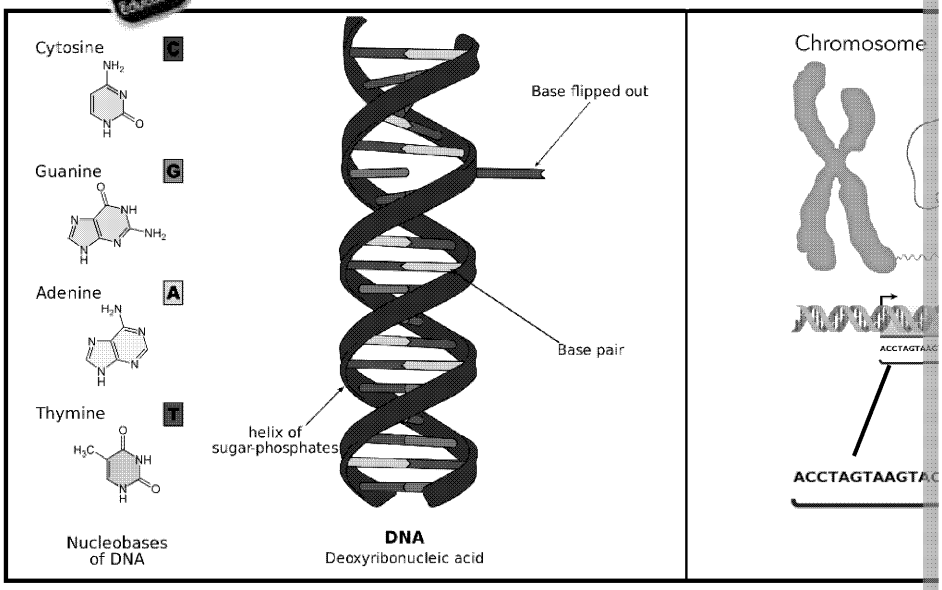
- ✓ describe how DNA codes for different amino acids
- ✓ explain, simply, how the structure of DNA affects the protein made

Background

DNA – understanding the code

The genetic material of a cell mostly consists of DNA ar d in the cell's contro arranged into large structures called **chromos me**. There are 23 pairs of the material in an organism is collectiv l k wn as the **genome**.

DNA carries a code. DN is a long molecule made up of four different **nucleot** of a sugar a pi e molecule joined to one of four bases which join up t DNA are r ented by the letters A, T, C and G.



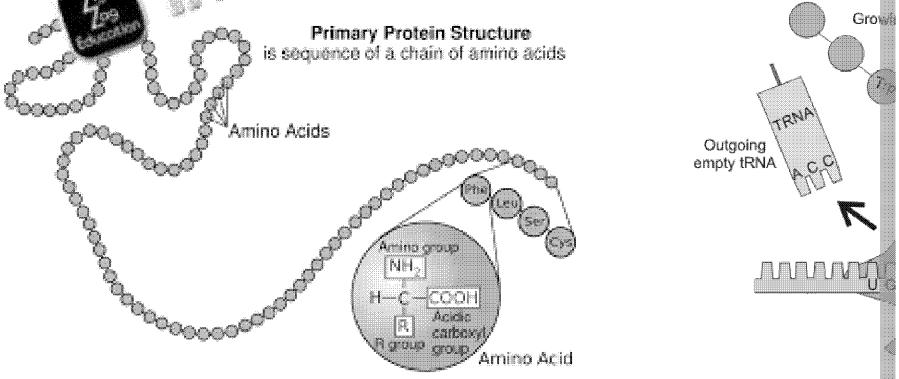
Protein synthesis

A sequence of three bases on the DNA strand (a triplet, or codon) codes for a p **amino acid**. Amino acids are the building blocks of proteins. The sequence of makes one protein is known as a **gene**.

Making a protein (**protein synthesis**) is a bit like code cracking – it begins with process called **transcription** (copying the code to mak a olecule called mRN followed by **translation** (reading the code to m ke a p ticular amino acid). Th happens on **ribosomes** which are fou i lls.

The amino acids are bond t get e to make a long chain; this folds up to m

See *www ube atch?v=rW8NKvQQ8P4* for more information on the trip



Proteins play key roles within all cells

Long amino acid chains are folded up to make specific proteins that can be
proteins, and many other functions besides.

Task 1 – True or false? (recap)

For each statement below, choose whether it is true or false. If it is false,
the statement.

a) Genetic material is stored in the cytoplasm of all cells

b) The four chemical bases in DNA are G, T, C and A

c) 23 pairs of chromosomes are found in most human cells

d) A cell that has an X chromosome and a Y chromosome is from a female

e) A chromosome is a small part of a gene

f) Chromosomes are made of DNA

g) Enzymes are proteins

h) Proteins are not very important in organisms

Task 2 – DNA dictionary

1. Complete the following table from your own knowledge or by reading

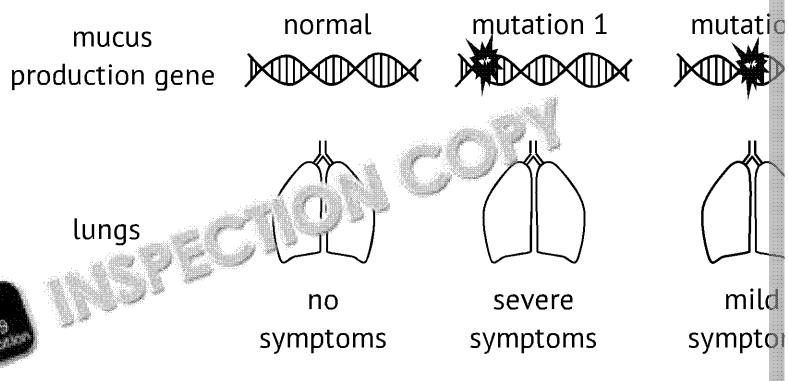
KEYWORDS	MEANING
NUCLEUS	
GENE	
DNA	
CHROMOSOME	
NUCLEOTIDE	
PROTEIN	
BASE SEQUENCE	
GENOME	
PROTEIN SYNTHESIS	

Task 3 – Silent and loud mutations

When a gene **mutates**, the protein encoded by that gene will be abnormal. that:

'A mutation to the mucus production gene will cause cy

Look at the diagram below and explain how correct the newspaper is.



Task 4 – Cracking the code (Higher tier on

Look at the table below, which contains the triplet codes for some of the 2
translate these two sequences of DNA triplets into amino acids.

1. ATGCTGTTCAGTCAT

   Triplet codes: .....

   Amino acids: .....

   .....

2. TCCCCCATTGTATGA

   Triplet codes: .....

   Am ids .....

   .....

Amino Acid	Triple
Isoleucine	**ATT, A**
Leucine	**CTT, CTC, CTA**
Valine	**GTT, GTC**
Phenylalanine	**TTT**
Methionine (START CODON)	**A**
Cysteine	**TGT**
Alanine	**GCT, GCC**
Proline	**CCT, CCC**
Serine	**TCT, TCC, TCA**
Glutamine	**CAA**
Histidine	**CAT**
STOP CODON	**TAA, T**

Task 5 – The human genome

1. Read the text below and highlight what you think are the most import

Since the structure of DNA was discovered in the 1950s, both our
scientific community have changed. Projects are far more likely to
laboratories and countries working together and sharing credit for
much more about what specific genes do, where they are located

In 1990, scientists began work on the Human Genome Project, wh
goal – to sequence the entire genome of 100 people. Each chrom
down into its component genes.

To read the genome, the researchers broke chromosomes down in
fragments of DNA using specialised enzymes called restriction enz
DNA molecules at specific sequences of base pairs; the sequence
e . They then used bacteria to produce many copies of these

The two strands of each DNA fragment were then separated, and
were built using 'labelled' fluorescent DNA bases (A, C, G and T),
colour of light when added to the DNA molecule. Incredibly, a sec
tiny emissions of light to read the DNA code.

The Human Genome Project was completed in 2003, three years
information on the human genome has been used:

- to produce personalised medicines for patients
- to provide evidence to support lifestyle advice, so people can
- to help people with damaged leg arteries to be more mobile

There are thousands more potential uses for the Human Genome
scientists to identify criminals. However, people also have ethical
insurance companies might refuse to sell life insurance to people w
about the right way to use our genetic information is an important
have strong, open debates about the proper role of science in our
of opinions from both experts and members of the public.

2. Based on what you have read, use the template on the next page to w
completion of the Human Genome Project. You should include some
well as some of its uses.
*(Hint: think about who you are writing for! Adults don't remember
need to include some extra information and skip some of the tough scien*

The Daily Gene

Put a headline here. Make sure your headlin

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who worked on the

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You could draw, or cut and stick, a picture here.

Extension

After the success of the Human Genome Project, a group of scientists from
'Genome Zoo' – a catalogue containing the genome of 10,000 vertebrate s

Using your own knowledge, and independent research if possible, write a
how this project would be useful to scientists.

16: The Theory of Evolution by N

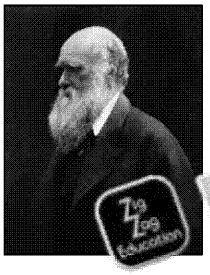
Learning Objectives

By the end of this lesson, you should be able to:

- ✓ describe some adaptations that allow organisms to survive and succeed in their natu
- ✓ explain how evolution by natural selection occurs over time

Background

Read the following with a highlighter to hand – highlight the most import



Most people who hear the wo ‘ ol tion’ will think of (expedition around the o d the ship *HMS Beagle*, Da evolution by n al s ction, based on observations an ultimat uh shed it in a book called *On the Origin of S*

ver, other explorers and naturalists had already sta populations and species might change over time. In thei came across organisms which were recognisably similar, water or desert. In addition, each species was clearly adapted to its own c

Lamarck’s first steps

Jean-Baptiste Lamarck was an expert in animal classification; in 1809, he p the theory of acquired characteristics to explain how animals changed ove Lamarck suggested that an organism could change and then pass on those its offspring; for example, a cheetah which chased a lot of prey would bec muscular, and then pass on these changes to its offspring. Although it has disproved, it was a start on the path to understanding evolutionary change

Wallace’s discoveries

Alfred Russel Wallace travelled extensively. He thought that similar specie related and have come from a common ancestor at some point in the past. wrote about how new species could have arisen (speciation).

Wallace was working at about the same time as Darwin, and produced the idea, even writing to Darwin to ask for his advice! Although the two scient present conferences and give speeches together, some argue that Wallace as much credit because he was not as rich or influential as Darwin. This di bother Wallace too much – he was a ‘hands-on’ explorer and naturalist, while Darwin was more of an academic.

Survival of the fittest

Evolution by natural selection is often described as ival of the fittest. A scientist called Herbert Spencer in e e term, after reading Darwin’s book; Darwin liked i later used it himself.

‘Survival of the fittest’ is a d y to think about natural selection.

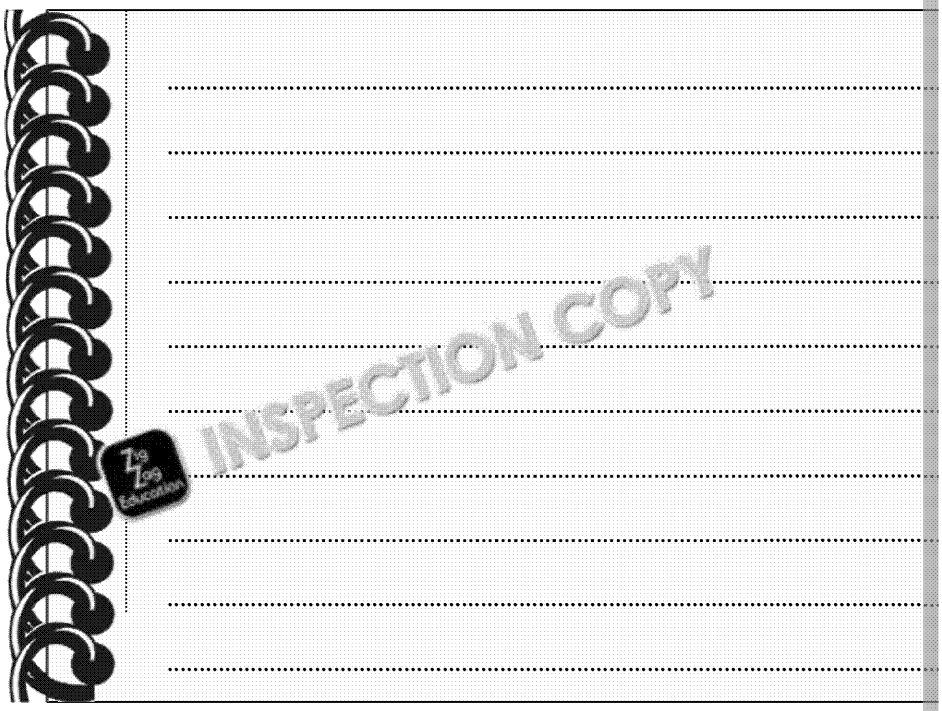
- If an organis s ll suited to its environment, it can compete we oo d for a mate.
- The ism will be likely to survive to adulthood, and have many offspring.
- Some of the offspring will inherit these good traits, so we say these traits are selected for.

However, ecosystems don’t stay the same; the climate changes, or a river is di new predator is introduced. What then? Organisms are at the mercy of their abiotic. If they have the correct adaptations, they can survive; if not, they are

Changes occur in species very gradually, over thousands of generations. We kn but, in 1859, genes had not been discovered, so Darwin and Wallace couldn’t e

Task 1 – Quick notes

Write four to six bullet points summarising the information you have just r
important details.



Task 2 – Natural selection and the evolutio

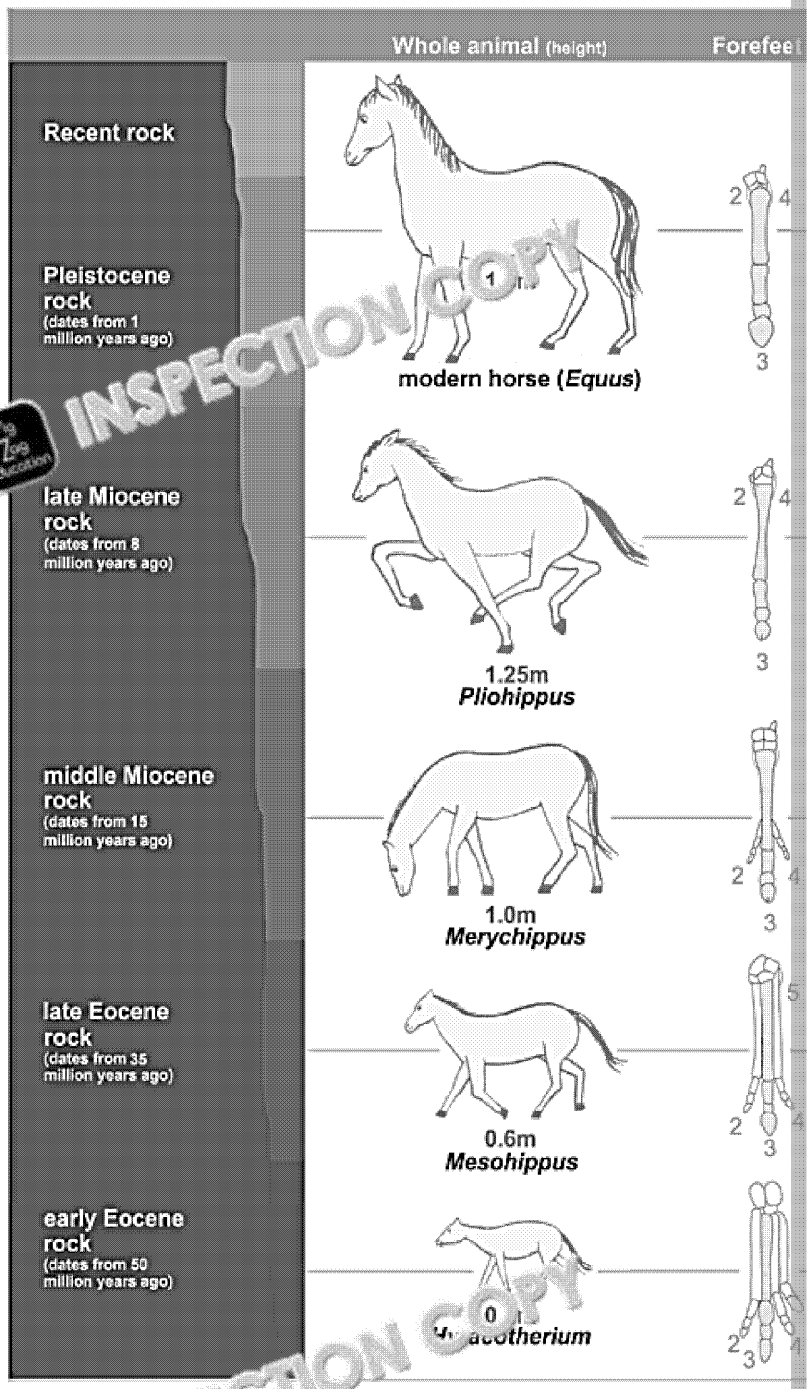
Below are two lists of statements, explaining the process of evolutionary c
The scenario on the left describes how evolution changes a species; the sc
evolutionary arms race between species.

Each scenario has been listed in the wrong order. You need to number the
correctly to explain the process of natural selection over time.

A population of a species faces competition within its habitat		A vicious predat population
Many die – only a few are left		The beneficial g offspring, giving characteristic
There is a struggle in trying times – some are 'fitter' than others (stronger, resistant c more attractive to the opposite se x)		This leads back t
This carries on th[illegible] several generations		At the same time own selection pr ability to catch t
They are competing for a limited resource (food, water, shelter, mate, etc.)		The survivors are
The species has become 'fitter'		Only those with those that taste
They mate and pass on their genes to the next generation – of many offspring, only a few will have the 'beneficial' genes		Over generation develops…

Task 3 – Anatomy of a horse

Horses have changed much over time. Look at the diagram below which s
the questions.



1. Circle the phrases which correctly describe the process shown in the d

Happened in hundreds of generations

Ho

Created new species

Each looked

Rock layers indicate age of species

2. Fill in the table to explain **what** changes have happened to horses ove
change might have happened.

Change	

3. Choose one of the changes, and explain how and why the population
horses with this adaptation survived, and the others eventually died o

*(Hint: you should be thinking about selection, and about the possible biot
environment.)*

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Extension: Of meerkats and scorpions (a case study in natural s

This meerkat is eating a scorpion. Scorpions
stinging tail that contains a paralysing venor
can inject into their prey, or use to deter pre
venom was once relatively weak, just enoug
a smaller prey animal, but has now become
stronger in response to predation by meerka

How could this resistance to venom have come about in the meerkat?

1. Using your knowledge of natural selection, com e the table below
population may have evolved to eat sco ns Use your answers to T
(Hint: what kind of conditions mi ve led meerkats to eat venomous

theory: how meerkats developed resistance t
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2. If the meerkat population became extinct, explain two changes that y
scorpion population.

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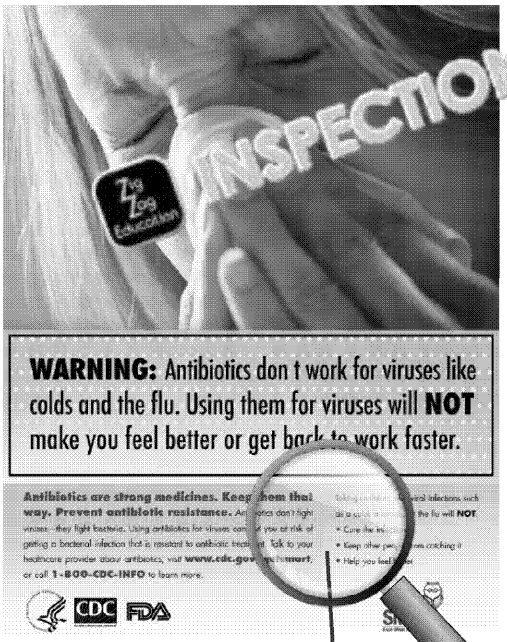
17: Evolution – Assessing th

Learning Objectives

By the end of this lesson, you should be able to:

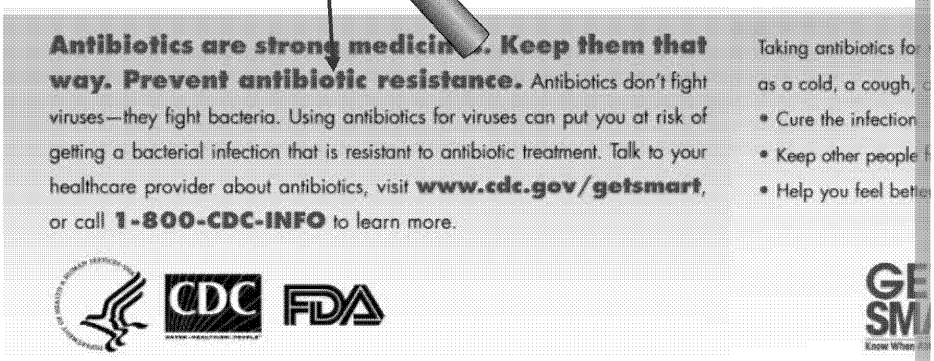
- ✓ Describe evolution as a gradual change in inherited characteristics over time that ma
- ✓ Describe the evidence for evolution with reference to antibiotic resistance

Background



This i a bl awareness poster ca use untreatable infection essential. Strict hygiene procedu try to restrict the spread of infect understand that antibiotics are o that the course of antibiotics mu bacteria time to **mutate** – which strains.

Scientists and medical professio possibility of **epidemics** caused b multiple antibiotics. In 2013, US multiresistant *Neisseria gonorrho* STI gonorrhoea) to be an urgent *Salmonella sp.* and *Mycobacteriu* increasingly resistant to known a



Public awareness of antibiotic resistance is impo

Global action plan

In May 2015, the World Health Organization endorsed a global action pla c the threat of antibiotic resistance. The plan inc five elements:

- Increasing public awareness of antibiotic resistance
- Promoting research into infectious disease and resistance
- Reducing the number of cases of infectious disease
- Promoting better use of antibiotics by doctors and patients
- Sustainable investment in global medicine

We can to assess arou

Task 1 – The evolution of super bacteria!

1. The diagram below right shows why antibiotic resistance can become
hospitals. Using the information you have read, together with your id
notes to explain the diagram.
*(**Hint:** you might guess that the different bacteria belong to different spec
diagram belong to the same species. The fully coloured-in bacteria have*

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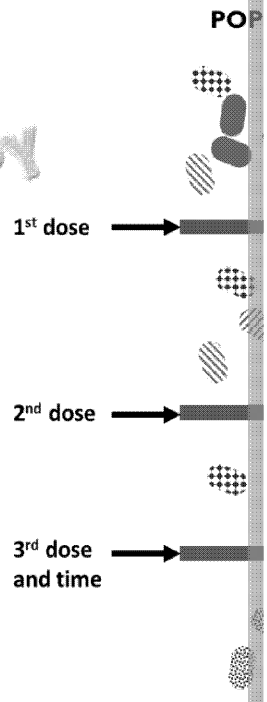

2. Why is it important that patients, as well as their doctors, are aware tha

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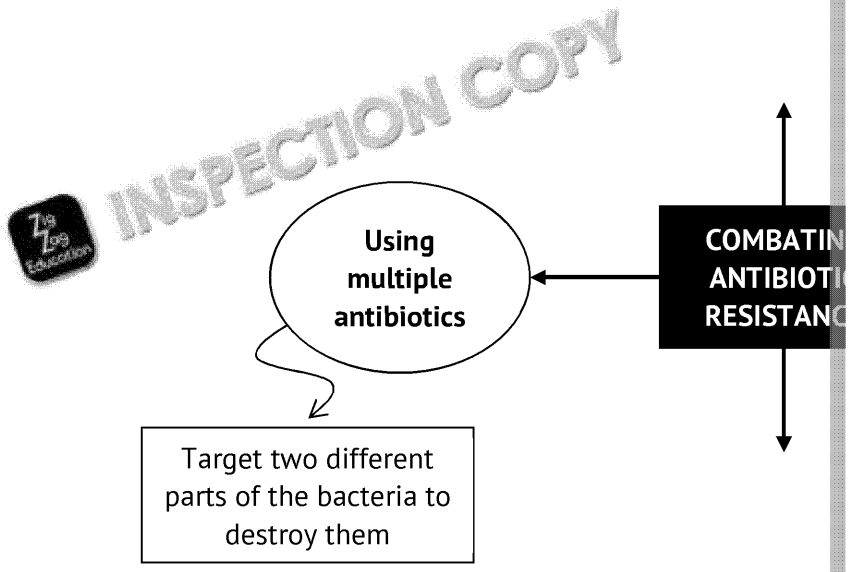
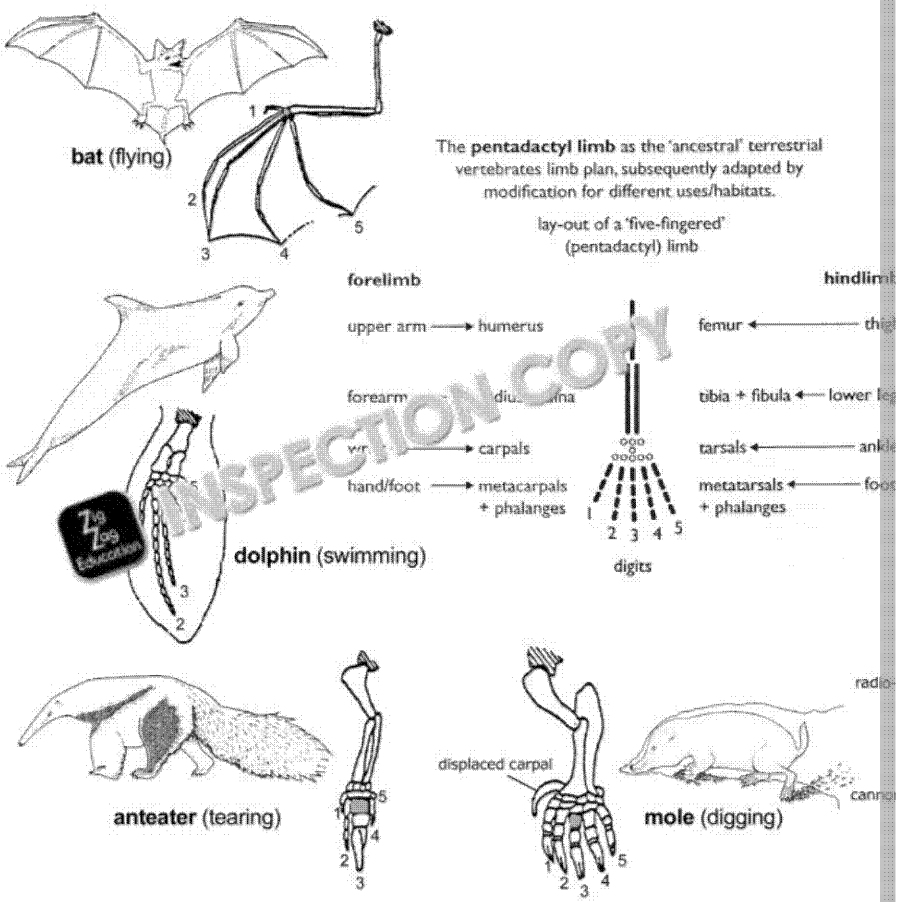
3. Draw a mind map to show the ways in which we can combat the probl
the information you have read and your own knowledge. The map ha



Task 2 – Out on a limb

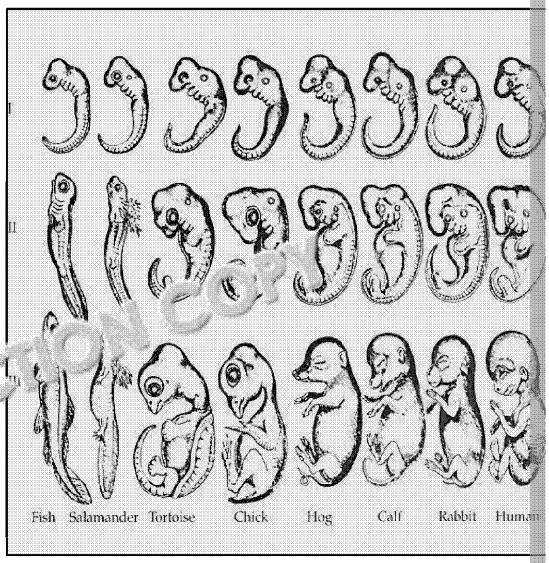


Look at the information above about the pentadactyl limb.

a) Write one paragraph to explain what this information shows about the
b) Write one paragraph to explain how this supports the theory of evolut
c) Try to identify two limitations of using this evidence to support evolut

Task 3 – Haeckel's embryos

These embryos were drawn by Ernst Haeckel (a German biologist) in 1879. patterns that you notice.



A student read in a textbook that:

'This shows we all evolved from a common ancestor.'

Write one or two paragraphs to explain whether you agree or disagree wit

Extension – Copycats in evolution

Sometimes organisms which occupy the same specific habitat type can de
the surface, even if they are not closely related. For example, bats and bir
they are not closely related, and other mammals do not have wings.

a) Why does this cause problems for evolutionary scientists? Why do yo
evolution?

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b) Try t think of as many examples as you can of similar features evolvi
closely related. Your answer could include drawings to help you expl
(3 = good, 5 = excellent, 7 = amazing)

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18: The Nervous Sys

Learning Objectives

By the end of this lesson, you should be able to:

- ✓ describe the structure of the nervous system
- ✓ describe the stages of a reflex arc
- ✓ explain the role of the nervous system in a coordinated response

Background

Our nervous system is made up of two parts:

1. the **central nervous system** (CNS)
2. the **peripheral nervous s** (PNS)

As shown, the cent h rv s system is made up of the **brain** and **spi d**. ogether, these control all of the actions that take pla ur body; these include basic functions such as digestion, breathing, heartbeat and sweating, as well as talking, listening, reading and moving.

PNS

Gangl

Nerv

The peripheral nervous system is made up of **sensory neurons** and **motor neurons**. Sensory neurons are connected to our **sense organs**, and motor neurons are connected to our muscles or glands so that we can feel changes in our environment (**stimuli**), and then respond to them. These include external stimuli and associated responses, such as stepping on a pin, and moving off it, or internal stimuli, such as feeling tummy ache and rubbing your tummy.

Remember – pain is good!

If we couldn't feel these changes, our body could be harmed because we wouldn't react. If we didn't feel a fire's heat, it would burn our skin and we wouldn't know!

Sense organs contain 'receptors' which receive signals and pass them on through sensory neurons to the CNS (brain and spinal cord). This is why sense organs are so important.

Task 1 – Sense match-up

Link the following organs with their functions. Two organs have more tha

Eyes	
gue	
Skin	
Ears	
Nose	

Task 2 – Think fast!

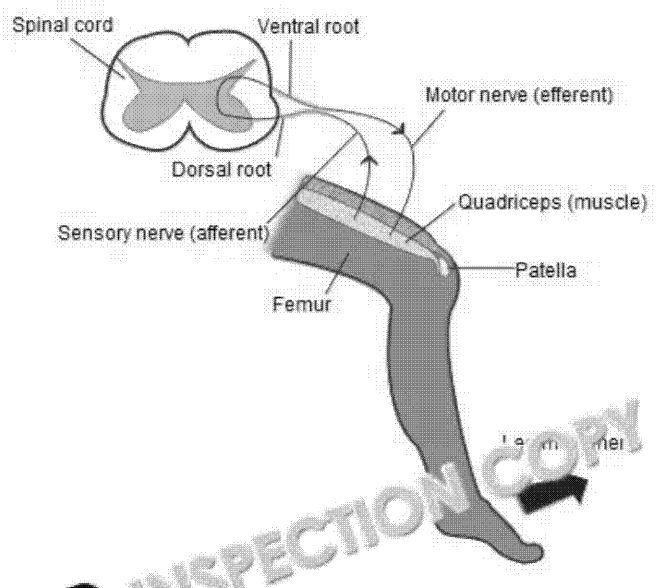
A reflex action is fast and automatic, and carried out without thinking. In t
mechanism. You also have voluntary control of some of these responses.

1. Complete the table below to show what your reflex action is.

Stimulus	Reflex response
Dust blows into your eye	
Dust goes up your nose	
You step on a pin	
W in bright light	
You hear a loud bang	
You are chopping onions	

In the 'knee-jerk' reflex, if the patella (kneecap) is hit in a particular place,
your lower leg move up and out. The same pathway is followed in every re

2. Using this diagram, place the following statements in the correct orde
for you.



1	S
	S
	M
	S
	R
	E
	R

3. Cor the following sentences to explain how your body responds
sharp object.
   - Pain r_ _ _ _ _ _ _ trigger n _ _ _ _ impulses that pass along the s_
   - In the spinal cord, the i_ _ _ _ _ _ is directed through relay neurons
   - The impulses travel to the e _ _ _ _ _ _ _ or muscle, causing it to co
     s_ _ _ _ _ _ _.
   - This is a fast and a_ _ _ _ _ _ _ _ response that bypasses the brain i
     quickest route, and acts as p_ _ _ _ _ _ _ _ against damage to the

4. What is a reflex action?

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5. What triggers a reflex action?

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6. What part of the CNS is first involved in a reflex action?

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7. How do reflexes help to pr[illegible]

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Task 3 – A day without reflexes

Write a short story called 'A day without reflexes', which explains what it w
reflex actions for a day. Your story can be written from your point of view,
write around 200 words.
*(Hints: think about all the things that people do routinely, such as cooking an
just one person who has lost their reflexes, or is it everybody?)*

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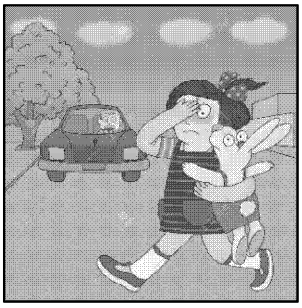
Extension: A nervy problem!



Trevor is driving down a residential road. A chil
Trevor brakes suddenly, and does not hit the chi
Trevor's eyes to his foot.

Describe the pathway taken by these signals. In
happening at each stage using as many keyword
this is a reflex action. Pay particular attention t
keywords.

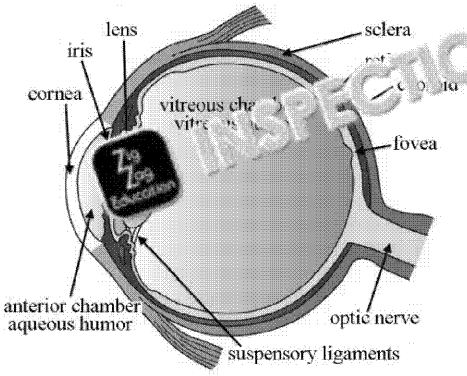
19: The Eye, Accommodation

Learning Objectives

By the end of this lesson, you should be able to:

- ✓ name the parts of the eye
- ✓ relate each part to its function
- ✓ explain how the eye focuses on near or distant objects

Background

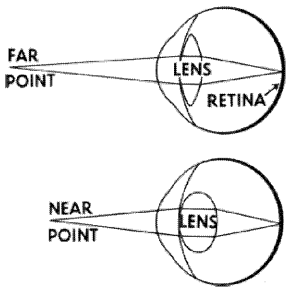


Structure of the eye

The eye is a complex structure ma
layers have separate functions; so
at the front of the eye. If the corn
scarred, making vision less clear.

You might think that the **pupil** is
in fact it is just a space between t
black because it is a direct windo
The iris consists of muscle which
pupil size – this controls how mu

The retina is a thin, light-sensitive tissue at the back of the eye, which con
'**rods**' – responsible for black-and-white vision – and colour-sensitive light
optic nerve is a bundle of nerve cells that carries signals from the retina to
processed so we know what we are seeing.



Accommodation

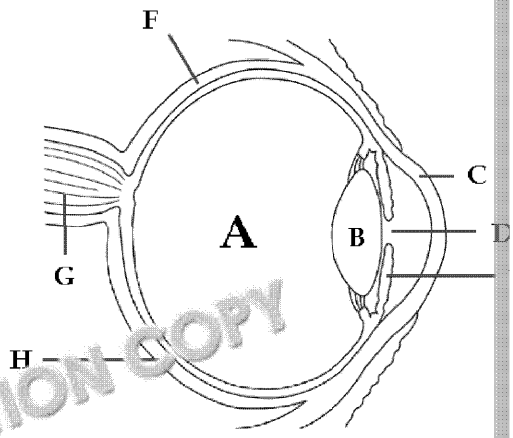
The **lens** bends, or **refracts**, light t
process occurs automatically thro
ciliary muscles attached to the **su**
lens in place.

- When the muscles relax, they
pulls the lens flatter so it can
- When the ciliary muscles con
and don't pull on the lens mu
objects.
- This change is called **accom**
with nking.

If there is a problem with the cilia es, then the **suspensory ligamen**
shape of the lens, and light is no focused correctly on the retina. This res
contact lenses or an operation are needed to correct vision. If the image is
person is said to be 'short-sighted', but if the image is focused behind the

Task 1 – Anatomy of the eye

Use the information on the previous page to label this diagram:



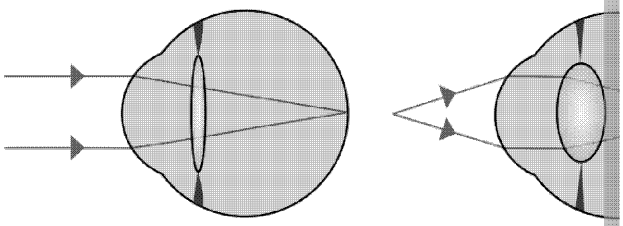
Task 2 – Parts working together

There are an awful lot of keywords in this topic, some of which you may ne
need to know, understand and be able to use them for your exam.

1. In the table below, fill in the gaps to make a glossary of the key parts
description of their shape or structure, as well as their function.

Key term	Description	
Ciliary muscles		Contract the lens
Suspensory ligament	Attached to the lens	
	The part of the eye which light reaches first	
Iris		
		Expands much li
	Contains lots of rod cells and cone cells	
	A huge cord made of many nerve cells	Carries
Lens	A convex disc	

2. Label the following diagram to show how the eye focuses on near and
keywords as possible.

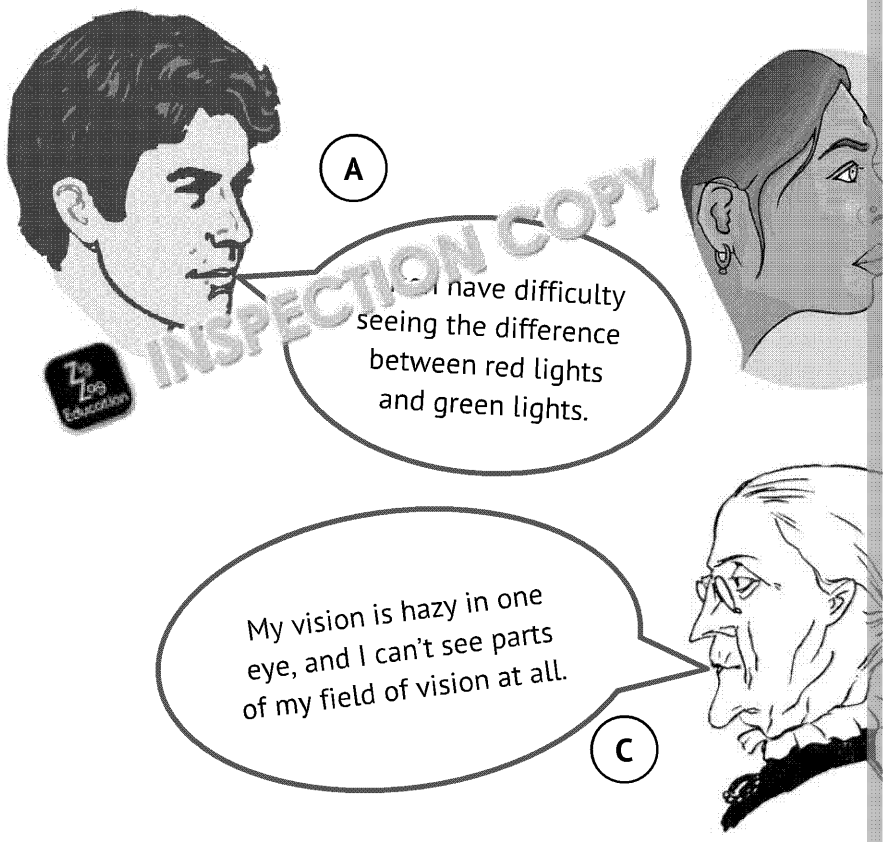


3. a) Fill in the missing words in the phrases describing how the eye fo
b) In numbers, put the sentences in order to describe how the ey
t, and then a distant object. The first one has been done for

	The suspensory ligaments are loosened, so the lens
	The ciliary _____ relax.
	The student is suddenly distracted by a helicopter in
	Light entering the eye is refracted less before it hits
	This whole process of the parts of the eye adjusting _____.
1	A student peers intently at a school textbook.
	The student strains to see the helicopter from a win
	The ciliary _____ contract.
	The suspensory ligaments are pulled tight, so the le
	Light entering the eye is refract more before it hit

Task 3 – Eye advice

Several patients are sitting in a waiting room, waiting for an appointment
doctor). From the patients' descriptions of their eye problems, see whethe
the eye each problem affects. Explain your answers. You should write you
the pictures.



Task 4 – Eye spy

The word search below contains 11 words or phrases relating to the eye.
all!

S W I U D S E Q K O S L
M H L R I S S V P X G O
N G O L I C P T Q T Q N
T A A R E S U P Q C G
R P A H L A N U S
R N S D N S V L I
Q T E G S I O D O E G
C R R H U T Y G R G N H
G V Y S E H Q D H J S T
E F C R P U P I L T A E
K S L L B R C X M J E D
R L L E C E N O C N Z D
C I L I A R Y M U S C L
A N I B S X U B Y W C V

Extension

A person who is short-sighted has eyeballs which are unusually long. Othe
similar way to other people's eyes.

1. Draw a diagram to show what might happen when light rays enter the
   sightedness.
2. Describe at least two treatments for short-sightedness, and suggest h

20: Homeostasis and C

Learning Objectives

By the end of this lesson, you should be able to:

- ✓ explain what homeostasis is with reference to the internal and external environment
- ✓ describe some examples of homeostasis in the body
- ✓ explain how insulin controls blood sugar levels

Background

In simple terms, **homeostasis** means to maintain a stable (or constant) inte
body temperature, **blood sugar** [illegible] ration, water content, salt levels an

The **brain** monitors temperature and levels of many dissolved substances as your blood passes through it. If levels (of blood sugar, temperature, etc.) are too high or low, it triggers certain responses that help to bring conditions back to the normal point, through a process called **negative feedback**. This acts like a thermostat in a fridge to turn mechanisms on and off, keeping your internal environment monitored and controlled at healthy levels. This can be drawn as a **negative feedback cycle**, as shown in Figure 1.

For example, if you're dehydrated, your water levels are detected as low, and this triggers the 'thirst mechanism' so you look for a drink (a **voluntary** response), but it also triggers your kidneys to produce less urine (an **involuntary** response).

Hormones and the regulation of blood sugar

Insulin is a protein hormone which controls blood sugar levels. When blood sugar levels get too high, for example after a big meal, insulin is produced in the pancreas and released. Insulin causes cells to take up the sugar molecule **glucose** and use it. It also causes the liver to convert glucose into **glycogen**. Glycogen is made up of lots of glucose molecules joined together, and stored for when some sugar might be needed in an emergency.

Insulin causes blood sugar levels to fall back to their normal level, and the body responds by stopping insulin production. Blood sugar levels will rise again if another meal is eaten.

Did you know?

There are two hormones involved in the regulation of blood sugar levels. **Glucagon** is released when blood sugar levels fall too low – the opposite of insulin.

Scientis
the 3D

Task 1 – Feedback in the body

Animals, including humans, have both **voluntary** and **involuntary** responses
Voluntary responses are ones which you generally have control over; for e
(normally) choose to go to sleep or stay awake.

Involuntary responses are not within your control; for example, if you are s

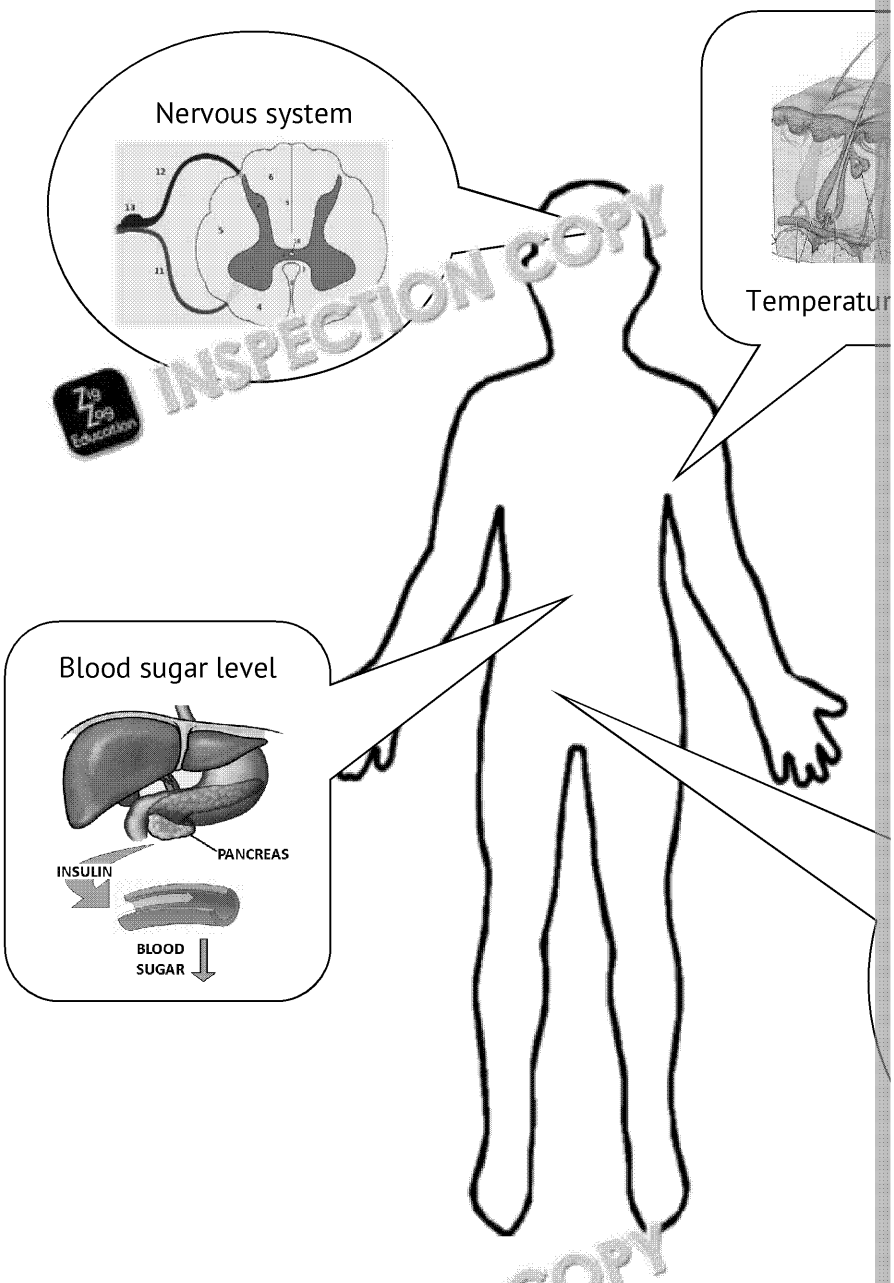
Homeostasis includes lots of examples of both involuntary and voluntary res
include high or low levels of sugar, oxygen, carbon dioxide, water and energ

Complete the table below to describe some scenarios which affect internal
response. The first row has been completed as an example.

Scenario	How do you feel?	How your body resp *(both involuntary an voluntary responses)*
1. You are under water and hold your breath.	Suffocated	**Involuntary**: chest tries expand / urge to brea **Voluntary**: resist the u breathe
2. You have been out running on a hot day.		**Involuntary:** **Voluntary:**
3. It's a cold day, and you've been drinking cups of tea all day.		**Involuntary:** **Voluntary:**
4. You've been sitting around eating sugary treats all day.		**Involuntary:** **Voluntary:**
5. You've been busy and have not had time to dri an all day.		**Involuntary:** **Voluntary:**
6. You were in a hurry and had no breakfast this morning. You've also done two hours of sport today.		**Involuntary:** **Voluntary:**

Task 2 – Control systems in a healthy bod

Using your textbook and your own knowledge, annotate the diagram with
the page (write each sentence next to the appropriate bubble). Some sent
aspect of homeostasis.



The concentration of the urine changes to help mana[illegible] this.	The kidneys are central to this.
Sw[illegible] is one example of this.	People with diabetes struggle to control this.
This involves electrical signals passing through the body.	The hypothalamus is involved.
The hormone insulin helps to regulate this.	The pancreas plays an essential role in controlling this.

Task 3 – Hormones and blood sugar – che

1. In humans, which hormone is released when blood sugar levels are hi

.....

2. What does it do?

.....

3. Where is glycogen made?

.....

4. Which organ makes insu...?

.....

5. The p...oduction of insulin in the body is an example of negative feedb...

.....

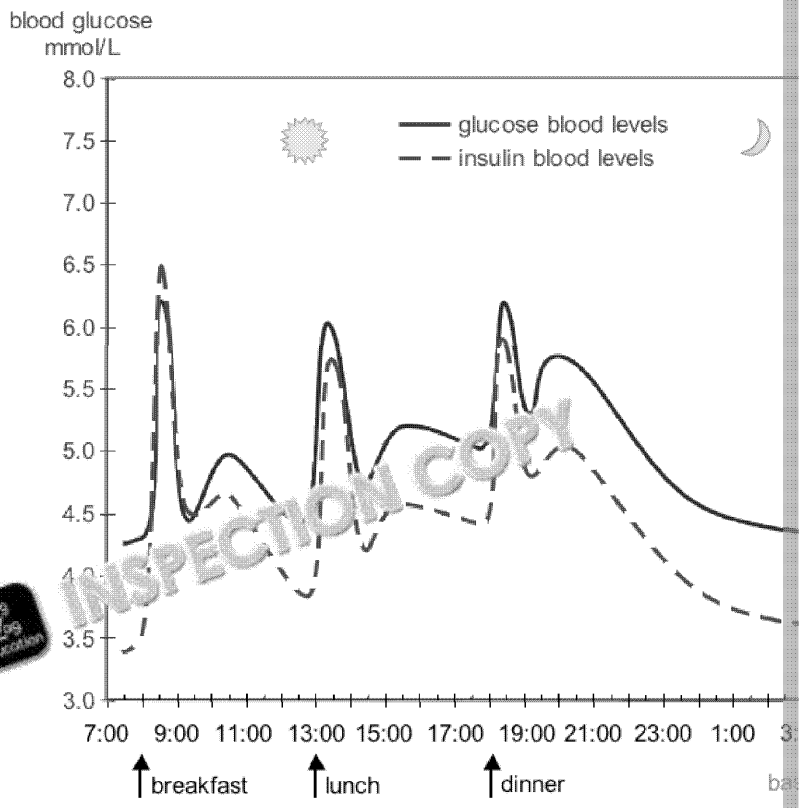
.....

.....

.....

6. Which process uses glucose in the body, and what is released during t...

.....



Extension:

Look at the graph above, and explain what it shows. Try to phrase your an and refer to specific times of the day in your statement.

For example: When blood sugar levels are high, insulin levels are also high person probably had lunch.

21: Temperature Control b

Learning Objectives

By the end of this lesson, you should be able to:

- ✓ describe the function of the skin in controlling body temperature
- ✓ explain how this is coordinated by the brain

Starter

Complete the following table with at least three observations about yourse
Think about your skin and body reactions

What happens when you feel hot?	What happ

Background

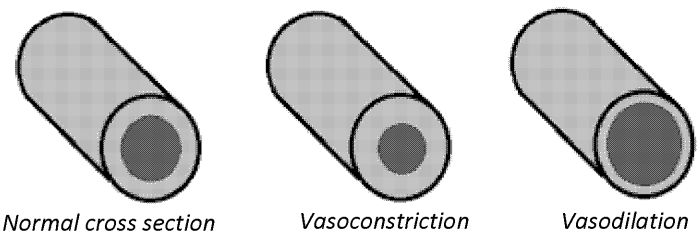
The skin responds to external temperature changes and can safely fluctuat
internal temperature stays fairly constant. If the body temperature falls to
'hypothermia' and this can cause the vital organs to shut down.

A rise or fall in body temperature is detected by temperature sensors in the **hypothalamus** of the brain (**thermoregulatory centre**). When it detects a rise in body temperature, nerve signals are sent to sweat glands in the skin. These open and release sweat onto the surface of the skin. As sweat evaporates, it carries some heat away from the skin to cause a cooling effect.

Epider
(outer l

Fatty t

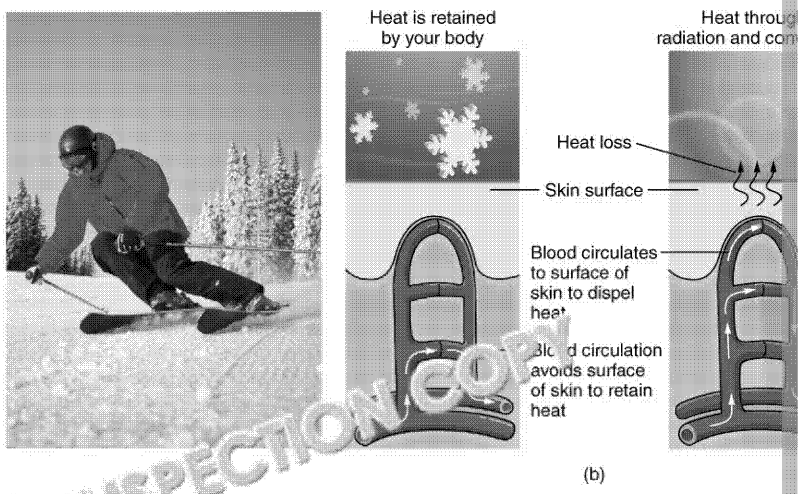
At the same time, the muscles around hair **follicles** rela , causing hairs to lie flat against the skin. Blood vessels also respond to internal temperature changes; when yo re cold, blood vessels widen (**vasodilation**) allowing more blood to flow to the skin's surface for heat radiation and when warm, they narrow (**vasoconstriction**) to keep the heat in. This is why your **extremities** (e.g. your nose) feel cold, but the **core temperature** is more constant.



Normal cross section *Vasoconstriction* *Vasodilation*

How the blood vessels adapt to temperature changes

Task 1 – Sorting the strategies



The information boxes below explain how the brain, blood vessels and sweat glands maintain body temperature constant, but they are in the wrong order. Organise the facts into the correct order to explain how the body heats up when cold, and cools down when hot.

Blood vessels increase in diameter (vasodilation)	Increases the rate of heat loss	
Body temperature decreases	Body temperature is falling below 37 °C	
Blood vessels decrease in diameter (vasoconstriction)	Decreases blood flow to skin surface	
Sweat glands produce more sweat	Sweat glands p… less swea…	
Decrease the rate of heat loss	Body temperat… rising above …	

The thermoregulatory centre in the brain monitors b…	
TOO COLD	

Task 2 – Essay time

Write a short essay to explain how the body maintains a constant tempera
weather conditions, and why this is important. You should write two or th

Some things you could consider in your essay:

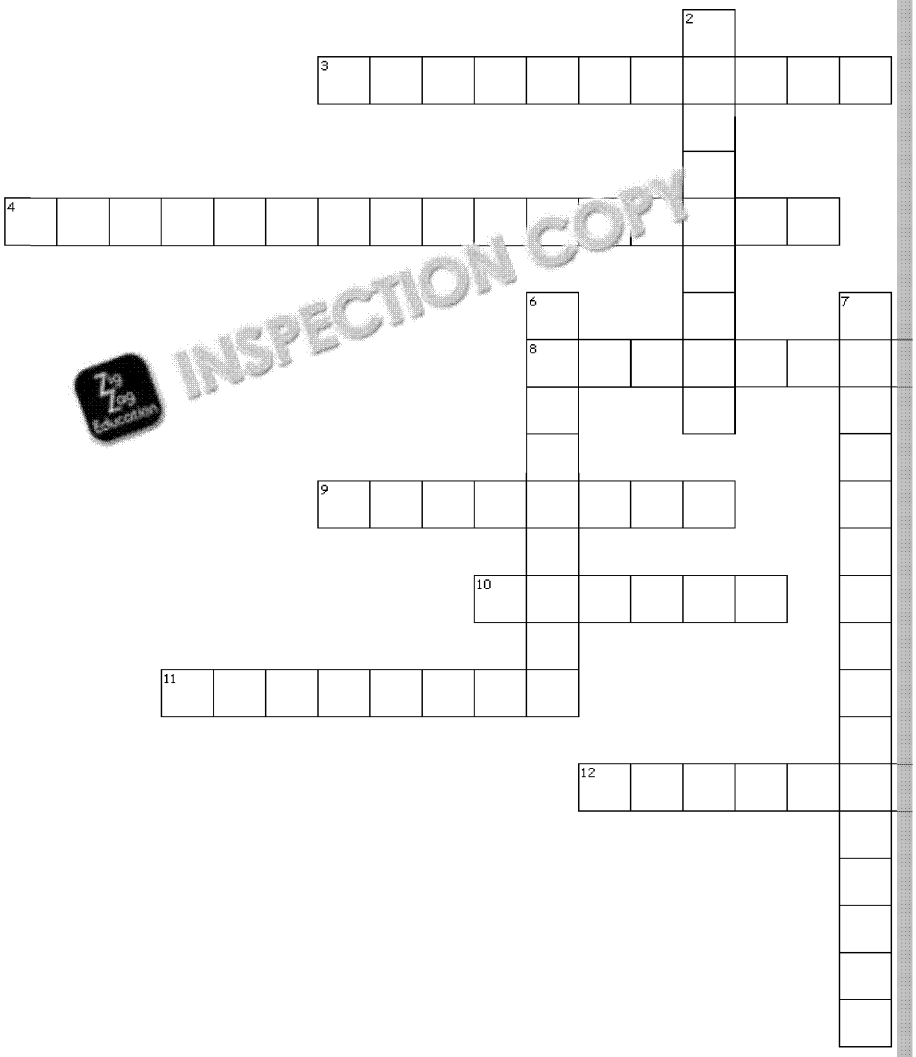
- How does the body respond when it is too hot, or too cold?
- How does each response work?
- What would happen if the body was too hot for an extended period?
- What would happen if it was too cold for an extended period?
- Which molecules are particularly affected by changes in temperature?
- Why can some parts of the body get colder t… ot…ers?

Introduction: Describe the main thi…g… …t your essay is going to talk abo…

Main body: Try to write at least three paragraphs to answer the questions … paragraphs each for hot and cold, for example.

Conclusion: Sum up your essay in a few sentences by explaining how you

Task 3 – Thermoregulation crossword



Across	
3. Keeping everything in the body constant (11) 4. This mechanism acts like a thermostat (8,8) 8. Part of the brain that maintains homeostasis (12) 9. When your sugar level goes too high or low, you have this disease (8) 10. To [illegible]nd, like a blood vessel, or like the pupil of the eye in dim light. (6) 11. You start _____ when you are hot (8) 12. This makes your skin appear red and flushed (12)	1. When your bod 33 °C, you hav 2. This process ca of your skin (9) 5. When you are (9) 6. Doing this gen (9) 7. This is the pro narrower, caus

Extension:

Go back through the tasks and background information and make your own and what each of them means.

22: Culturing Microbes using Ase

Learning Objectives

By the end of this lesson, you should be able to:

✓ describe and explain how to culture bacteria using aseptic techniques

Background

Microbiology is the study of **microorganisms**, which are only visible using a microscope. Microorganisms include **bacteria**, **proti** and some **fungi**, and occur everywhere in nature – air, water, soil, plants and in animals. Microorganisms improve the fertility of soil, aid digestion, fix nitrogen for plants, and produce oxygen. We use microorganisms in the production of cheese, bread and beer.

We can learn a lot by growing cultures of microorganisms and observing them. However, many microorganisms (particularly bacteria) divide very quickly, and this can create problems for us. For example, bacteria can divide out of control in our bodies, causing disease.

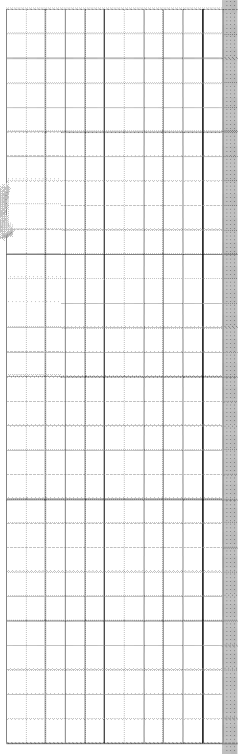
Task 1 – Perilous pizza

Imagine the scene: it's a warm summer's evening, and you're watching the friends. You order takeaway pizza, which arrives at 8pm. In the excitemen leftover pizza out on the side in the kitchen. It's a warm, humid night. Wh you get dressed and stumble downstairs at 8am, still half asleep. You spot so you grab the last couple of slices and eat them for breakfast... Should y

In ideal circumstances (warm, with lots of moisture and nutrients), bacteria ca to model the growth of a single bacterium on the pizza, which grows and divi

a) Fill in the table by doubling the number of bacteria each time.
b) Try to devise a sensible way of showing the results on a graph.

Time	No. of bacteria	Time	No. of bacteria
0:00	1	6:30	
0:30		7:00	
1:00		7:30	
1:30		8:00	
2:00		[illegible]	
2:30		9:00	
3:00		9:30	
3:30		10:00	
4:00		10:30	
4:30		11:00	
5:00		11:30	
5:30		12:00	
6:00			



TASK 2 – PRACTICAL ANALYSIS: CULT

Read the practical description below and answer the analysis and conclusi

Background and recap

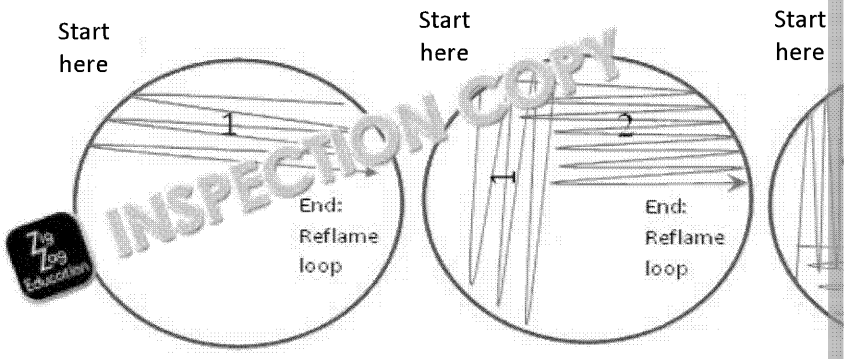
Microbes occur most abundantly if they have lots of nutrients, space and a
microbes in a laboratory, we need to provide a suitable culture medium wh
require; the medium usually used is called agar jelly, and the bacteria grov
Agar jelly contains water, sugars, proteins and other nutrients. Sometimes
nutrient broth can be used.

Equipment and tools for culturing bacteria m[illegible] b[illegible] **terilised** to ensure tha
on them are killed. An **autoclave** is [illegible] pressure cooker; it heats ec
pressure, to kill bacteria and pre[illegible]ross-contamination.

Metho[illegible]

Before s[illegible]g, the equipment is autoclaved and temporarily wrapped in c
sprayed with a disinfectant to sterilise them. Fresh gloves are worn by the
In research laboratories, special air filtering systems and sterile gowns are

- A Bunsen burner is set up at the workstation, causing hot air to rise ar
- Two Petri dishes are removed from their cling film, labelled A and B, a
- The bottle of (heated) liquid agar is opened, and the opening of the bottle is passed through the Bunsen burner flame (this is called 'flaming'), to kill or inactivate any pathogens which have landed on this part of the bottle.
- Each dish is opened while liquid agar is poured in, and then immediately closed by adding a lid.
- The agar is allowed to cool and solidify.
- An inoculating loop (a wooden rod with a metal loop at its tip) is used the tip of the loop is held in a flame until it glows, and then allowed to cool.
- The inoculating loop is then dipped into a bacterial sample; in this case, water from a stagnant lake is used.
- The inoculating loop is then used to inoculate plate A (Figure 2). The lid is then immediately placed over the Petri dish.



Step 1: Streak plate across the top sector, using continuous motion, but do not cross lines.

Step 2: Turn plate 90 degrees. Streak plate across the second sector, using continuous motion, making sure to cross into the first sector during the first streak or two.

Step 3:

Figure 2: Inoculating plate A

- At a later stage, a photosynthesising bacterium (*Microcystis aeruginosa*
plate A and then allowed to grow and divide in a nutrient broth, to ma
bacteria.
- Plate B is divided into four sections (Figure 3).
- Each section has a few drops of the bacterial culture added to it using
pipette.
- The culture is carefully spread across the agar plate.
- Four discs are placed onto the gel using forceps, one in each section.
disc has been immersed in a specific antibacterial substance (penicilli
bleach, for example).
- The plate is immediately sealed and turned upside down.
- The plates are incubated at room temperat[illegible] (20 °C) for 48 hours.
- The plates are retrieved and exami[illegible] while still sealed. Notes are ta
the bacteria-free 'zone' are[illegible] disc is measured for comparison.
antibacterial with [illegible] est effect will have the largest bacteria-fre
(zone of inhibition) around it.

Tasks

1. Write an equipment list for this method.

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2. Complete a risk assessment for this practical.

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Questions

1. What equipment is used to sterilise the equipment at the start of the e

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2. How does this equipment work?

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3. Why is it necessary to disinfect surfaces?

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4. Why are gloves worn?

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5. Why **flame** the inoculating loop?

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6. A student places the inoculating loop immediately into the bacterial s why this approach will not work.

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7. Why **flame** the mouth of the bottle?

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8. Why should the agar plates only be open while inoculating?

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.....

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9. Suggest why the plates are turned upside down while they are incuba

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10. Why are the plates kept sealed when they are being inspected?

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11. How could you s[illegible]y dispose of the cultures once the experiment is c

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12. If you wanted to examine the bacteria using a microscope, you would tiny pinpoint of the culture off the plate, and smear it onto a microsco stain the smear to see the bacteria.

    a) Is this safe?

    .....

    b) What precautions could you take?

    .....

    .....

    .....

Extension

Explain how this method could be modified to test how effective a newly d bacteria which are known human pathogens (for example, *Streptococcus* sp

.....

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23: Fighting Pathogens – Immun

Learning Objectives

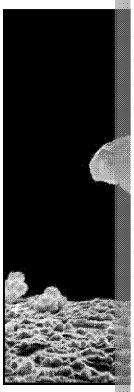
By the end of this lesson, you should be able to:

- ✓ describe how the body defends against infection using the words 'non-specific' and 's
- ✓ explain the role of the immune system in defence

Background

At any one time, our bodies are swarming with billions of bacteria and mar
The vast majority of those microorganisms will never hurt us. For example
can cause severe food poisoning, but some strains of the bacterium are les
happily living in our gut [illegible]

Unfortunately for us, however, there are microorganisms that can cause ou
us; they are collectively known as **pathogens**. Our bodies have a range of
these pathogens in their tracks – they are all **non-specific defences**, becau
general rather than specific types of pathogen.



Primary Defences

- Skin – has a tough outer layer of dead cells which physically stops pathogens
- Mucus linings – trap pathogens so they can be swallowed or destroyed by enzymes
- Tears/sweat/saliva – can contain pathogen-digesting enzymes
- Stomach acid – destroys most pathogens

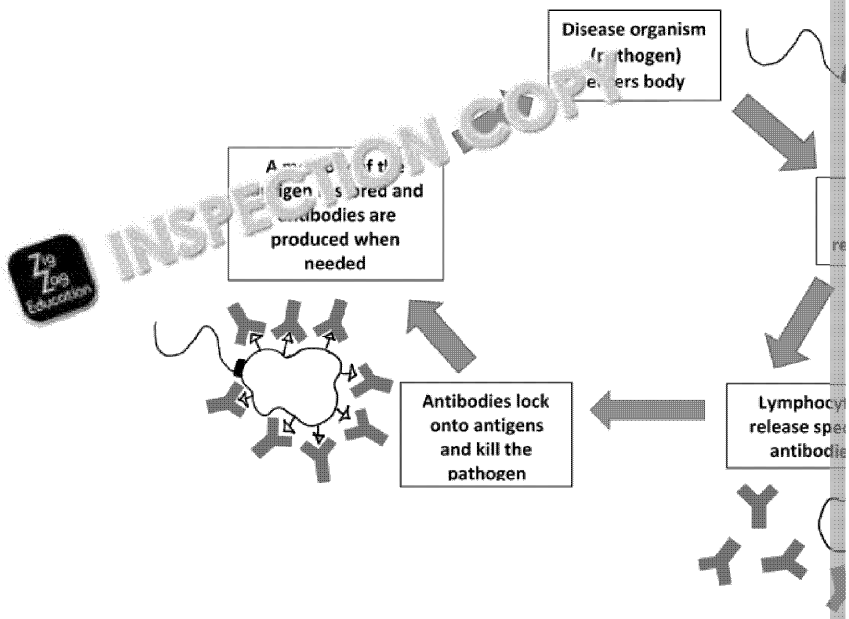
Blood and defences

Although blood appears red in colour, it is mostly made up of a yellow liqu
called **plasma** that carries dissolved substances, **red and white blood cells**
platelets as shown on the right. Blood looks red because of the billions of
rich red blood cells in it, which are needed in huge numbers to carry oxyge
around the body. There are far fewer white blood cells, unless you have an
infection, but there are different types of white blood cell.

Sometimes, our body's primary defences fail and pathogens get into our bl
tissue fluid or cells. The **immune system** is our body's second-line defence
against pathogens which have managed to breach our primary defences. I
two different types of response, both using **white blood cells**:

1. Non-specific – this involves white blood cells called **phagocytes**.
   - Phagocytes have a lobed nucleus.
   - They are like cleaners – they destroy pathogens by **engulfing** and
     the harmless waste.
   - They act in the same way against our own dead cells, so they are
   - This form of defence quickly destroys individual pathogens, but it
     infection.

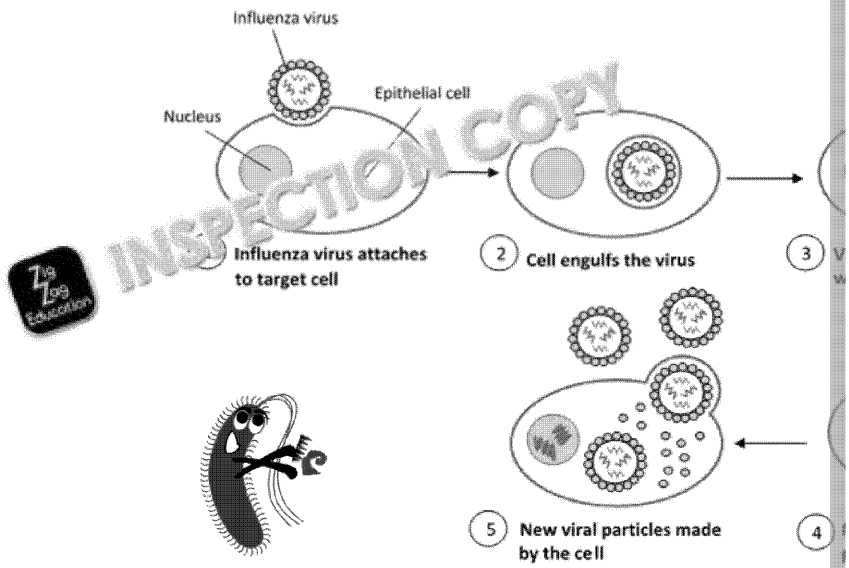
2. Specific – this involves white blood cells called **lymphocytes**.
   - Lymphocytes normally have a large, round nucleus.
   - They take longer to act than phagocytes.
   - Lymphocytes recognise specific molecules called **antigens** from e
     then produce particular **antibodies** to fight them (like a locksmith
     lock).
   - Once they have the code, it is stored in a special 'memory lympho
     again, the response is much faster. This means you're immune to



Bacterial and viral infections

Bacteria and viruses enter the body in the same way, but have different wa
produce **toxins** that make us feel unwell, so our specific antibodies often w
effect. The antibodies can also kill the bacteria. Finally, antibodies help t
so they can engulf and digest the bacteria more easily.

Viruses are harder to kill as they are harder to reach; they are much smalle
our cells as shown in the picture below. This means that, once inside, they
phagocytes and antibodies! Some viruses lie hidden and **dormant** for man
difficult to fight off.



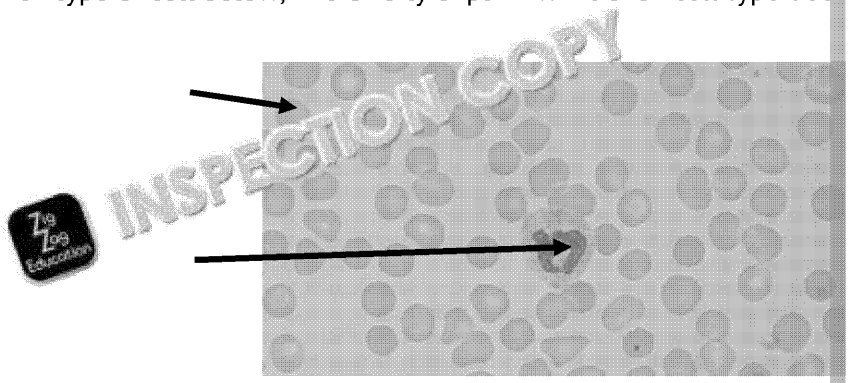
Task 1 – Key points

You have just read a lot of information. Go back through the background i
underline what you think is the most important information.

Task 2 – Cells of the blood

The image below is from a microscope and shows a blood smear that has b
more clearly; you can see **red blood cells**, as well as a **lymphocyte** and a **ph**

Label each type of cell below, and briefly explain what each cell type does

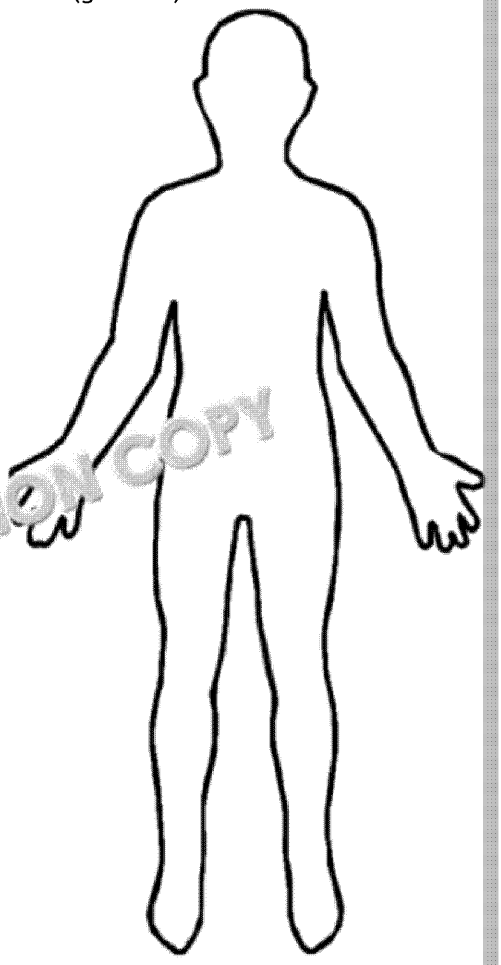


Task 3 – Invaders!

Read the background information carefully, and then:

a) draw arrows on the outline of the human body to show where microbe
in the body

b) label the body with its non-specific (general) defences – the skin is or



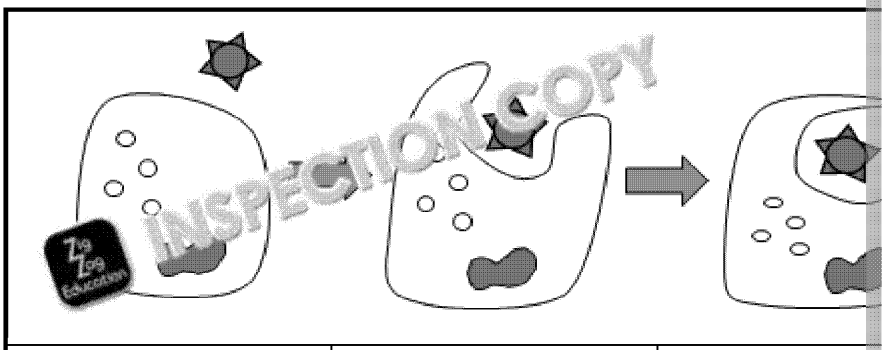
Task 4 – The immune system – checkpoint

1. State which type of blood cell has a **specific** response, and which has a

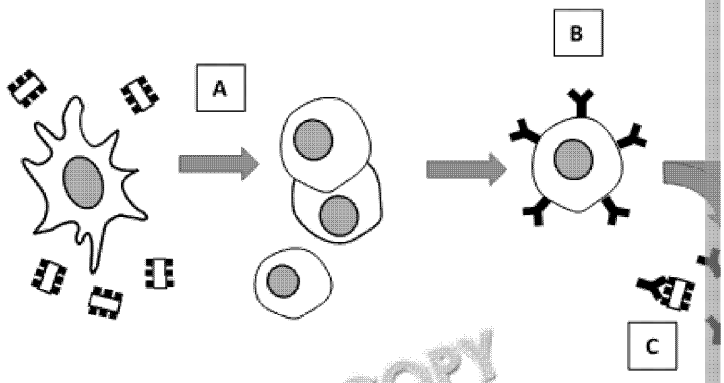
   Specific: .....

   Non-specific: .....

2. Look at the diagram below. What type of blood cell is this showing? D each stage using as much detail as you can.



3. Label the diagram below to show cells and molecules/structures. Exp stage (A–D), and why this response takes time.



A: .....

.....

B: .....

.....

C: .....

.....

D: .....

.....

4. Match up the body part with its NON-SPECIFIC defence mechanism, u

EYES	Stic
CUTS	
STOMACH	A
EAR CANALS	Pha
SKIN	Pla
AIRWAYS AND OPENINGS	Wax
BLOO	Salt
MOUTH	

5. What do we mean by a 'specific response' and a 'non-specific response

.....

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6. The following table outlines the processes involved in developing im
Your task is to number them in the order that makes the most sense.

	The virus enters a cell in the airways and hijacks the nuc
	On entry into the bloodstream, many copies of the virus
	The antibodies are specific to those antigens and stick to and making it easier for phagocytes to find and destroy t
	A child breathes in cells enclosed in a water droplet.
	You are now immune to that strain of the viral pathogen.
	The cell bursts and releases copies of the virus into the b
	Once the lymphocytes have the antigen's code, they can complementary shape to the antigen – this can take a fe
	A special memory lymphocyte is also created which will to guard against future infections.
	The cell's nucleus is reprogrammed to make copies of the
	Lymphocytes are alerted and set about obtaining the ant

Task 5 – Immune system recap quiz

Question	A
1. Which are bigger, bacteria or viruses?	
2. What are pathogens?	
3. What is a pandemic?	
4. What is on the surface of pathogens?	
5. How do bacteria make us ill?	
6. How do phagocytes fight infection?	
7. How do viruses make us ill?	
8. How do lymphocytes fight infection?	
9. Are all bacteria pathogens?	

Extension

Scientists can produce 'fake' antibodies which match a specific antigen, if t
an infected pathogen. Suggest the purpose of this technology, and why it

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24: The How and Why of Va

Learning Objectives

By the end of this lesson, you should be able to:

- ✓ explain how vaccines work inside the body to prevent illness
- ✓ explain how vaccination programmes prevent the spread of disease

Background:

Most children that are born in the UK are vaccin[illegible] to protect them from these include polio, injections such as m[illegible]as es[illegible]mps and rubella (MMR a few.

Parents can refuse [illegible]s v[illegible]cinations, but they will be leaving their child e our envi[illegible]nm[illegible]nd easily caught. They can cause very bad symptoms th unprotec[illegible]erson disabled, so, by having the vaccine, they are being give immunity to that pathogen.

Vaccines are made using part of the bacteria or virus that the vaccine aims someone is vaccinated, they are given a weakened form of the pathogen, v spread disease. Alternatively, they might be injected with a dead pathoge pathogen.

Although phagocytes will destroy some of the pathogens, the body still ha antigens to match the antibodies on the pathogen. Special cells called 'me the information on how to produce these antigens in case the pathogen is

Task 1 – How vaccines work

1. The following instructions for making a vaccine, and developing immu Your task is to number them in the order that makes the most sense.

	On entry into the bloodstream, many pathogens are dest
	The pathogen is isolated, and weakened or killed.
	This is then injected into a healthy person.
	The individual has be[illegible]me i[illegible]mune to the pathogen.
	Th[illegible]a[illegible]dy is specific to a particular antigen, and stick
	A special memory lymphocyte cell is created which will s
	A lymphocyte recognises one of the pathogen's antigens, the blood.
	A small amount of pathogen material is made into a vacc

2. Draw three or four labelled diagrams to go with the information on th
vaccine works, starting with taking the vaccine.

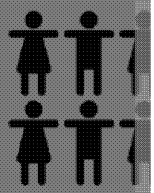
3. Explain why one vaccine is not effective against all infectious disease

Task 2 – Vaccination programmes

FAST FACT

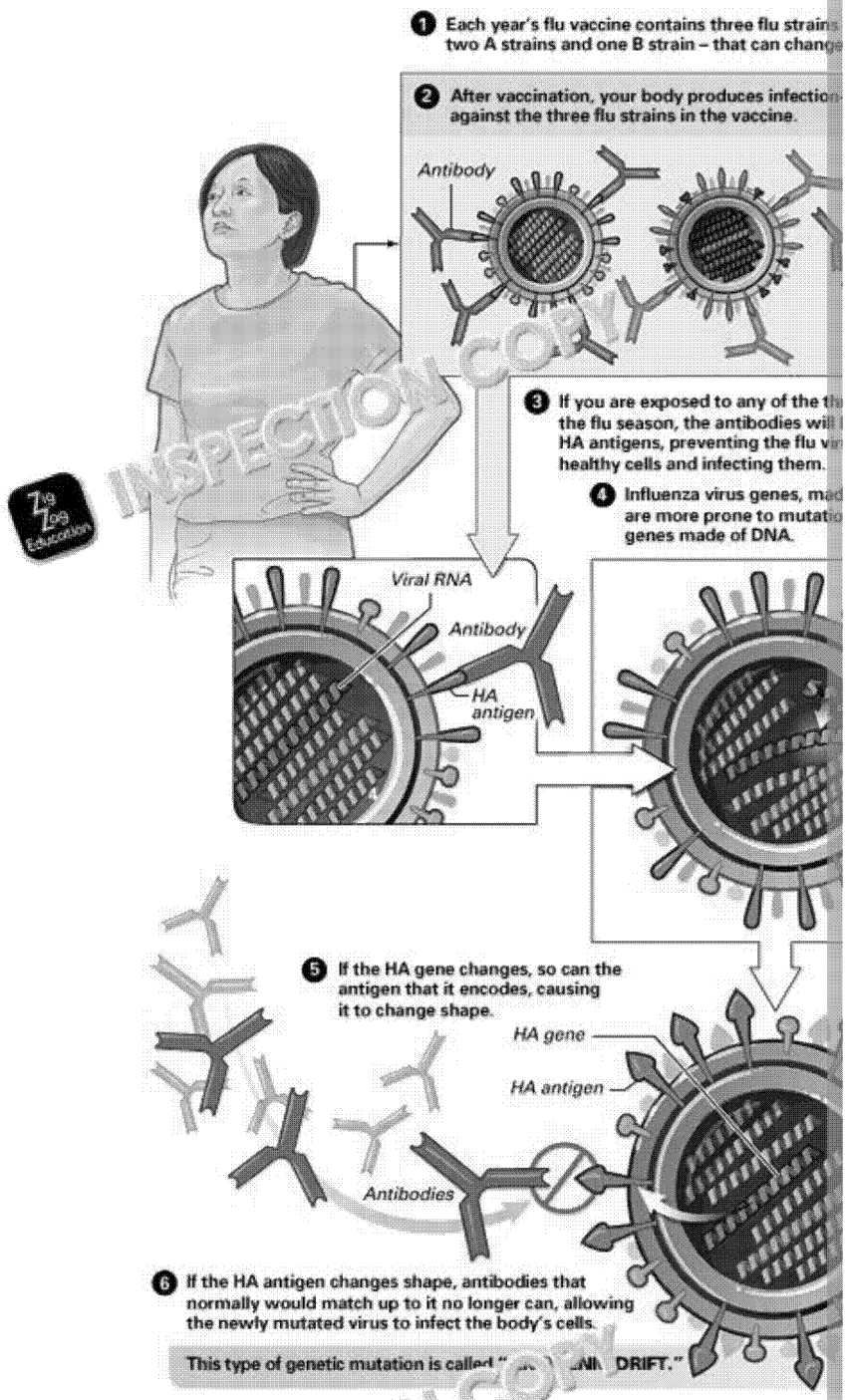
The herd immunity threshold (the percentage of the population that needs to be immunised for the whole to be protected) for a very infective disease like measles can be as high as 94 per cent, whereas for mumps it could be as low as 75 per cent.

Source: Centers for Disease Control, USA
www.bt.cdc.gov/agent/smallpox/training/overview/pdf/eradicationhistory.pdf



1. Read the information above, and look at the diagram above and at Fig
diagrams help to explain the principle of herd immunity?

2. The poster below shows some information about the flu vaccine. If y
unfamiliar words; then, answer the questions below.



a) Choose a word fr
which matches each of these des
i) The g
terial found in an influenza virus.

.....

ii) A subtype of a virus, such as the influenza virus.

.....

iii) Changes in the sequence of the genetic material.

.....

b) How do antibodies help to fight the flu virus?

.....

.....

.....

.....

c) Why does the body make so many different types of antibody?

.....

.....

.....

.....

3. The measles vaccine and smallpox vaccine have been effective for ma
why it is so difficult to make a flu vaccine that lasts for several years?
to help you.

.....

.....

.....

.....

.....

.....

.....

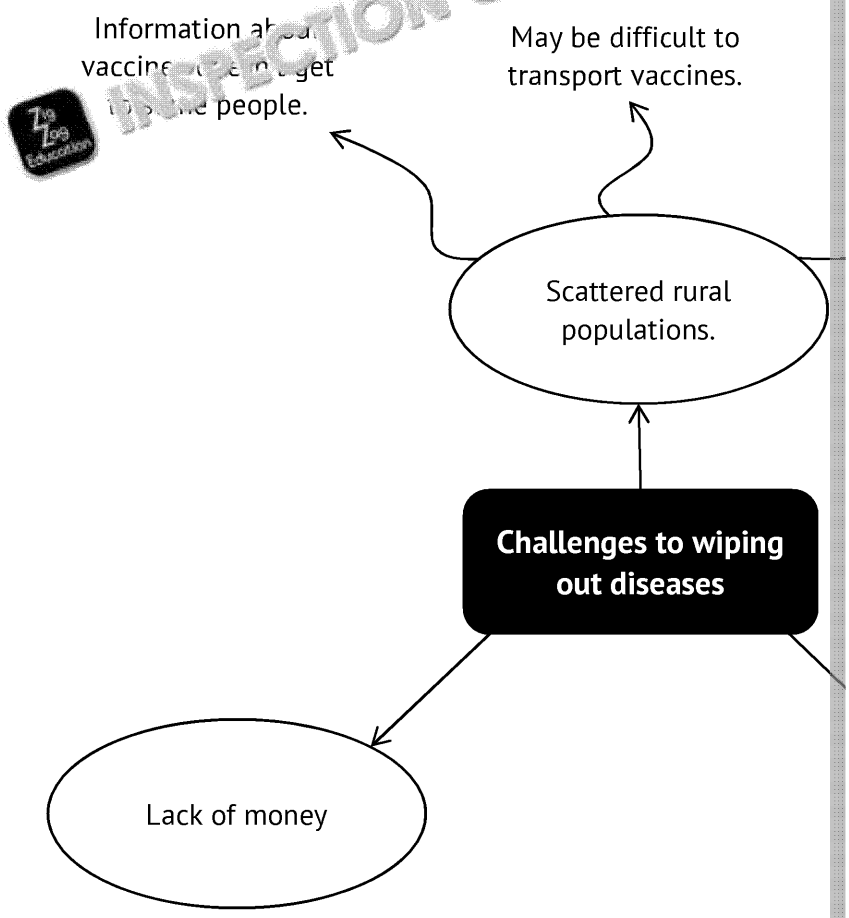
.....

Task 3 – The quest to destroy diseases

Many human diseases have had some form of effective vaccine produced a
has ever been completely wiped out in the human population – smallpox.
nearly been completely wiped out several times, but it keeps recurring, an
people in Afghanistan, Pakistan and Nigeria each year.

Why do you think it is so difficult to use a vaccine to wipe out a disease? T
reasons.

1. For each reason on the mind map, add an explanation (the first one ha
2. Add to the mind map, by suggesting other r... vhy completely wi



Extension

1. When producing viral vaccines, scientists sometimes only include a sp
your knowledge of pathogens and the **immune response**, try to explai
works.

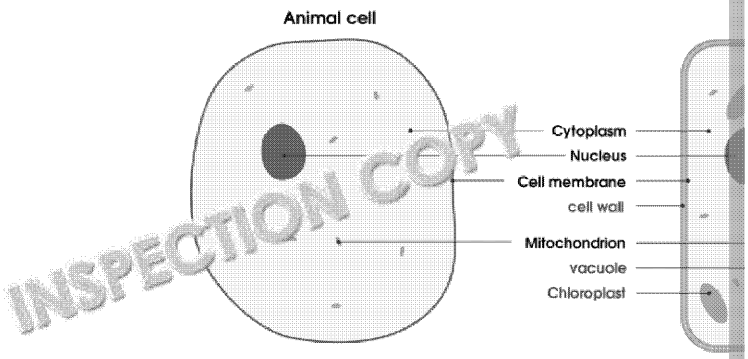
   You should include concepts such as **antigens**, **antibodies**, **specific sha**
so on. Remember to use as many keywords as you can. Alternatively,
storyboard, on plain paper.

2. New vaccines are being made all the time, but they are very expensive
weighed against the benefits. As a result, many vaccines are not giver

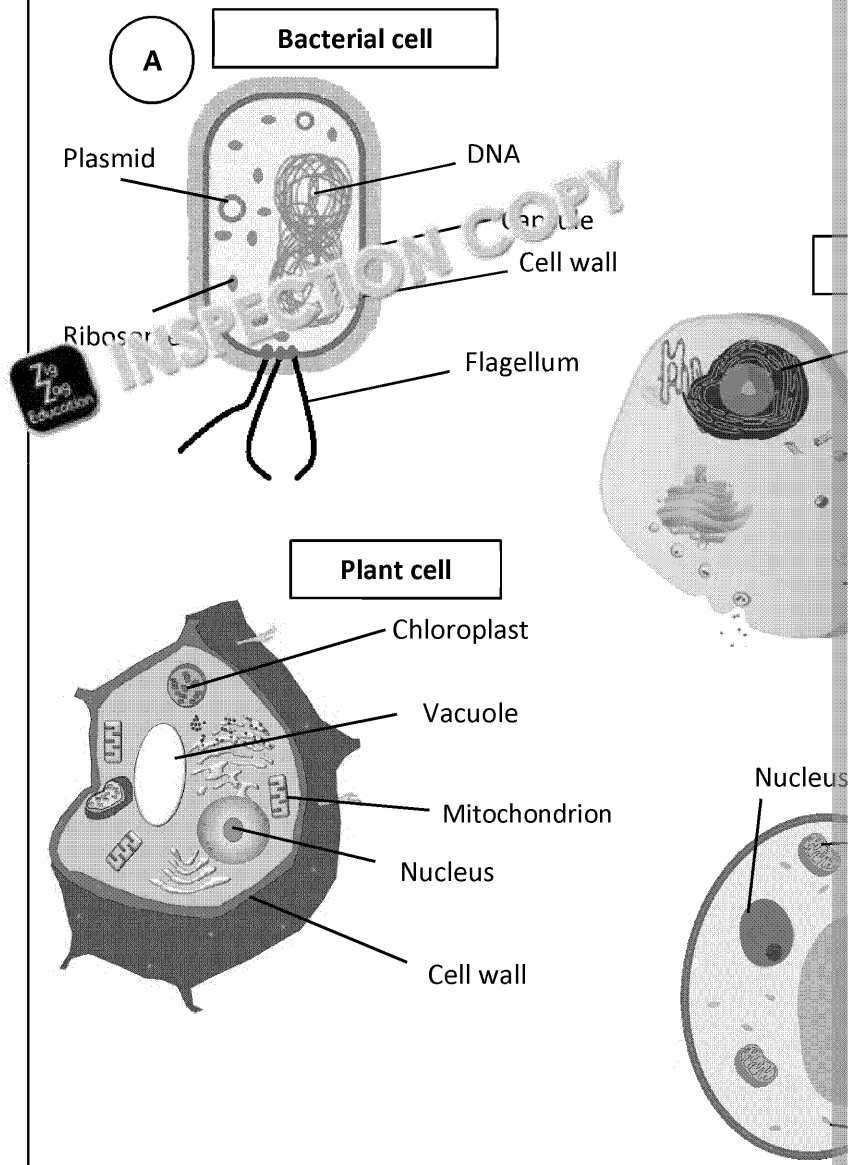
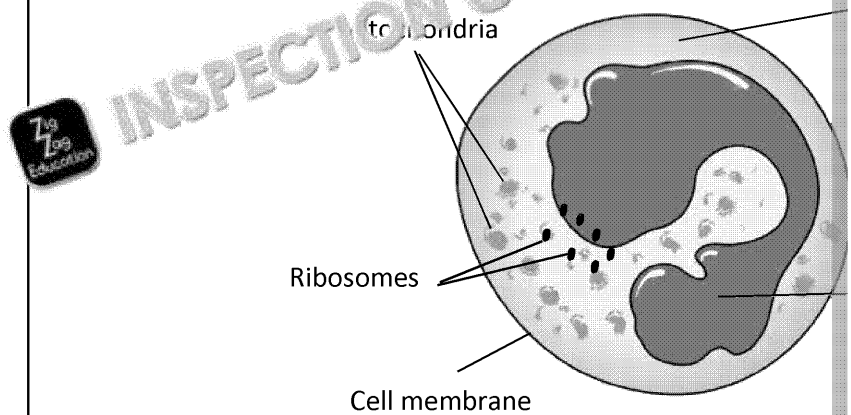
   For example, in the UK the NHS only provides the seasonal flu vaccine
young children, pregnant women, and adults over 65 years of age. Ot
vaccine.

   Explain whether you think this decision is right or wrong. You should
argument, and think about what you have read about the flu vaccine.

Answers

Lesson No.	Answers
1	**WHAT'S IN A CELL?** ***Task 1***  ***Task 2*** **Chloroplast** — Contains chlorophyll, a molecule for photosynthesis. **Cell wall** — The outermost structure of a pla from pathogens and stops it from **Cell membrane** — This thin layer controls which sub cell. **Cytoplasm** — This fluid fills the cell, and is mad various molecules. Reactions hap **Vacuole** — This is a permanent storage orga cell sap. **Nucleus** — The control centre of animal and found. **Mitochondrion** — The factory of the cell, where glu respirati… produce energy. ***Task 3*** Accept the followi… ar… …s or the reverse argument for differenc

Similarities	Diffe
Both have a cell membrane	Prokaryotes have no 'true'
Both cell types have cytoplasm	Prokaryotes have no mito
Both cell types have ribosomes	Prokaryotes sometimes ha
DNA is found in all cells	Prokaryotes sometimes ha
	Prokaryotes have a cell wa
	All prokaryotes have a cell

Lesson No.	Answers
1	***Task 4*** A is a prokaryote as it doesn't have a nucleus, and its DNA is in the c three cells are eukaryotes because they each have a nucleus as wel such as mitochondria/chloroplasts.  ***Task 5*** a) labels as follows: 

Lesson No.	Answers
1	b) Adaptations: • Many mitochondria to release energy needed for moving antibodies • Many ribosomes to make proteins, including enzymes and • Cell membrane to control movement of substances secret • Nucleus to control the production of proteins needed for pathogens c) Differs from: i) Plant cell – by not having chloroplasts / a permanent vacuo ii) Fungal cell – by not having a cell wall (of chitin) or large va
2	**SIZE, SCALE AND SURFACE ARE** ***Starter*** *q... s...* 1. A unicellular organism is made up of only one cell. 2. A multicellular organism is made up of many cells / layers of ce 3. Bacteria / protoctists / protists / some fungi are unicellular, wh are multicellular. 4. There are five kingdoms. 5. Prokaryota and Protoctista contain unicellular organisms, and a multicellular organisms. ***Task 1*** 1. We need lungs as we have a small surface area to volume ratio, as that all need oxygen. Diffusion would be too slow to reach all the cells would die, so the lungs are inside the body, connected with t the oxygen to diffuse faster into our blood. An amoeba is only ma large enough surface area to volume ratio to allow enough oxyge 2. Plants with deep root networks are able to grow large because over which to absorb the water and nutrients they need. The l rate of transport of nutrients and water. Plants with a large vo for water and nutrients, and only a root network is sufficient to contrast, small plants such as mosses can get enough water an complex network of roots. 3. Blood vessels are needed to move substances (including oxyge will be very active and will need lots of oxygen and sugar for re to have a constant supply of sugar and oxygen, and also to hav constantly so they do not build up. Ha... lots of tiny blood ve distance between the blood ve... and cells is never large. So lots of small blood ve... clude: muscles, lungs, kidneys, lun ***Task 2 – ... analysis: Effect of size on uptake by diffusi***

A Length of side of agar cube (cm)	**B** = 6 × A^2 Total surface area of cube (cm^2)	**C** = A^3 Volume of cube (cm^3)	**D** = B/C Surface area to volume ratio
0.5	1.5	0.125	12
1.0	6	1	6
1.5	13.5	3.375	4

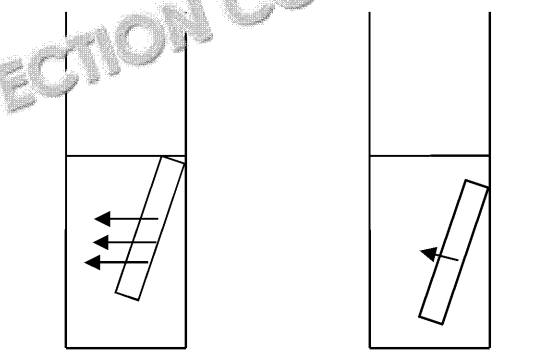
Lesson No.	Answers
2	***Questions:*** 1. Run each experiment separately so that the stopwatch can be touches the HCl. Use colorimeter to determine change in colour, rather than est Repeat the experiment with smaller intervals between cube siz Repeat the experiment several times to improve reliability. 2. Percentage increase = (13.5 – 1.5)/1.5 × 100 = 800 % increase in 3. 1/0.125 = 8. The medium cube has a vol e which is eight time 4. As the side length of the cube increases, the surface area to vo 5. As the size of the cube increases, the rate of diffusion decrease - perature – diffusion happens faster at higher tempera - Diffusion distance – diffusion happens more slowly if the d - Particle size – larger molecules will tend to diffuse more sl blocked by the agar - HCl concentration – the rate of diffusion will be quicker if diffuse 7. - Large organisms are made of many small cells which all re - Large organisms are usually more active so would require - Large organisms have a small surface area to volume ratio get all the nutrients they need, or get rid of all their waste not enough surface area for each cell. - Diffusion distance is quite large in a large organism; nutrien - Special transport systems (with large surface area) are nee nutrients/oxygen and get rid of waste products. ***Extension:*** - Leaves have a very large surface area and tiny volume, maximis (and absorption of light energy for photosynthesis). - An African elephant has large ears to allow it to lose heat in ho area means more heat energy is transferred from the blood to - Roots tend to have a big surface area and small volume to max increase uptake of mineral ions.
3	**ACTIVE AND PASSIVE TRANSPO** ***Task 1*** 1. active transport – acti e 2. osmosis – pa ive 3. diffu ion – p sive a ve transport – active osmosis – passive 6. diffusion – passive 7. diffusion – passive 8. active transport – active ***Task 2 – Practical analysis: Investigating the effect of temper*** Prediction: as time goes on, more glucose will diffuse out of the Vis Benedict's solution will turn from blue, through mint, green, yellow (brick) red.

Lesson No.	Answers
3	**Analysis and discussion:** 1. Out of the Visking tubing and into the water 2. Higher concentration of sugar in the tubing and lower/none in … diffuse from an area of higher concentration to an area of lowe… 3. Independent: temperature Dependent: colour of solution / concentration of sugar 4. Suggestions from the following, but accept other sensible ideas - Use a probe or sugar detector, or … her method that wi… concentration of the suga… soluti… - Label each tube b… a… in case it gets mixed up in the… - Use a fres… pi… each time 5 ml of water is drawn from… - U… wat… bath to keep the beaker of water constant at… As time passes, more sugar moves from the tubing into the wa… than at 20 °C, since the Benedict's test detects higher glucose l… time has passed. This means that the rate of diffusion is faster… 6. The colour of the Benedict's solution will change more quickly … intervals than it does at 20 °C, but slower than at 60 °C. 7. Use differently shaped partially permeable containers (such as … chosen to represent different surface area to volume ratios. ***Task 3 – Practical analysis: Observing osmosis in potato tissu…*** 1. To keep surface area and volume as consistent as possible in al… because surface area and volume affect the rate of diffusion/o… between tubes, the results will not be reliable. 2. a) i), ii)

Potato in	Starting mass (g)	Ending mass (g)	+ /
Concentrated salt solution	3.2	2.5	
Dilute salt solution	3.4	3.3	
Distilled water	3.1	3.7	

b) The potato chunks have different initial weights. Converti… values which aren't dependent on the initial weights of th… can directly compare results.

3.



Concentrated salt solution

Dilute salt solution

Lesson No.	Answers
3	4. Water entered the potato chunk by osmosis in the distilled wat had more solutes than the pure water around it. Therefore, th firmer. Water left the potato chunk by osmosis in the tube of concentr potato chunk had a much lower concentration of solutes than t the potato shrank and became less firm. 5. This suggests that the concentration of salt was similar to the c potato; therefore, there was no NET movement of water (or th into and out of the core). ***Extension:*** The effect of [illegible] concentration on red blood cells: • H[illegible] – the concentration of water in the plasma is greate moves into the cell, causing it to burst/become 'haemolysed' (a animal cell). • Isotonic – the plasma concentration and cytoplasm concentrati movement of water into or out of the cell. • Hypertonic – water is leaving the red blood cell because there i inside the cell and a lower water concentration in the plasma, s causing it to shrink/become 'crenated'. The effect of solution concentration on cells: • Hypertonic – the concentration of water in the solution is great the cell so water moves into the cell, causing it to swell and be is a protective cell wall. • Isotonic – the solution concentration and cytoplasm concentra movement of water into or out of the cell. • Hypertonic – water is leaving the plant cell because there is a g the cell and a lower water concentration outside, so water mov membrane to pull away from the cell wall. Cell walls in algae: Algae live in water, and the concentration of solutes in the water m concentration in the surrounding water / outside the algal cell is lov osmosis, and the cells may burst. The cell wall reduces this risk.
4	**WORKING WITH ENZYMES** ***Task 1*** 1. catalyst[illegible] 2. [illegible]ed u[illegible] 3. u[illegible]d 4. specific 5. active site 6. specific 7. large 8. small 9. large 10. damaged 11. temperature and 12. denatured 13. substrate ***Task 2 – Practical Analysis: Breakdown of hydrogen peroxide*** 1. While hydrogen peroxide can be harmful, water and oxygen ar not harmful to the body and can be easily used or disposed of. 2. Should include: - thermometer, ruler, pipettes, 1 cm^3 syringes

Lesson No.	Answers
4	3. Controlled: amount/concentration of acid/alkali used; amount water baths; type of sample (i.e. celery, liver, potato purée) us substrate. All of these are controlled variables, because they a experimenter before the experiment starts, and the values of e Not controlled: room temperature (this is not controlled – it's starts and may vary from time to time). Height of foam (this is to measure). 4. Safety precautions should include: • Wear goggles to protect eyes agains[t] acid / hot water • Move test tubes carefully f[rom] w[ater] bath (65 °C), using t • Wear gloves and ha[ndle] h[ydro]gen peroxide with care so it • Use dilute [acid] and alkali rather than more concentrated s 5. Answers should include: - Measure and record temperature for each tube – do not A - The hydrogen peroxide should also be heated to the same - More measurements could be taken - An exact amount of catalase could be used, instead of a sa amount of catalase - The whole investigation should be repeated to see whether t 6. Students should have: - 'Temperature' on x-axis and 'height of foam after 1 min' o - Units clearly labelled (° C/ cm) - Look for scale errors – usually irregular spacing between n - Check plotting is correct 7. The results show: - as the temperature increases to 35 °C, the enzyme activity produced. (Experiments 1 and 2) - above 35 °C, enzyme activity sharply decreases, and the ra 65 °C. (Experiments 3 and 4) - as temperature increases, the height of foam increases up rapidly towards 50 °C; at 65 °C, the amount of foam produ - as the pH increases from 4 to 7, the enzyme activity increa - above pH 7, enzyme activity decreases at roughly the sam pH 10. (Experiment 6) 8. The enzyme's optimum conditions are closest to pH 7 and 35 °C conditions the most foam is produced by catalase breaking do 9. At high temperatures, the enzyme [has] become denatured. Its to the substrate / hydrogen peroxide and, therefore, it can't c down into water and oxygen. This means no foam is produced 10. Use smaller intervals of temperature to get a more precise mea curve around temperature. Use smaller intervals of pH, and an ele levels accurately. Test more temperature intervals around the 'optimum' (for exa and 50 °C as the enzyme activity could have peaked at a differe Test more pH intervals as well (for example, pH 4, 5, 6, and so ***Extension:*** - Chemicals in the blood can affect its pH. If the pH of the blood enzymes in the blood function. - The bacteria that live in thermal vents have enzymes which are temperatures, and do not become denatured.

Lesson No.	Answers
5	**AEROBIC AND ANAEROBIC RESPIRATIO**

Task 1

1. glucose + oxygen → carbon dioxide + water + energy
2. $C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O$ + energy
3. a) glucose → lactic acid + energy
   b) glucose → ethanol + carbon dioxide + energy

Task 2

1. Aerobic
2. Aerobic
3. a) 38
   b) 2
4. A[illegible]ethanol)
5. The production of wines and spirits; medical and industrial alc
6. a) Carbon dioxide
   b) As food/fuel for the yeast to respire
   c) Creates better / optimum temperature conditions for the reactions work best in these conditions
   d) Aerobically
   e) It has access to oxygen as the bread is kneaded/mixed an
7. During exercise
8. Oxygen is used during exercise, to release energy to keep us m
9. Anaerobically, as there is little or no oxygen under layers of mu
10. a) Aerobic respiration releases more energy so those organis be more active.
    b) Anaerobic respiration releases less energy so those organi less energy.

Task 3 – Exam-style question

a) Time on x-axis; breathing rate on y-axis; both axes labelled and plotted correctly (1 mark)

b) *Accept answers within the ranges specified:*
   i. 2–3 minutes (1 mark); Tovah's breathing starts to increase for respiration (1 mark).
   ii. 4.5–5.5 minutes (1 mark); Tovah's breathing rate reaches i with a slight delay as she gradually makes up her oxygen s

c) Exercise requires greater rate of respi[illegible]c to move muscles (1 leads to increased demand for oxy[illegible]er (1 mark)

d) i. Intake lower th[illegible]us[illegible]e an extended period; oxygen level
   ii. Releas[illegible]bit [illegible]re energy (1 mark) so muscles can keep w
   iii. [illegible]s / stitch / muscle fatigue (1 mark)
   iv [illegible]e mark for each point:
   - build-up of lactic acid (1 mark)
   - rest to allow the body to make up its oxygen debt / ta to break down lactic acid) (1 mark)

Extension:

Many possible answers:
Lactic acid can cause blood pH to drop, which causes enzymes to wor
Glucose levels drop, and need to be regularly replaced by consumin
Diet needs to be high-calorie to provide energy, but without slowin
Anaerobic respiration produces less energy than aerobic respiration
can lead to physical exhaustion / fatigue.

Lesson No.	Answers
6	**THE HEART AND CIRCULATION** ***Task 1*** Discussion questions: 1. Artery is under higher pressure because it carries oxygenated b contraction of the heart muscle sends pressured 'pulses' of blo tissue is needed to recoil and withstand the high pressure. 2. Short diffusion distance for oxygen into tissues, and waste subs 3. Once to the lungs to get oxygen; once onwards to the rest of th ***Task 2*** 1. Answers are on the in[illegible]t: 1. Right ventricle 2. [illegible] 3. [illegible]a cava 4. Aorta 5. Pulmonary artery 6. Left atrium 7. Pulmonary vein 8. Left ventricle Pulmonary artery Vena cava 2. Q A Q A a 8 g 2 b 1 h T c 3 i 5 d 4 j F e 7 k 1 f 8 l 6 ***Task 3*** 1. Vena cava – Right atrium – Tricuspid valve – Right ventricle – P Pulmonary vein – Left atrium – Bicuspid valve – Left ventricle – 2. a) Right atrium; b) the body 3. a) Left atrium; b) the lungs 4. Veins (vena cava and pulmonary veins) 5. Arteries (aorta and pulmonary artery) 6. Ventricles 7. Right ventricle 8. Left – has to generate greater pressure to force blood out and 9. Left ventricle 10. a) Arteries b) Elastic walls which allow elastic recoil and a thick layer of 11. So that blood flows under suffi[illegible]ressure to get around the 12. a) Arteries have a t[illegible]umen so blood flows faster under oxygen and other substances quickly to all cells, whereas v [illegible]deoxygenated, plus the vessels are wider, with a t travelling against gravity. b) The aorta is much thicker-walled to withstand the greater ventricle, which is needed to force the blood around the b pulses, while the thick layer of elastic tissue allows for elas The pulmonary artery is only transporting blood to the nea required from the right ventricle, so the vessel has a thinn ***Extension*** A) Thick wall with lots of elastic tissue and highly muscular. The p blood at relatively high pressure from the lungs. B) *Refer back to earlier in worksheet/textbook as needed.*

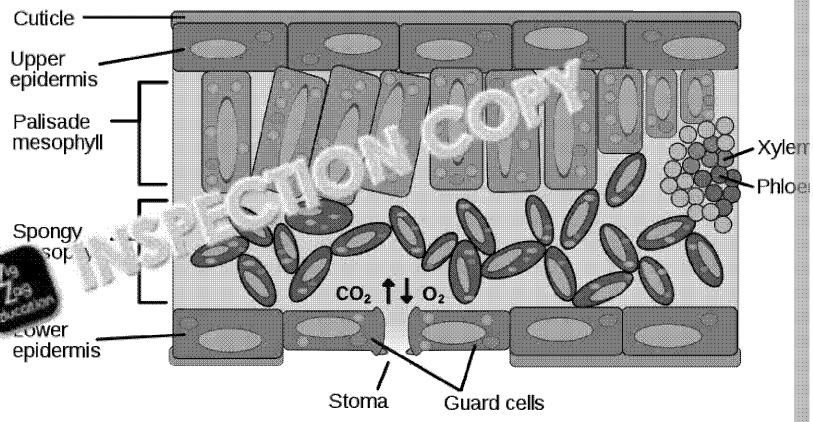
Lesson No.	Answers
7	**THE PROCESS OF PHOTOSYNTHE**

Starter

Carbon dioxide + water → glucose + oxygen (using light energy and

Task 1

1.



2.

Structure	Function
Guard cells	Cells which allow the stomata to open c water loss
Stomata	Gaps between guard cells which allow c into the leaf, and oxygen and water vap
Xylem	Small, woody tubes which transport wa towards the leaves of a plant; provides
Phloem	Small vessels which transport sugars an the leaves to other parts of a plant

Task 2

1. $6CO_2 + 6H_2O \rightarrow C_6H_{12}O_6 + 6O_2$
2. Similarities:
   Both equations include the same four molecules: CO_2, H_2O, C_6H respiration are the same as the products of photosynthesis.

   Differences:
   Respiration breaks down larger molecules into smaller ones, w molecules from smaller ones; photosy is uses light energy
3. Endothermic reactions abs b ne , from their surroundings; reaction because it so ght energy.

Task 3

Va is absorbed into the roots, and travels (2) up to the leaves es, (3) where it reacts with water in the chloroplasts. Glucose (reaction. These molecules (5) can react in the mitochondria via aer (6) carbon dioxide and water as waste products. The molecules wh diffuse (7) through the leaves back into the bottle. Excess glucose c process may continue for years, as long as (9) light energy is availab

Lesson No.	Answers
7	***Task 4*** Many possible answers. Examples: *Amino acids* • used to make proteins in plants and animals • proteins used as: - enzymes to catalyse metabolic processes - growth factors to control growth - hormones to manage growth and homeostasis - molecules which provide structural strength • plant proteins consumed and absorbed as nutrients by herbivo *Oxygen* • Oxygen released as a waste product; absorbed by animals and • Used with glucose in aerobic respiration, producing energy/CO • Required for any process which involves fire/burning ***Task 5*** + O X Y G E N + S R + + + + R R O O T S + R + E + + + + + E + M + + E + P T + + R + + + S + E C + H + A + E + + + + + P U L L + + W W + + + + + + D I O Y + + O + + + + + + O + E R + X L + + + + + + R L M + + A F H C R A T S P + I + + + + T + + + + + + + + G + + + + + I + + + + + + + H + + + + + + O + + + + + + T + + + + + + + N + + + + + + + + + + + + + + + + + C A R B O N D I O X I D E + 1. Res 2. Phl 3. Wa 4. Car 5. Ox 6. Flo 7. Xyl 8. Lig 9. Ro 10. Sta 11. Pro ***Extension*** Photosynthesis is endothermic which means it needs to take energy Respiration is exothermic which means energy is released during th photosynthesis has to have an external source of energy (from sunli organic molecules, while respiration releases energy for use in cells.
8	**CONTROLLING PHOTOSYNTHES** ***Task 1*** 1. Factors include temperature, light intensity, carbon dioxide le throughout the tunnel, spacing of plants (i.e. competition for carb shading) effects 2. Oxygen 3. • Three graphs with 'number of bubbles in 30 seconds' on t intensity', 'temperature' or 'CO_2 level' on the x-axis. • Graphs should have axes with regular intervals (5, 10, 15... • Axes should be labelled with units where appropriate (°C f and light intensity). • All data points should be plotted and at least half the grap • Curve of best fit should be a smooth line, with no plotted

Lesson No.	Answers
8	4. a) Light intensity causes the number of bubbles / rate of pho intensity, but it plateaus / does not increase above this le b) Temperature causes the number of bubbles (and rate of p 30 °C, after which it begins to fall. c) Carbon dioxide concentration causes the number of bubb increase up to 25 % CO_2, but it plateaus / does not increas 5. a) 50 % b) 30 °C c) 25 % 6. Because the rate of phot[illegible]s is highest at these points ***Higher tier:*** [illegible]ting factor is something which places constraints on photosynthesis, stopping it from increasing further b) light intensity (accept competition for nutrients in soil, but rainforest) c) temperature ***Task 2 – Practical analysis: Light intensity and photosynthesis*** 1. a) number of bubbles produced / amount of O_2 produced b) temperature of room; concentration of $NaCHO_3$; same la 2. No, this is an anomalous result caused by human error. It shou calculating the means. 3.

	Distance fro		
	5 cm	**10 cm**	
Bubbles (1st repeat)	58	24	
Bubbles (2nd repeat)	51	21	
Bubbles (3rd repeat)	57	10	
Mean	55	23	

4. Oxygen / O_2

5. Light is needed to provide the [illegible]gy [illegible]r photosynthesis (to cr carbon dioxide and wat[illegible]f t[illegible]amp is closer to the pondwe more intensely [illegible]ht, so photosynthesis happens faster. produ[illegible]

A[illegible]y sensible answer. Possible answers include:

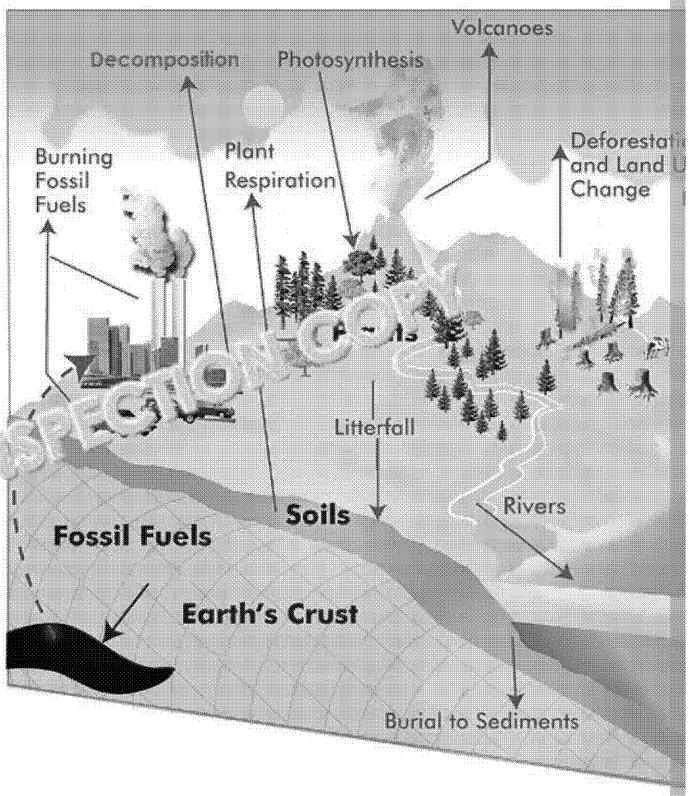
Limitation: light levels in the room may interfere with results. fully darkened room.

Limitation: number of bubbles isn't a perfect measurement of vary in size. Solution: use a sensor to measure levels of O_2 in w

Lesson No.	Answers
8	7. Clamp stand (to hold boiling tube) **Extenstion** a) Temperature: remove the lamp and ruler. Preheat beakers of and repeat the experiment several times using different tempe experiment with the beaker placed in a water bath. Heat the temperatures (20 °C, 40 °C, 60 °C) and count number of bubb Carbon dioxide concentration: remove the lamp and ruler. Set but use varying concentrations of carbon dioxide in the solutio b) This should be taken from the ima[illegible] information provided tube, clamp stand, pondweed, scissors, gloves, solution with di lamp, tank of wat[illegible] stopwatch. Depending on the answer to 8 require[illegible] (for carrying out dilutions), multiple strengths [illegible], Bunsen burner.
9	**MEASURING MINERAL UPTAKE IN P** 1. Graph should have time (min or h) on the x-axis, and sulfate io Points should be plotted so that each experiment's data points circles and small crosses). Two lines should be drawn connecting each series of data, wit lines can be distinguished. Scale should be sensible. 2. a) Whether the gas bubbled through the nutrient solution is b) Temperature / size or mass of seedlings / starting concent nutrient solution / light availability / humidity 3. **Anaerobic** – without oxygen **Ions** – atoms or molecules which have gained or lost electrons **Radioactive** – atoms which are unstable and release particles (breaking down into other types of atom 4. The solution which had oxygen bubbled through it The seedlings in the oxygen solution took up more sulfate ions. 5. Respiration (happens in all cells, including the roots). 6. Respiration requires oxygen, and releases energy. This energy cell membranes by active transport. Wh[illegible] oxygen is not prese aerobic respiration, and so relies [illegible]-efficient anaerobic res transport happens more slowly. 7. Either: Ye[illegible] experiment shows that sulfate ions are taken up faste under aerobic conditions). The same process also controls the OR No – the experiment only proves that sulfate ions are taken up present (i.e. under aerobic conditions). It doesn't prove that al more effectively. 8. a) Independent variable – concentration/percentage of oxyg rate of sulfur (SO_4^{2-}) ion uptake. b) Use same type of seedling; use same nutrient solution; use of oxygen from air to roots.

Lesson No.	Answers
9	***Extension*** Methods may vary, but key details as follows: - Experimental set-up as above but with nutrient media containi - Sulfate uptake measured. - Plot a graph of the results, and draw a line of best fit. The poin becomes parallel with the x-axis) is the amount of oxygen nee - At this point, adding more oxygen will not increase mineral ion
10	**CYCLES IN BIOLOGY** ***Task 1*** In this ecosystem, the eagl… are predators of the snakes, while the … Decomposers su… as fu…gi break down dead animals (and plants), … nutrients … the soil. If co…mposers were not present in this food web, nutrients would … organisms extremely slowly. The nutrients released by decomposition include sugars and nitroge… If there were no decomposers present, plant growth would be very … could stop altogether. Other microorganisms help to recycle nutrients by breaking down t… urine, or by decomposing dead cells. ***Task 2*** Starting with the plant and going anticlockwise: 1. Plant – producer; snail – herbivore and/or consumer; bird – ca… carnivore and/or consumer; microorganisms – decomposers 2. Arrows pointing from the bird, snail and plant to the decompos… dead plants, dead animals and animal waste products, not just … 3. Decomposers use enzymes to break down large organic molecu… temperatures, enzymes work slower because there is less heat … decomposition is slower. 4. Nothing would decompose, or decomposition would happen o… would become a problem, as well as minerals and raw materia… recycled being locked away, so fewer things would grow. ***Task 3*** a)

Process
…the volcano suddenly erupts.
Animals respire aerobically.
A tropical plant photosynthesises, producing oxygen.
Sea organisms die and form sediment on the seabed.
A factory burns coal to produce steam.

Lesson No.	Answers
10	b)  ***Task 4*** If it disappeared: *Rhizobium* – there would be less nitrogen available in the ecosyste proteins and would grow more slowly. *Coelastrum* – there would be less oxygen for animals to respire, so a *Lactobacillus* – yoghurt would not be produced and the enzymes w *Ruminococcus* – cows would not be able to digest their main source ***Extension*** Many possible interactions for each answer. **Temperature** – affects rate of photosynthesis (and, therefore, stora decomposition; high temperatures will kill microorganisms by dena membrane. **Moisture** – levels of water in an ecosystem affe t competition betw water to survive; moist conditions enc d composition. **Acidity** – carbon dioxide react ith w making oceans more aci enzymes so nitrogen-fi b ria may die; high CO_2 levels in air c **Oxygen level** gen levels needed for aerobic respiration b produ ding algae such as *Coelastrum*) in photosynthesis.

Lesson No.	Answers
11	**INVESTIGATING ECOSYSTEMS**

Task 1

ECOLOGY KEYWORDS	
Population	A group of organisms of the same species livi same time and able to interbreed
Community	Populations of different species living togethe
Environment	The physical area surrou ding an organism
Ecosystem	Communities of g sm together with thei
Abiotic	Non-li ac s
Habitat	W e an organism lives – home
B	The living environment
Niche	An organism's role in the community
Competition	Coexisting species trying to obtain the same r

Task 2

Check: Biotic or Abiotic?		
pH	Abiotic	Minerals
Rainfall	Abiotic	Oxygen level
Predators	Biotic	Light
Temperature	Abiotic	Parasites
Moisture levels	Abiotic	Competition
Food	Biotic	Space

Task 3

1. Decrease – plants in the water would photosynthesise more slo
2. Decrease – starvation/disease will reduce population size.
3. Decrease – the predator will kill herbivores and reduce their nu
4. Increase – food is plentiful so herbivores are well fed, and will offspring.
5. Increase – the virus will affect the predators' ability to catch th will survive.
6. Decrease – there will usually be s m etition between he food/water/shelter).
7. Decrease – s e p a will die due to lack of water (and plant roots for water).
8. D crease – rabbits tend to eat a range of ground plants.
9. Decrease – trees will create shade, so the light energy reaching
10. Increase – light intensity reaching ground plants is increased.
11. Increase – if rabbits are eaten by a new predator, the rabbit po plants.

Lesson No.	Answers
11	***Task 4*** Analysis: Students should ensure that, unless asked to do so, they DO NOT E to describe data. 1. *Points might include:* - In Stream A there are more freshwater shrimp than other Stream B (96 g in Stream A compared to 23 g in Stream B). - The second most abundant organisms in Stream A are cad stonefly larvae; however, shrimp ha[illegible] a much higher biom - There are no mayfly nymph[illegible] stonefly larvae in Stream B - There are many (81 g) sludge worms in the sample from sample fr[illegible]m A. - The [illegible] g of bloodworms in the sample from Stream [illegible]m A. - There is an approximately equal total biomass (g) of samp - All of the organisms are represented in the sample from S are found in the sample from Stream B. 2. *Conclusions might include:* - Stream B is quite heavily polluted. - Stream B does not appear to have any very clean areas in others, so caddis fly larvae and shrimp can be found. - Stream A has some pollution in it (hence some bloodworm - Stream A has some very clean areas in it (hence mayfly nym ***Extension*** a) $40 \times 2 \times 2 \times 2 = (40 \times 2^3) = 320$ b) $40 \times 2^6 = 2560$ c) $40 \times 2^{12} = 163\ 840$ d) As the population increases, the voles are forced to compete f without reproducing while others have fewer surviving offspri crowded, disease is more able to spread. In addition, if any pre predators will have more food and so their numbers will rise.
12	**HOW SPECIES INTERACT** ***Starter*** a) light, water, space, pollinators, nutrients in soil (nitrates/phosp b) Dandelion: large and upright leaves to [illegible]rb more light; deep more water and from deeper [illegible]ow Daisy: lower, flatte[illegible] leaves that would survive being trampled o spreading [illegible] on the ground and taking up more space so othe ***k*** • food (all species) / small birds and voles (foxes and sparro (small birds and voles) • hunting territory (foxes and sparrowhawks) • nesting space (small birds and voles) • shelter (all species) • water (all species) • mates/partners for reproduction (all species, but only co same species) • compete to avoid capture by predators (worms, small bird

Lesson No.	Answers
12	b) Answers based only on the given food web • **Predator:** fox, small bird, sparrowhawk • **Prey:** small bird, vole, worm • **Producer:** plants • **Carnivore:** fox, sparrowhawk • **Herbivore:** vole • **Omnivore:** small bird c) Adaptations: • **Fox:** good eyesight, colouration (c[illegible]uflage), good sense excellent hearing, eyes for[illegible]ng to keep prey in sigh • **Sparrowhawk:** si[illegible]ht, powerful claws, sharp beak, e • **Small bir[illegible]:** ey[illegible]the side of its head to see on all sides, [illegible]wider range of food to survive, small so can be d • **[illegible]ole:** eyes on the side of its head to see on all sides, small camouflaged, hides in undergrowth close to its food so do harder to catch with it, good hearing, lives in groups for sa d) Within a population/species, animals compete for mates, since species can interbreed to produce fertile offspring. They may a and territory, which are linked to their ability to get food and a ***Task 2*** 1. Point A: the predator population is low, so the prey are able to many are eaten. The prey population increases. Point B: the prey population has risen dramatically, causing the rapidly as they have more food available. Point C: the predator population is high, so the number of prey the prey population is falling. Point D: the fall in the prey population means that predators d predators starve or die from disease, and the predator populat decreases; the number of predators decreases. 2. Cyclic fluctuation means that the numbers of each 'go up and dow ***Task 3*** Answers will vary from individual to individual. Creative clues are a sink in. General definitions are as follows: Across: 2 – An organism which lives on or in[illegible]other organism, and ha 4 – An organism which is fo[illegible]r [illegible]ther species in an ecosystem 6 – To increase and [illegible]repeatedly 8 – Conflict[illegible]organisms for resources [illegible] particular lifestyle or ecological role An organism which kills and eats another organism Down: 1 – All the organisms from one species in an area (or something w 3 – Organisms relying on each other within an ecosystem 5 – Happening again and again over time 6 – A diagram which shows which species eat which other species 7 – A state which is generally caused by a pathogen, making organ **Extension** This is an independent task, but consider range of competition types

Lesson No.	Answers
13	**WHAT IS BIODIVERSITY?** ***Task 1*** **Question** / **Bri** 1. Why has the human population increased so much over the last 300 years? — Advances in medicine a fewer diseases, more f old age 2. Give three ways in which humans use land. — F ming, building settle mining/quarrying, wast 3. Give three practical problems caus by increasing human population. — More waste; habitat de materials used up quick unsustainably; increasi overcrowding in cities 4. Give three consequences of an increasing global temperature. — A rise in sea level; flooc desertification, extincti weather patterns; mor 5. What proportion of rhinoceros species are currently vulnerable to extinction? — 100 % / all of them. 6. What are the main problems caused by deforestation? — Loss of useful plants an being fixed by plants; i atmosphere because o 7. What do we mean by 'sustainable development'? — Using natural resources destroyed for future ge 8. How are we trying to maintain biodiversity? — Seed banks, conservati sustainable fishing laws etc. ***Task 2*** The maths is relatively simple, but the answers will vary depending values: **Number of** plantain **21** / daisy **15** / dandelion **22** / * but 1. Estimates are different becaus species are not evenly distribu coordinates chosen w between individuals. Random coo estimates sin so organisms are clustered together (such a com ly). Ideally, the larger number of quadrats should give answers clos might depend on your sample.) Random coordinates can also organisms are clustered together (such as dandelions) and may 3. Part 1 should have taken the least time. 4. If samples are too small, they are not likely to be representativ they won't 'describe' it very well. However, scientists have a li resources, and counting all the organisms in an area is usually be found. In addition, it's important that the method of sampli organism is equally likely to be sampled. This makes the sampl

Lesson No.	Answers
13	***Task 3*** Independent and open written task: • Writing should be in the style of a speech, i.e. it should be addr • Style doesn't need to be as formal as most scientific writing, bu understandable. • Terminology used might include: deforestation/replanting; glob extinction; conservation; wildlife reserve; Marine Conservation renewable energy; sustainability. • Students should use relevant information from the information knowledge, as well as research if able to do so.
14	**STEM CELLS** ***Task 1*** 1. Adult stem cells can only differentiate into a few types of cell, b differentiate into many different types of cell. 2. Adult stem cells are easier to use as they are more easily availa 3. **Reproductive cloning** = making clones of organisms; **therapeut** replace ones that are damaged. 4. Scientists don't agree with making genetically identical copies as it can be abused (e.g. to replace a dead pet or even a dead f copies are often abnormal in some way, and will be susceptible genetic original. 5. Lost limbs could be replaced, as could diseased or damaged org defects, faulty kidneys or liver). 6. Embryonic stem cells are better for therapeutic cloning in term organs that can be made from them, but they are more difficul dilemmas (such as killing the embryo). Adult stem cells are more accessible but are not useful for grow and organs. 7. Look for a range of examples from the following: - grow healthy pancreatic cells to replace a faulty pancreas - grow new muscles, tendons, limbs, etc. to replace damaged - grow new nerves to treat paralysis - embryos are cloned in a lab; the necessary stem cells are ex tissues and organs can be grown 8. Some arguments for and against therapeutic cloning: For / Against Grow new organs to replace diseased ones / Need human egg donors procedure for wo Be able to walk again / Human eggs ar (to help peopl Live longer / People see i Needed for research into cures for many diseases / People will stop worrying abo as through drinking and smo can get re 9. The speech should consist of a personal argument, and should and in the info.

Lesson No.	Answers
15	**FROM DNA TO PROTEINS** ***Task 1*** a) False; the genetic material is stored in the nucleus. b) True c) True d) False; females have sex chromosomes XX, males have XY. e) False; a gene is only a small section of a chromosome. f) True g) True h) False; proteins are essential to all living things, and have a rang ***Task 2*** Students to complete glossary using the stimulus material. ***Task 3*** Broadly speaking, the newspaper is correct – a mutation in the cystic fibrosis. However, the position of the gene mutation on the chromoso fibrosis, so mutation 1 causes much worse symptoms than mutation 2, cystic fibrosis. Therefore, it is not enough just to know that a mutatio the organism will depend on the position of the mutation on the chr ***Task 4*** 1. Triplet codes: ATG, CTG, TTC, AGT, CAT Amino acids: methionine, leucine, phenylalanine, serine, histid 2. Triplet codes: TCC, CCC, ATT, GTA, TGA Amino acids: serine, proline, isoleucine, valine, STOP (no amin ***Task 5*** There is no single correct way to approach this. Marking points mig • The article should be clearly written, with any unfamiliar terms • The article could explain what genes are, and should probably produce proteins. • The diagram could show the structure of DNA, or show how th • The article could include some information on the history of th • Uses of the Human Genome Project should be included. ***Extension*** Many possible points. Some points which might reasonably be incl • Agricultural researchers can study and breed animals and help to higher yields of milk/wool/meat • DNA sequences can be compared to see how organisms are rel • Genetic information can be used to encourage genetic diversity conservationists. • Differences between human genomes and those of other orga how humans and human societies evolved. • May provide information to improve human health, by studyin cancer / other diseases.

Lesson No.	Answers
16	**THE THEORY OF EVOLUTION BY NATURA**

Task 2

A population of a species faces competition within its habitat	1	A vicious preda population
Many die – only a few are left	4	The beneficial g their offspring, useful characte
There is a struggle in trying times – some are 'fitter' than others (stronger, resistant or more attractive to th opposite sex)	3	This leads back
This carr s th ough several en	6	At the same tin its own selectio improve its abil
ey are competing for a limited resource (food, water, shelter, mate, etc.)	2	The survivors a
The species has become 'fitter'	7	Only those with those that taste
They mate and pass on their genes to the next generation – of many offspring, only a few will have the 'beneficial' genes	5	Over generatio species develop

Task 3

1. Happened over millions of years; created new species; rock lay

2.

Change	
Horses have become taller / have longer legs	Enables faster runnin potential predators
Feet have become hooves	Allows horses to run f absorbing shock of im
Teeth developed for grinding	Switch from mixed die down tough vegetatio
More muscular	Ability to run faster a predators.
Longer mane/tail	ffers protection agai neck warm

3. Many possible ans rs. A strong answer will include changes i envi n n causing specific traits to be useful. These traits a s l on, and become universal over time.

Example answer:
A horse population could have moved into a new environment, whe vegetation was tougher. In this environment, horses with larger an grinding tough vegetation would have been able to get more nutrie been able to survive in tough conditions and have more offspring. S have had larger teeth, better shaped for grinding tough vegetation. teeth in the horse population would have changed.

Lesson No.	Answers
16	***Extension:*** 1. A reasonable sequence of events might be as follows: • There is genetic variation in the meerkat population. • Some meerkats (by chance) were more able to tolerate sc • When food was scarce, meerkats ate scorpions; some die able to survive. • The meerkats who could eat scorpions were able to explo competition, and survive the tough conditions. • Those that survived reproduced, pas g on their genes. • When food was scarce agai nee kats which ate scor to die. 2. • The sc r on p ulation would grow, since they would ha • c pion venom would become weaker, because very useful; resources used to produce strong venom could be would still produce venom, to sting and paralyse prey.) • Alternatively, the scorpion population may rise and then f which was previously occupied by the meerkats. • This could lead to the venom becoming weaker and then s
17	**EVOLUTION – ASSESSING THE EVID** ***Task 1*** 1. • There is genetic variation within a population of pathogen • Some bacteria have no resistance to the antibiotic; some h • Occasionally, a mutation will create a strong resistance. • When the antibiotic is used, many die but a few survive. • The survivors multiply by cloning, thereby copying the ben • Repeated antibiotic use destroys bacteria with weaker res • The bacteria with stronger resistance continue to thrive, c resistant bacteria. 2. This is important so that patients realise they should complete th they feel better. Also, informed patients are less likely to deman bacterial infections, which would waste the GP's time and increas ***Task 2*** a) The pentadactyl limb has the same basic structure in all mamm near (or arranged in a certain way relative to) other bones. Ho a lot in terms of the size of the different b nes, depending on t *Students should use some exam l s g n t e diagram.* b) This shows that all of n organisms must be related in order control the g wth o the limbs. It also suggests that the comm also h d p tadactyl limb. *Students should use some exampl* • Structures are actually quite different from each other (e.g. could be seeing what we want to see and forcing new inform • It could simply be that a certain structure exists in lots of c most logical way for a limb to be organised, rather than be a common ancestor.

Lesson No.	Answers
17	***Task 3*** Students should give their own ideas on whether they see this as ev arguments. Some points to include: • The embryos can be seen to be evidence of genetic similarity as the animal kingdom (mammals, reptiles, fish and birds) that all • This suggests that if organisms all have the same basic body pla evolved from a common ancestor with the same body plan. • As different genes get switched on, the organisms change to ha different bony structures. • This suggests that evolution works gra a. y, by changing an or functions. • This is backed up by c idence (e.g. gene sequencing). • Evidence ag st – complex animals may tend to look similar du heads, tails, etc. are just things animals 'need'. T vertebrate embryos don't account for evolution of inver ***Extension*** a) This can be confusing – evolutionary scientists might think that than they actually are, based on external traits. However, ther which scientists can look at to support evolution, e.g. gene seq be produced by quite different genes. b) A huge range of possible answers. For example: Dolphins and sharks both have fins on their backs (dorsal fins), both live in an oceanic environment; however, dolphins are ma
18	**THE NERVOUS SYSTEM** ***Task 1*** Eyes – sight (via light receptors in the retina connected to the optic Tongue – taste (via chemical receptors in taste buds) Skin – touch (via pressure receptors) / temperature (via thermorece Ears – hearing (via auditory receptors near the eardrum, connected (via the semicircular canals) Nose – smell (via olfactory receptors in the cells lining the nose) ***Task 2*** • Dust blows into your eye – you blink – yes (you can blink if you • Dust goes up your nose – sneeze – no • You step on a pin – flinch away quickly – ye ou can twitch/move • Walking into bright light – pupil nt ct – no (can't control yo • You hear a loud bang – no (can't make yourself jump in • You are chopping on – eyes sting and water – no (you can't subject your eyes to an external stimulus and then allow the te 1, 5, 4, 2, 3, 6, 7 Or: stimulus, receptor, sensory neuron, spinal cord, motor neu 3. • receptors, nerve, sensory • impulse, motor • effector, stimulus • automatic, protection

Lesson No.	Answers
18	***Questions*** 4. A fast and automatic response to a stimulus, which does not in brain. 5. A stimulus – either external or internal 6. Spinal cord 7. They are fast and automatic, which means you don't waste tim the stimulus – the body reacts quickly to protect itself ***Task 3*** Style and content may vary, but the e several concepts should be in • Otherwise very qui[illegible] ef[illegible]actions become slower • Body is at [illegible]ph[illegible]sical risk from own actions, e.g. from hot pl • B[illegible]s more risk from actions of others, e.g. cars brake mor • More difficult to do fast physical activities, such as sports • Uses up processing capacity, so the brain may respond to othe ***Extension*** • Reference to light receptors in the retina / optic nerve • The correct sequence in order from receptor to effector and re • Correct reference to neurons *(they may have drawn a neuron –* • Correct reference to synapses / connections between neurons • Reference to the effector as a muscle in Trevor's leg/foot • Chemicals/transmitters travelling through the neurons/synaps • Response needs to be fast • May make reference to the effect of alcohol or a stimulant, or speed of transmission or response **Keywords they could have used:** sensory, motor, relay, neuron, mu cord, reflex, stimulus, receptors, synapse, chemicals/neurotransmit
19	**THE EYE, ACCOMMODATION AND FO** ***Task 1*** 1. Labels: A. vitreous humour B. lens C. cornea D. pupil E. iris F. sclera G. optic [illegible]e H [illegible] 

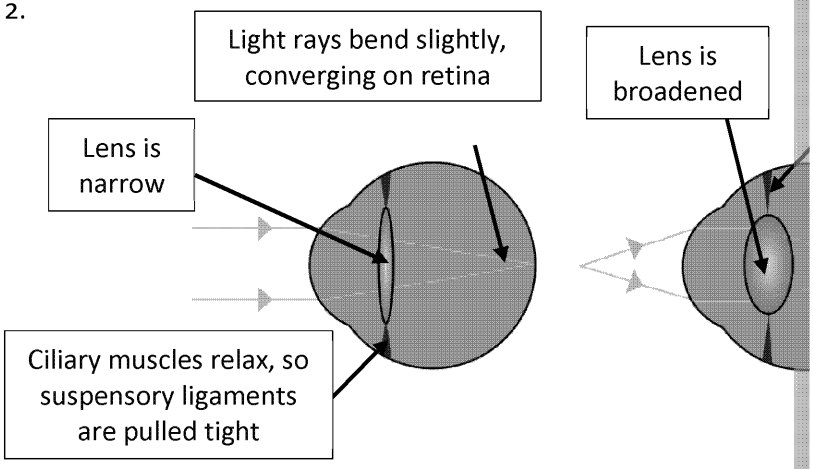
Lesson No.	Answers
19	

Task 2

1.

Key term	Description	
Ciliary muscles	Muscles that connect the suspensory ligaments to the outer eyeball	Contra of the
Suspensory ligament	**Attached to the lens**	Is loose changi
Cornea	**The part of the eye which light reaches first**	Protec
Iris	Ring of muscle s... ur...g the pupil	Contra shape
Pupil	Just pa...etween muscles which all... light to enter the eyeball	**Expan much**
[illegible]	**Contains lots of rod cells and cone cells**	Conver
Optic nerve	**A huge cord made of many nerve cells**	**Carries**
Lens	**A convex disc**	Refract

2.



3.

3	The suspensory ligaments are loosened, so the lens be**convex**.
7	The ciliary **muscles** relax.
5	The student is suddenly distract...by a helicopter in th
9	Light entering the eye i...re ra...d less before it hits the
10	This whole pr...s...f the parts of the eye adjusting to **acco...noti...**
1	A st...ent peers intently at a school textbook.
[illegible]	The student strains to see the helicopter from a windo
2	The ciliary **muscles** contract.
8	The suspensory ligaments are pulled tight, so the lens
4	Light entering the eye is refracted more before it hits t

Lesson No.	Answers
19	

Task 3

a) Retina – cone cells in the retina distinguish between different c
one type of cone cell is absent or doesn't work properly.

b) Iris – if the iris muscle isn't functioning correctly, it may not co
in bright light. This means that too much light will enter the ey
cause temporary blinding or permanent retinal damage.

c) Cornea/lens – if the cornea is damaged it can become scarred,
and making vision blurry. The lens can also become damaged,
or detached, making vision blurry and of a low-resolution.

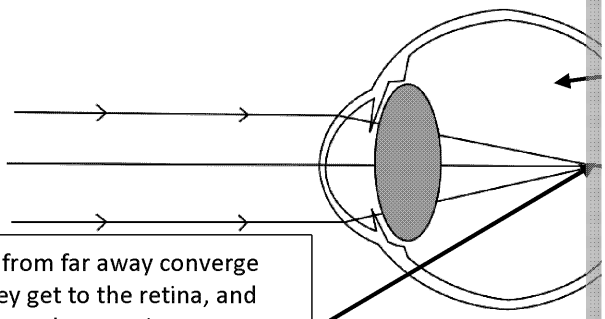
Task 4

S	+	I	+	+	+	+	+	O	+	L	A	+	
+	H	L	R	+	+	+	+	+	+	O	E	+	
+	+	C	+	+	+	T	+	+	+	N	N	+	
+	+	K	E	S	I	+	+	+	+	G	R	+	
+	+	+	T	C	+	+	A	+	+	S	O	+	
+	+	+	+	N	S	D	N	+	+	L	I	C	+
+	+	+	E	+	+	I	O	+	+	E	G	+	+
+	+	R	+	+	T	+	G	R	+	N	H	+	+
+	V	+	+	E	+	+	+	H	+	S	T	+	+
E	+	+	R	P	U	P	I	L	T	+	E	+	+
+	+	+	+	+	+	+	+	+	+	E	D	+	+
+	L	L	E	C	E	N	O	C	+	+	D	+	+
C	I	L	I	A	R	Y	M	U	S	C	L	E	S
+	+	+	+	+	+	+	+	+	+	+	+	+	+

Word/phrase
CILIARY MUSCLES
CONE CELL
CORNEA
IRIS
LENS
LONG SIGHTED
OPTIC NERVE
PUPIL
RETINA
ROD CELL
SHORT SIGHTED

Extension

1.



Light rays from far away converge before they get to the retina, and spread out again

2. Surgery to shorten/reshape the ey so that the distance be
isn't too long for converging light rays.

Surgery to cha ape of the lens, so that light from far a

Glas change the angle at which light rays enter the ey
c ly by the lens.

Lesson No.	Answers
20	**HOMEOSTASIS AND CONTROL**

Task 1

Scenario	How do you feel?	How your body respo *(both involuntary and voluntary*
1. You are under water and hold your breath.	Suffocated	**Involuntary**: chest tries to e urge to breathe **Voluntary**: resist the urge t
2. You have been out running on a hot day.	Tired, hot thirs	**Involuntary**: sweating to co as d sense of thirst **luntary**: removing extra c having a cold shower / getti / eating food to restore sug
3. It's a h da, and yo ve been drinking cups of tea all day.	Bladder full	**Involuntary**: urge to urinate **Voluntary**: control of the bl (going to the toilet, or resis urge and waiting)
4. You've been sitting around eating sugary treats all day.	Hyperactive / restless Sick?	**Involuntary**: twitching / mo / other hyperactive behavio **Voluntary**: exercising / doi to burn off excess energy
5. You've been busy and have not had time to drink anything all day.	Thirsty	**Involuntary**: dry mouth / in sense of thirst **Voluntary**: drinking lots of
6. You were in a hurry and had no breakfast this morning. You've also done two hours of sport today.	Tired	**Involuntary**: rumbling stom tiredness / increased irritab increased sense of hunger **Voluntary**: having a large a meal / resting to conserve e

Task 2

Nervous system: this involves electrical signals passing through the generally very quick.

Blood sugar level: people with diabetes struggle to control this; the in controlling this; this can be controlled by eating food low in gluco regulate this.

Temperature control: sweating is one e f this; hair standing vasodilation and vasoconstricti h lp this; the hypothalamus electrical signals passing ro the body.

Water level co the concentration of the urine changes to help central to s th hypothalamus is involved.

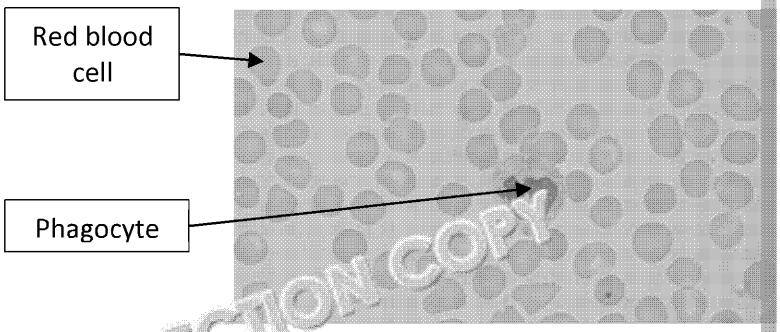
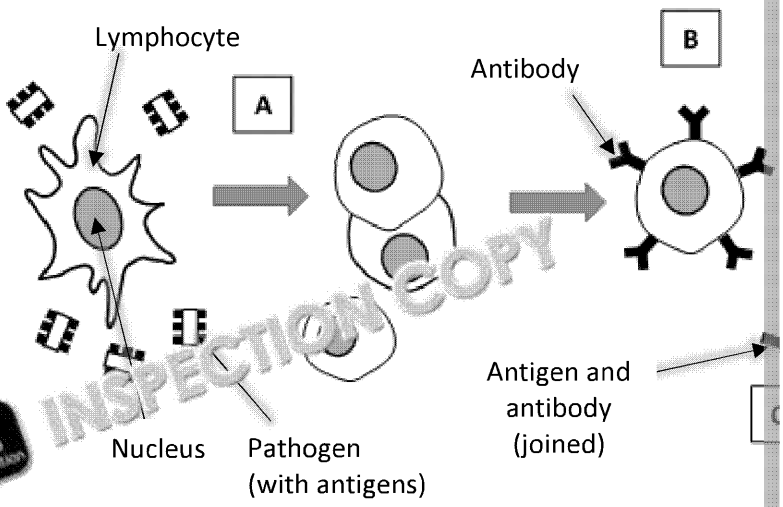
3

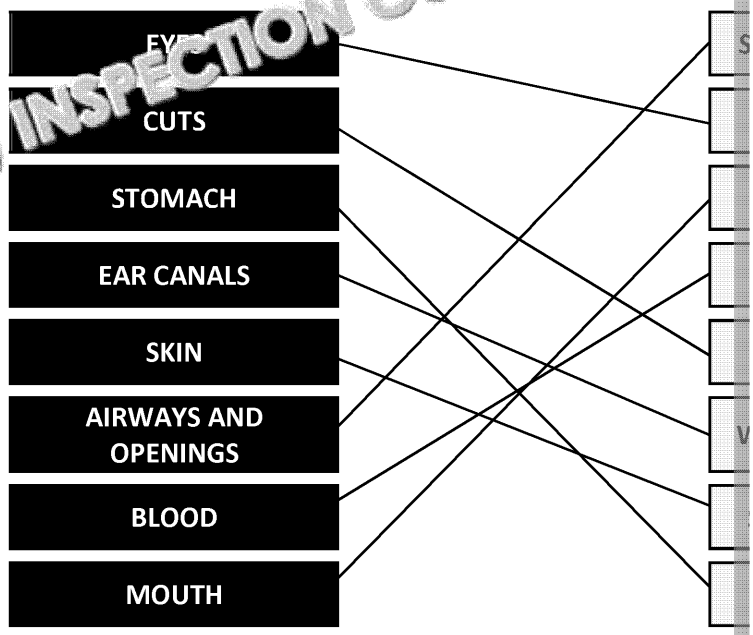
1. Insulin
2. Lowers blood sugar levels – increases uptake of sugar by cells a muscles and liver
3. In the liver and muscles
4. Pancreas
5. Insulin is released when blood sugar levels are too high, and it a lower level. When the blood level returns to normal, insulin i
6. Respiration (aerobic and anaerobic), which releases energy, ca

Lesson No.	Answers
20	***Extension*** Look for key points broken down, following the graph by describing demonstrated below: • Before breakfast, insulin and glucose levels are low (glucose ap 3.4 mmol/L) • Breakfast at 8am • Levels of insulin and glucose begin to rise about 20 minutes lat higher at 6.5 mmol/L and glucose at ~6.2 mmol/L) • Glucose at ~4.5 mmol/L by 9:30am, then fluctuates until 1pm (• Reference to the effect of sucrose rich foods on glucose levels • Reference to the way insulin patterns follow glucose patterns b • Tapering off aft • Some manipulation of data (such as comparing which after-me the difference between insulin and glucose at a fixed
21	**TEMPERATURE CONTROL BY THE** ***Starter – table:*** When hot – redness, sweaty, thirsty, itchy… When cold – pale, dry skin, shivering, blueness… ***Task 1*** Too cold Too hot Body temperature is falling below 37°C Blood vessels decrease in diameter Decreases blood flow to skin surface Sweat glands produce less sweat Decrease the rate of heat loss Nervous signal is sent to muscles and shivering begins Body temperatur cre Body in Blood (v Increa the Sweat Increa Bod

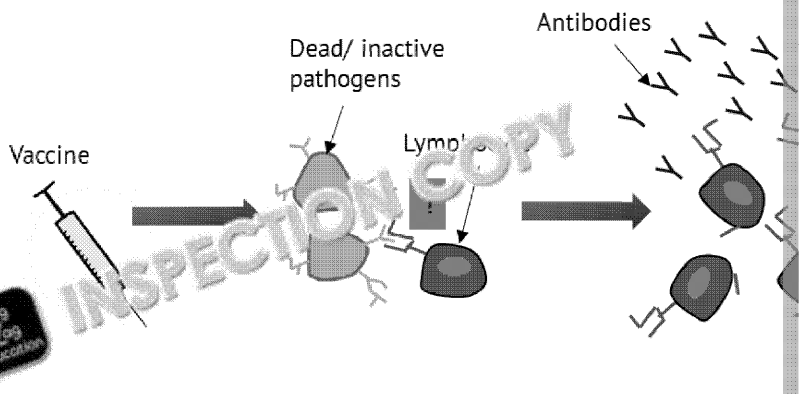
Lesson No.	Answers
21	***Task 2*** Style: • A good essay should be clearly structured. • Generally, each paragraph should cover a separate topic (respo importance of temperature regulation). • Each sentence should make a single point. • Make sure that each point is relevant to the title of the essay. Accept points from below, and any other sensible statements: • Hypothalamus monitors temperatu blood • Sends signals to sweat glands - if h they release sweat, if col • If cold, sends signals to muscles causing shivering to release he • If cold, blood vessels in the extremities (nose, ears, fingers, toe blood is directed and focused on the body core (brain and to If hot, blood vessels in the skin and extremities dilate to facilita In addition, the individual will have a sensation of hot/cold, an if they are cold – this is a voluntary response • People who are hot may remove extra layers of clothing, while behaviour and stay still to stop creating extra heat energy • If the body is cold for too long, the temperature of the extremi 'frostbite'. Parts of the body are not getting enough blood and temperature starts to fall, this is known as hypothermia, and ca • If the body is overheated for too long, enzymes which work be effective. Water is lost from the body very quickly through swe painful headaches. If the body's core temperature rises above hyperthermia, and can cause coma/death. • The extremities can get colder because it is less important if th core of the body, it is very important that the internal organs c ***Task 3*** **Across**: 3 – homeostasis 4 – negative feedback 8 – hypothalamus 9 – diabetes 10 – dilate 11 – sweating 12 – vasodilation **Down**: 1 – hypotherm 2 – radiation 5 – constrict 6 – shivering 7 – vasoconst
22	**CH G MICROBES USING ASEPTIC TI** ***Task 1*** th e, students can check their answers with their peers. It' graph is more difficult as the growth is exponential, but check t with time on the x-axis and number of bacteria on the y-axis. Some graphs may include some kind of graded scale which increase regular intervals. It's important that there is a consistent pattern to

Lesson No.	Answers
22	***Task 2 – Practical analysis tasks:*** 1. Autoclave, Petri dish (× 2), pen, gloves, Bunsen burner, inocula (× 4), pipette, bacterial source, agar gel, antibacterial substanc 2. Possible risks and precautions include: - Autoclave needs to be used appropriately (make sure trai - Bunsen burner is fire hazard (take care around open flames, - Inoculating loop may cause burns (hold away from you an - Bacterial sample may contain pathogens (wear gloves, do hands afterwards) ***Practical analysis questions:*** 1. Autoclave 2. Uses hi… e… ature, pressure and steam to destroy or inact 3. T… …any microbes on the work surfaces 4. To prevent any microbes being transferred to the culture, or to 5. To kill and, therefore, prevent entry of other microbes 6. A hot loop will kill the bacteria we are trying to culture/grow 7. To kill any other microbes on its surface as the liquid agar is po 8. Microbes in the air could settle on the plates and contaminate 9. More difficult for microbes entering the plate to land on the ag by gravity 10. Because there are billions of bacteria now present and it may 11. By heating to very high temperatures again, then opening the by pouring concentrated acid onto the agar then sterilising. Th thrown away; if the plate is thrown away, the correct protocol must be followed. 12. a) Not safe but can be done b) Wear a face mask and gloves; have air flow nearby; use a to kill the bacteria but leave them visible under a microscope ***Extension*** Modifications could include: Pathogen incubated at a higher temperature (3… °C) to mimic condi Extra safety steps taken (more protecti… …h…g) to prevent the p investigation becoming infected Use a fume cupboard (… …s m… …) to reduce the risk of people becon assembled Antibi… …t… compared to existing antibiotics which target the vi

Lesson No.	Answers
23	**FIGHTING PATHOGENS – IMMUNITY AN** ***Task 2***  **Red bl… …** – carries the protein haemoglobin which transports **…ph…yte** – responds to specific threats by making antibodies **…gocyte** – engulfs and digests pathogens ***Task 3*** Annotations should be around the entry points such as eyes, mouth, defences will include tears (produced by the eyes), mucous linings (n as a protective barrier all over. The stomach (stomach acid), somewh torso, and the intestines (mucous lining) in the lower torso may also b ***Task 4*** 1. Specific response by lymphocytes, and non-specific response b 2. Storyboard shows (in brief): • a phagocyte approaching a bacterium • engulfing it by extending its cell membrane around it • having absorbed it • breaking it down using digestive enzymes 3. Labels as below: 

Lesson No.	Answers
23	• A: The phagocyte has encountered pathogens and alerted with the antigen/pathogen recognition molecule they nee • B: Lymphocytes recognise the antigen and produce specifi • C: Antibodies are released which float in the bloodstream, disabling them. • D: A memory lymphocyte has been produced that will sto infection. • This response takes time because the lymphocyte has to w 'right' antigen so it can produce antibodies. 4. Ruled lines drawn as below:  5. A specific response is to a particular pathogen and only attacks specific antibody. A non-specific response is one that acts agai phagocytes which engulf and digest any pathogen and even de 6.

2	The virus enters a cell in the airways and hijacks the
5	On entry into the bloodstream, many copies of the v phagocytes.
9	The antibodies are specific to those antigens and sti pathogen and making it easier for phagocytes to find
1	A child breathes in a virus enclosed in a water drople
10	They are now immune to that strain of the viral pathc
4	The cell bursts and releases copies of the virus into t
7	Once the lymphocytes have the antigen's code, they with a complementary shape to the antigen – this ca
8	A special memory lymphocyte is also created which antigen to guard against future infections.
3	The cell's nucleus is reprogrammed to make copies
6	Lymphocytes are alerted and set about obtaining th

Lesson No.	Answers
23	***Task 5*** 1. Bacteria 2. Disease-causing microorganisms 3. A disease which has spread across several countries/continents different populations across the world 4. Antigens 5. They release toxins 6. They engulf foreign particles 7. They hijack cells and reproduce inside them, releasing many m more cells 8. They produce specific antibodies 9. No – many are useful and beneficial for our bodies ***Extension*** Artificial antibodies can be injected into the patient's blood. They w them together, so that the pathogens can be immobilised and then could be useful if the patient has an immune system which needs su AIDS, or if they are taking medical drugs which weaken their immun
24	**THE HOW AND WHY OF VACCINAT** ***Task 1*** 1. **4** On entry into the bloodstream, many pathogens are dest **1** The pathogen is isolated, and weakened or killed. **3** This is then injected into a healthy person. **8** The individual has become immune to the pathogen. **6** The antibody is specific to a particular antigen, and sticks **7** A special memory lymphocyte cell is created which will s **5** A lymphocyte recognises one of the pathogen's antigens into the blood. **2** A small amount of pathogen material is made into a vacc 2.  3. One vaccine will usually only contain the antigens for one path vaccine, such as MMR (measles, mumps and rubella), hence ea antibodies against that specific pathogen. Each pathogen has a mutations cause that code to change, so vaccines would need t pathogen known. This is an impossible task and often it is bett develop immunity to it naturally rather than artificially through pathogen is not likely to cause serious harm.

Lesson No.	Answers
24	***Task 2*** 1. Herd immunity is when a lot of people are vaccinated against, a pathogen, but a few aren't vaccinated – those few are protecte pathogen cannot easily multiply inside them, meaning it canno an unvaccinated community. 2. a) i) viral RNA, ii) strain, iii) mutations; b) they attach to viral an attaching to healthy cells; attach to viral antigens to encourage virus; c) each antibody is specific to a single antigen 3. Bacteria and, sometimes, viruses (such as the flu virus) mutate their antigens may change over time so the same antibodies no long needs to make new ones by going through the whole immune ***Task 3*** • **Lack of money**: vaccines can be expensive; not everyone has th services in developing countries; not enough money to fund re • **People don't trust government/scientists**: some people choos achieve herd immunity. Many other possible answers, including: • **Ethical objections to vaccines** (e.g. because of animal testing): vaccinated; hard to achieve herd immunity. • **Many viruses and bacteria mutate quickly**: newly developed v resources wasted. • **Many vaccines stored in specific conditions**: transporting then • As a disease becomes rarer, **people see the risk as being lower** vaccinated, so it is difficult to finally wipe out the disease. ***Extension*** 1. Pathogens are typically killed or weakened, but viruses are not killed. Some viruses may be a threat to the body even in a wea injected as these are the parts of the virus that trigger an immu When the vaccine is given, phagocytes engulf some of the antig the antigen, making specific antibodies against it. Memory cell If the 'real' pathogen enters the vaccinated person's blood, the make the specific antibodies to kill it. The vaccinated person is 2. Personal views, but look for reasoned argument and justificatio include: • Money is limited and producing a flu vaccine is expensive. • Money saved can be spent on other important medical res • Every year vaccine must be produced every year because the v • Healthy adults need the vaccine much less than people in • Some versions of the flu virus are more virulent/dangerou • Virus cannot spread easily if most people are vaccinated. • Some economic costs to not vaccinating people, e.g. days • Producing vaccine in bulk may reduce cost to vaccinate ea