Zig Zag Education

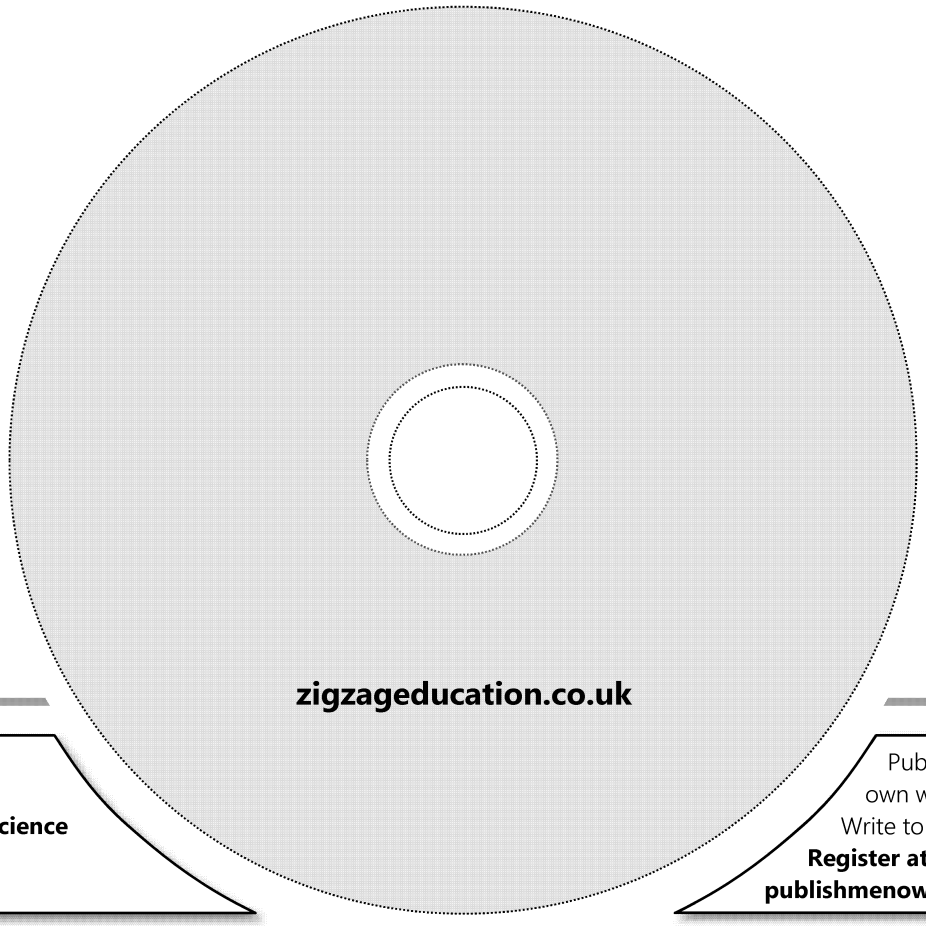
Biology

AS & A Level | OCR A | H020/H420

PowerPoints & Worksheets

for AS / A Level (Year 1) OCR Biology A

Module 4: Biodiversity, Evolution and Disease



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Contents

Product Support from ZigZag Education ii
Terms and Conditions of Use iii
Teacher's Introduction 1
Worksheets 2
4.1.1 Communicable diseases, disease prevention and the immune system 2
1.1 Pathogens and disease transmission 2
1.2 First defences 5
1.3 Phagocytosis 7
1.4 Immune responses 9
1.5 Antibodies and antigens 11
1.6 Creating immunity 13
1.7 The frontiers of medicine 15
4.2.1 Biodiversity 17
2.1 Biodiversity and fieldwork 17
2.2 Sampling species 19
2.3 Measuring biodiversity 21
2.4 Diversity in danger 23
2.5 Protecting the wild 25
4.2.2 Classification and evolution 27
3.1 The organisation of species 27
3.2 A new order: rethinking classification 29
3.3 Evolution and phylogeny 31
3.4 The mole's claws: variation and adaptation 33
3.5 Quantifying variation 35
3.6 Evolution and its implications 37
Answers 38
1.1 Pathogens and disease transmission 38
1.2 First defences 39
1.3 Phagocytosis 40
1.4 Immune responses 41
1.5 Antibodies and antigens 42
1.6 Creating immunity 43
1.7 The frontiers of medicine 44
2.1 Biodiversity and fieldwork 45
2.2 Sampling species 46
2.3 Measuring biodiversity 47
2.4 Diversity in danger 48
2.5 Protecting the wild 49
3.1 The Organisation of species 50
3.2 A new order: rethinking classification 51
3.3 Evolution and phylogeny 52
3.4 The mole's claws: variation and adaptation 53
3.5 Quantifying variation 54
3.6 Evolution and its implications 55

Appendix: **Printed handouts of the PowerPoint presentations** **(55 pages)**

Teacher's Introduction

This resource supports delivery and learning of OCR AS / A Level (Year 1) Biology **Module 4** (Communicable diseases, disease prevention and the immune system, biodiversity, and classification and evolution)

The prescribed theory is broken down into 18 topic areas:

4.1.1.1	Transmission
4.1.1.2	First Defences
4.1.1.3	Phagocytosis
4.1.1.4	Immune Responses
4.1.1.5	Antibodies and Antigens
4.1.1.6	Creating Immunity
4.1.1.7	The Frontiers of Medicine
4.2.1.1	Biodiversity and Fieldwork
4.2.1.2	Sampling Species

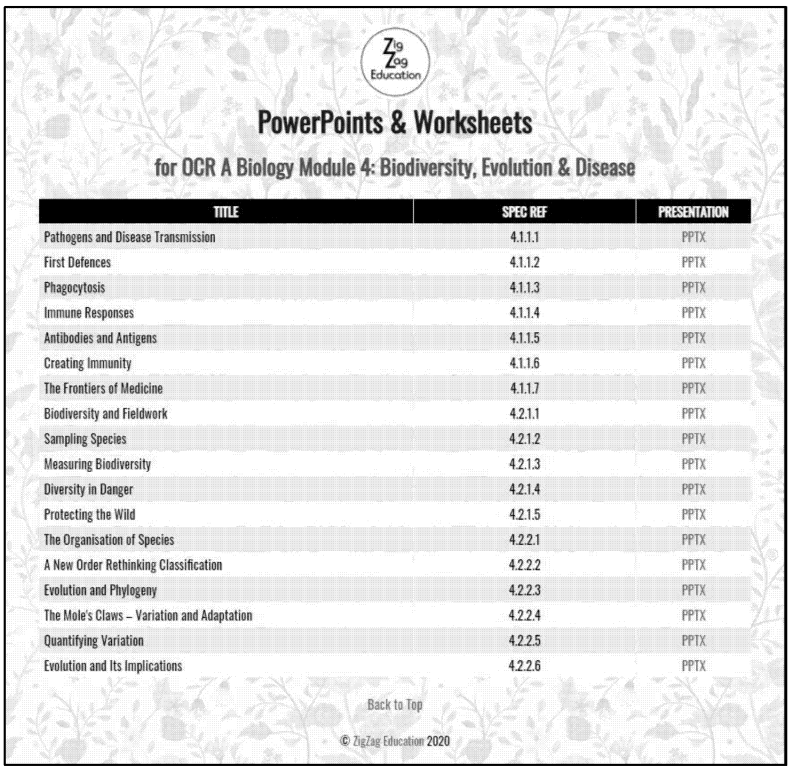
4.2.1.3	Measuring Biodiversity
4.2.1.4	Diversity in Danger
4.2.1.5	Protecting the Wild
4.2.2.1	The Organisation of Species
4.2.2.2	A New Order Rethinking Classification
4.2.2.3	Evolution and Phylogeny
4.2.2.4	The Mole's Claws – Variation and Adaptation
4.2.2.5	Quantifying Variation
4.2.2.6	Evolution and Its Implications

For each of the topic areas listed above, there is the following:

1. A comprehensive PowerPoint presentation provided on CD, covering the topic theory. Packed with student-friendly notes, diagrams and images.

Providing easy access to the presentations is an HTML menu. ⟶

Tip: *copy the Module4 folder from the CD to an accessible network location and provide a link/shortcut to the index.html file inside it.*



2. Matching worksheets designed to develop both understanding and application of the presentation content.

These worksheets feature a range of activities, including diagram labelling/annotation, definition matching and gap-filling exercises.

Answers for every worksheet, plus printed handouts for every presentation, are provided at the back of this resource.

January 2020

4.1.1 Communicable disea
disease prevention and the immu

1.1 Pathogens and disease transm

1. Fill in the gaps to complete the paragraph.

Pathogens such as bacteria and _____ replicate ver
conditions. Additionally, the genetic material of viruses _____
virulence difficult to [illegible]. Because they change rapidly, it is difficult to p
_____ programmes to provide herd immunity agai
diseases include the sexually transmitted disease _____
cells and compromises the _____ system, and the t
_____ virus, which causes brown spots to appear o
growth.

2. Under the right conditions, a specific strain of *Streptococcus lactis* can duplic
bacterium is incubated in a nutrient broth at optimum temperature, how ma
consist of after 11 hours? Give your answer in standard form.

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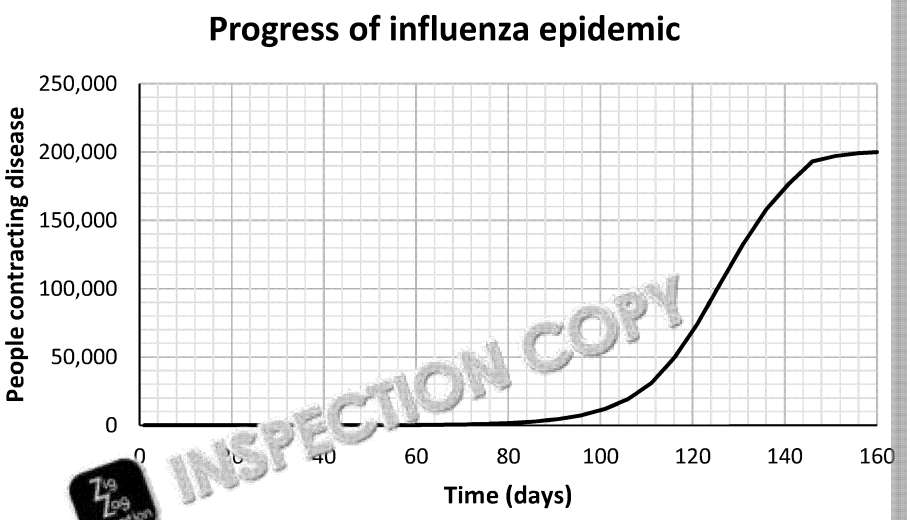
3. The graph below shows a model of transmission for an influenza epidemic in that, at the outset of the epidemic, each individual passes on the disease to



i) Identify a more appropriate method for plotting this graph.

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ii) Use a tangent to estimate the number of people infected per day at 110

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iii) Suggest an explanation for the shape of the graph after 130 days.

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4. Using malaria and influenza as examples, explain the difference between dir indirect transmission.

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5. Suggest why countries with warm, wet climates are at increased risk from di
contaminated water.

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6. Extens th reference to Guinea worm disease, outline why poverty may
infectio diseases.

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1.2 First defences

1. A plant leaf recognises the presence of a fungus. Suggest two responses the

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2. Identify two adaptations of a tree's vascular ti[illegible]ich reduce the risk of in

.....

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3. Draw lines to connect each defence mechanism to the correct description.

Phenolic	Sticky substance prod is
Resin	This cell produces muc
Glucanase	Polysaccharide depos prevent mov
Callose	Compound contain poisonous t
Goblet cell	This is produced at t s
Cytokine	Signalling substance cells to th
Histamine	Substance which br p

4. Fill in the gaps to complete the paragraph.

The mucous membrane in the throat has two major adaptations to stop in

_____ cells produce mucus, which is thick and sticky,

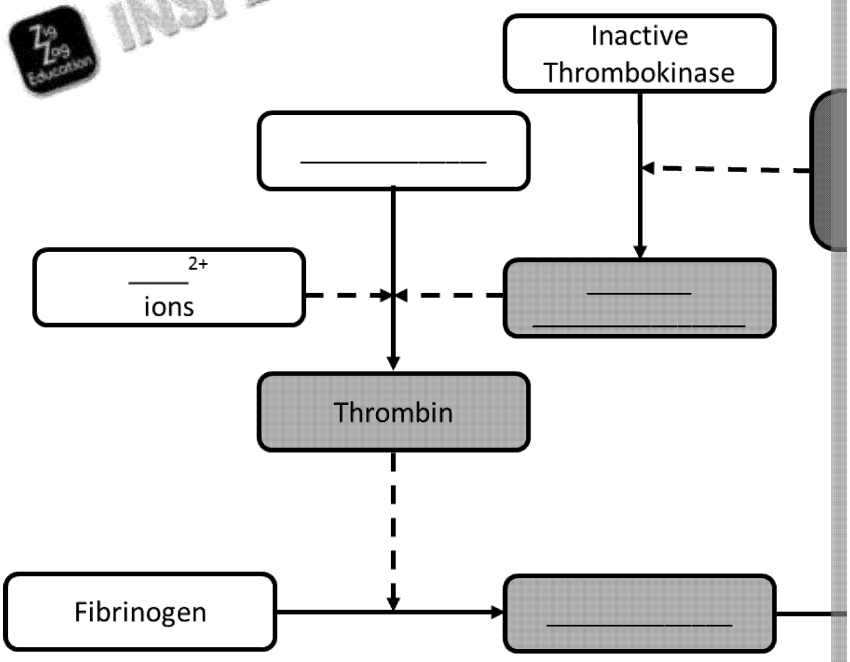
can't easily penetrate the epithelium. _____ epithelia

which _____ mucus towards the throat so it can be sv

swallowed, they can easily be destroyed by the _____

which has a pH in the range _____.

5. Fill in the gaps in the diagram to describe the process of blood clotting.



6. Extension: Review the process of blood clotting in the diagram above. State health issues which might cause an individual to continually bleed when they

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1.3 Phagocytosis

1. Fill in the gaps to complete the paragraph.

Neutrophils can be recognised by their multilobed nucleus; they are a type
blood cell, unlike _____ blood cells which have no nuc
_____ on the surface of a pathogen, they grow 'arms'
engulf it. They then digest the pathogen using _____
stored in organelles called lysosomes. The number of lysosomes present in
cytoplasm its _____ appearance.

2. Draw a diagram which shows how macrophages process pathogens.

3. Why do you think antibodies are specific to a single antigen rather than bindin

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4. Write a definition for each of the following terms:

Opsonin: .....

.....

.....

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Antigen presenting cell: .....

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5. Open extension: Research and write a paragraph about how cells recognise a

1.4 Immune responses

1. Unscramble the words below, and match each unscrambled word to a descri

IKONEMON ***TELL-RELLICK*** ***CASTL***

NIURENKITEL ***MOOWERBARN*** ***T***

Where B-lymphocytes are made and mature.	
Cytokine produced by macrophages to promote B-cell expansion.	
Any cell surface molecule used to [illegible] a cell as non-self.	
Chemical [illegible] T-helper cells to recruit other immune cells.	
This cell produces perforin to rip cell membranes apart.	
A T-helper cell marks out a B-cell for activation.	

2. Describe what happens during and after clonal expansion of a B-cell.

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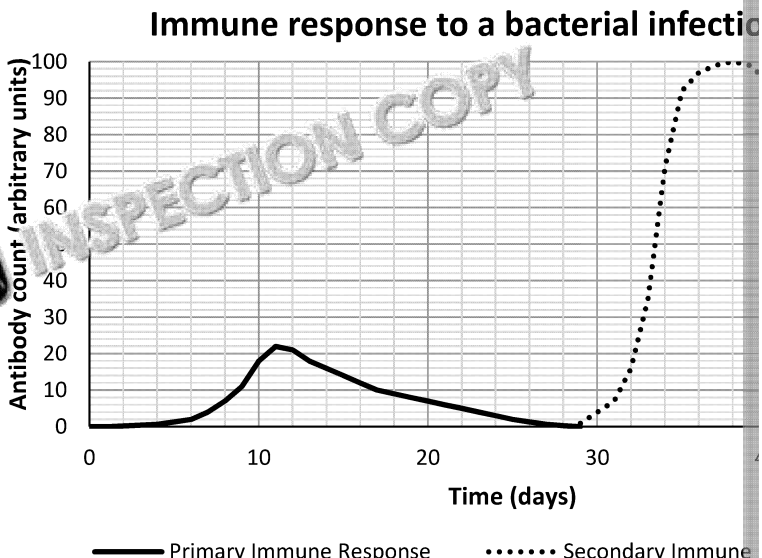
3. The graph below shows the difference between antibody levels in a primary and



i) Describe the reason for the different shape of the two curves.

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ii) Use a tangent to measure the rate of antibody production at day 32.

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4. Extension: The article you have read includes examples of positive feedback a
the difference between the two, giving an example for each. *(Your examples c*

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1.5 Antibodies and antigens

1. Mark the following statements as either true or false, and correct the false st

   A) Antibodies act as agglutinins, cross-linking to each other to make larger

   .....

   B) An antibody molecule is made up of four heavy chains and two light cha

   .....

   C) The separate peptide chains in an antibody are joined together by stron

   .....

   D) Antibodies act as antitoxins, binding to toxins so that they are no longer

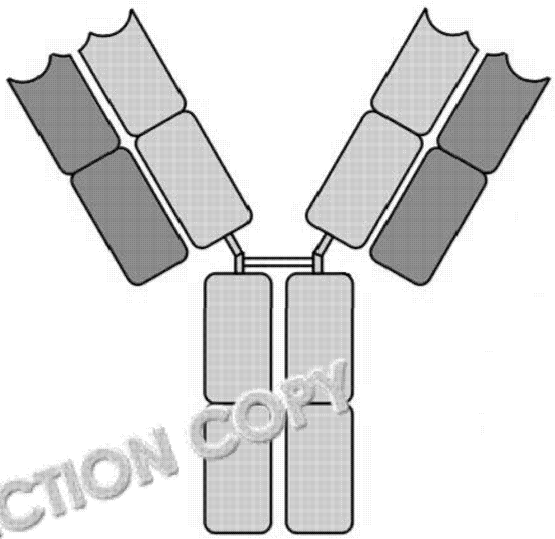
   .....

   E) Antibodies bind to antigens, which are protein molecules on a pathogen

   .....

2. Label the antibody to show a part which:

   i) would be different in two different antibodies
   ii) binds to the receptor of a phagocyte or T-killer cell
   iii) consists of an S–S bond between two amino acid chains



3. How is the relationship between an antibody and its antigen similar to, and d
between an enzyme and its substrate?

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4. Open extension: Produce a diagr[illegible] w[illegible] shows, in stages:

- how a B-cell t[illegible] into different cells
- h[illegible] cells produce antibodies which bind to pathogens
- ho[illegible] can destroy a pathogen population

(There are different approaches you could take – a flow chart or sketches of eac

1.6 Creating immunity

1. For each event listed, identify the type of immunity which is created.

   i) A child receives an MMR vaccine.

   .....

   ii) A patient receives a tetanus jab to stop them from being poisoned by th

   .....

   iii) A baby absorbs immunoglobulins from its mother's milk.

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2. An individual is occasionally inoculated with antibodies to prevent the outbreak
   Suggest two reasons why this method of treatment does not replace vaccina

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3. Draw lines to connect each word/phrase to its definition.

Colostrum	Communicable diseas
Attenuate	Introduce a pathog r
Antigen	A surface protein or g
Inoculate	lk produced by the is rich
Ring vaccinati	To weaken a pathog
Rubella	Creating immunity in recent contact wi

4. Identify two ways in which Jenner's technique was more dangerous than mo
attenuated pathogens and hypodermic needles.

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5. Open extension: Fa[illegible] the diseases listed below, research and explain
progra[illegible] ha[illegible] been developed.

HIV/AIL[illegible] Malaria, Zika virus

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1.7 The frontiers of medicine

1. Fill in the gaps to complete the paragraph.

_____ medicines, such as willow bark and henbane, to treat diseases. An example is _____, from poppy painkilling (and recreational) drug opium, but is now used in carefully regul doctors. However, the search for new medicines from nature goes on. Van _____ which was found in _____ _____ can be used to destroy anthrax _____ been used in mode[illegible]n.

2. Explain whether each of these substances could be effective as an antibiotic.

a) A drug which breaks down peptidoglycan cell walls.

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b) A drug which stops 80S ribosomes from producing proteins.

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c) A drug which causes DNA which is not protected by organelles to fragm

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3. Fill in the gaps to complete the table.

Type of drug	Effect
	Modifies the behaviour of the immune system; reduces the likelihood/intensity of immune responses.
Anti-inflammatory	

4. In synt…io…gy, bacteria may be genetically modified to produce valuab…
why ba…are used for this process.

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5. Explain how antibiotic resistance spreads throughout a population.

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6. Extension: Type 1 diabetes is considered to be an autoimmune disease. It oc…
pancreas are destroyed, and the body can no longer pr…uce the hormone in…

Suggest the role which the immune syste… …lay.

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4.2.1 Biodiversity

2.1 Biodiversity and fieldwor

1. Statements about some ecological terms are written below. Match them to t
term. The first one has been completed for you.

   i. The place where an organism lives.

   ii. All of the organisms, of all of the differ nt s ies in a habitat, living an
with each other.

   iii. A self-or self-perpetuating system, made of all of the organism
e ment in which they live and interact.

   iv. A group of organisms of the same species, living in the same place, at t

   v. The variability among living organisms from all sources, including terre
and other aquatic ecosystems, and the ecological complexes of which t

   vi. Group of organisms with similar characteristics, and potentially able to
and have fertile offspring.

   A = habitat B = species C = biodiversity D = population E = c

2. State three types of biodiversity, and explain what each type tells us about a

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3. Thandi is a sixth-form student who wants to investigate attitudes to school u
to take a stratified sample by gender and by school year.

i) Outline a method Thandi could use.

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ii) Thandi initially plann[illegible] to h[illegible] out surveys to 50 students as they arrive
sampling wou[illegible]s t[illegible]?

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4. For each example, identify the type of sampling being carried out.

A) A university Social Science department is studying attitudes to money f
incomes. They split their survey responses into high income (20 %), mec
income (30 %), and only use 100, 250 and 150 surveys from each group r

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B) An ecologist uses a random number generator to pick coordinates on a
these coordinates, counting the plants within each quadrat.

.....

C) A hotel leaves out questionnaires asking people to rate their stay, and c

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D) A zoologist measures the echolocation activity of bats using an ultrasou
period, repeating this at half hour intervals throughout a day.

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5. Extension: Sampling errors can cause your data to be fundamentally flawed,
results. A famous example of a sampling error occurred when the *Literary Di*
of the USA 1936 election. Research this error and explain the errors which v

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2.2 Sampling species

1. Describe the difference between a point quadrat and a frame quadrat.

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2. A group of college students wants to investigate how biodiversity changes ov
the ed[illegible] the sand dunes. Describe a way the students could carry out an a

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3. Fill in the gaps to complete the paragraph.

Small insects can be removed from trees without harming them using a po
_____. The suction created by the mouthpiece draws
chamber, while a _____ stops insects from being suck
live mostly on the ground, they may be captured by digging a small, steep-
_____ trap, and covering it with leaves and other deb
_____ net may be used to capture insects which live i
organisms (such as worms and crustaceans) which live on _____

4. A gardener was upset by snail damage to his lettuce, so he decided to find ou
first night, 40 snails were captured, marked and then released. The following
snails was taken, 24 of which had been marked.

i) The paint the gardener uses is bright red. Suggest why this might make

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ii) Using the Lincoln index, estimate the snail population size.

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5. Open extension: The sampling techniques discussed are all used to sample p
and write about some techniques used to sample large animals.

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2.3 Measuring biodiversity

1. A list of recorded observations from a field trip is shown below. For each obse measure of density, frequency or percentage cover.

Observation	Measu
6 dandelions m^{-2}	
Tussock sedge grass – 13 of 30 quadrats, 43 %	
Marram grass – dominant (> 75 %)	
8 acorn barnacles per 50 × 50 cm q a ra	

2. Using the diagram to t estimate the percenta ov cies A and B.

3. Using the data provided in the table below, comment on the species richness A and B.

Species	Field A			
	Number present	n/N	$(n/N)^2$	Number present
Perennial rye grass	71			30
Timothy grass	10			25
Dandelion	4			7
Daisy	8			6
White clover	3			25
Meadow but	4			7
To	100			100

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4. Fill in the gaps in the table on the previous page, and use the information yo
Simpson's Diversity Index for each field.

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5. a) An endangered flightless bird population is studied on an island in the S
The bird species has 25,518 genes, of which 339 a[illegible]hown to be polymo
Calculate the genetic diversity of the po[illegible]tio[illegible]

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b) The bird population's genetic diversity is low, compared with other popu
concern the ecologists studying the species.

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6. Extension: Write a paragraph explaining why agricultural land generally proc
and scores low on different measures of biodiversity.

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2.4 Diversity in danger

1. The study of biodiversity loss provides many examples of cause and effect be
your reading, give one example.

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2. Fill in the gaps to complete the paragraph.

Cities are a major cause of _____ destruction – they r
into the rivers and build on the habitats which organisms live in. Howeve
(farming-based) land use also reduces diversity. A single species is grown a
_____. The surviving parts of the ecosystem may be p
_____ become isolated from one another, and the ___
diversity of each new group is low.

3. Draw lines to connect the words to their descriptions. Two of the words have

Invasive species	
Habitat diversity	A chemical that may b deter small inver
Cultivar	You could get a mea Diversity I
Species diversity	A specific variety of a as wheat or rice h
Pesticide	A variety of a croppe do
Herbicide	These may take over e other organis
l type	

4. In the table below, write two arguments for preserving biodiversity in each c

	Aesthetic	Ecological
1		
2		

5. Explain why low genetic diversity increases the risk of extinction for populati

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6. Open extension: A politician says that *'humans shouldn't worry about climate* which explains why the politician is wrong, from a biodiversity perspective.

2.5 Protecting the wild

1. Define the following terms.

   Stud book: .....

   .....

   Site of special scientific interest (SSSI): .....

   .....

   Convention on International Trade in Endangered Species (CITES): .....

   .....

2. Classify the conservation methods listed below as either in situ or ex situ.

Scheme	Cons
Berlin Zoological Garden	
Grand Teton National Park, Wyoming	
Watercress Nature Reserve, St Albans	
UPM Seed Bank, Madrid	

3. Based on what you have read and your own reasoning, fill in the grids below disadvantages of *in situ* and *ex situ* conservation.

in situ – conserving in an area where the organism is n	
Advantages	**Dis**

ex situ – conserving outside the area where the organis	
Advantages	**Dis**

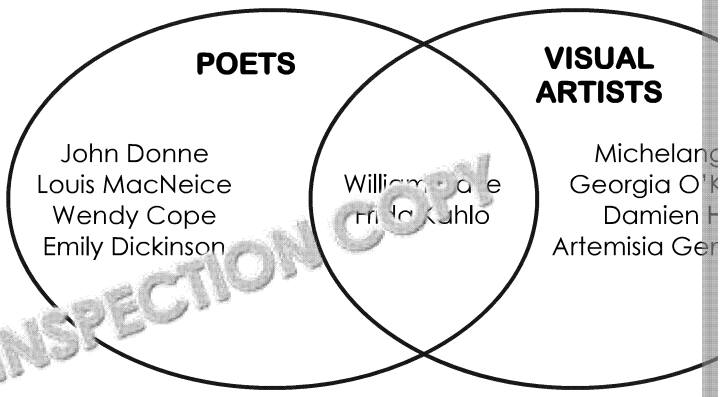
4. Write a paragraph to explain the purposes of seed banks.

5. Extension: You are the head of a conservation organisation which is asked to
which has recently become extinct in the wild, and only exists in captivity. W
different approaches to explain how you might ensure the survival of the spe

4.2.2 Classification and evol

3.1 The organisation of specie

1.



The diagram above shows a simple classification system for famous artists. E could not be used to classify a group of organisms in a taxonomic system.

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2. Write the numbers 1–7 in the empty boxes to order the classification of the n with the most organisms, and 7 for the taxon with the fewest organisms.

Classification	Rank
Genus: *Salmo*	
Class: Actinopterygii	
Species: *Sa...*	
Family: Salmonidae	
Phylum: Chordata	
Order: Salmoniformes	
Kingdom: Animalia	

3. A red kangaroo has the binomial *Macropus rufus*. Identify whether each of th
or false, and correct the false statements.

A) The red kangaroo must be the only species in the genus *Macropus*.

.....

B) The genus *Macropus* may include animals with radically different body p

.....

C) If you are writing 'Macropus rufus' by hand, you should underline it to sh

.....

D) No other organism can have the specifi na e *rufus*.

.....

E) No other s e s n have the binomial name *Macropus rufus*.

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4. Extension: Describe the purpose of a taxonomic classification system, and gi
taxonomic system.

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3.2 A new order: rethinking classifi

1. Unscramble the words, and match each unscrambled word to a description.

OHEXBOOM ***UNTIMETEUCALL***

SKOTEPARROY ***PHOTORASPR*** ***A***

Organisms without a nucleus – like one of the five kingdoms.	
A system of groups and ranks which is used to organise species scientifically.	
A slow-evolving gene which is involved in producing the body pattern of an organism.	
An organism which gets its nutrients by breaking down organic compounds in dead matter.	
A structure with several nuclei within the same cell membrane.	
Kingdom of unicellular organisms which includes amoebas and green algae.	

2. Suggest which kingdom each of these species belongs to, according to the fi classification.

   a) A motile, single-celled organism with a flagellum, which has both chlor

   .....

   b) A multicellular spore-producer which grows on a dead organism and secr

   .....

   c) An organism which has no cytoskeleton or membrane-bound organelle and a cell wall rich in peptidoglycan.

   .....

   d) An autotrophic eukaryote with a cellulose-based cell wall.

   .....

   e) A heterotroph which has many differen tissues and has sensory recept evade danger.

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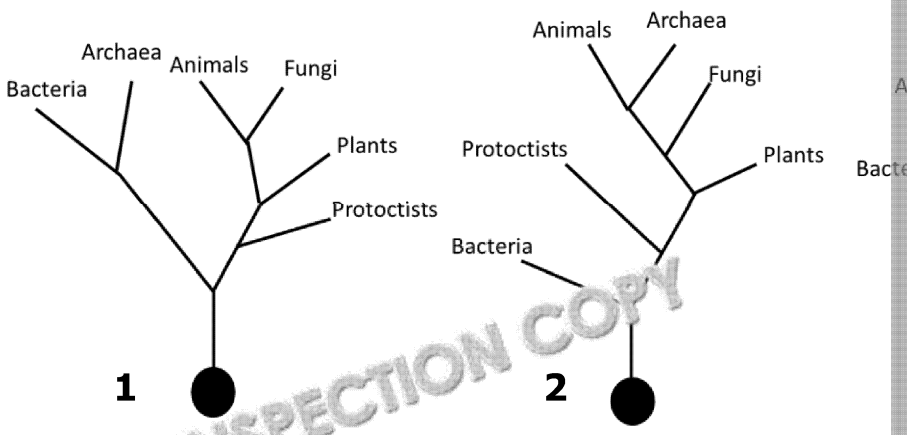
3. Which of these 'family trees' most accurately describes the relationship betw
according to the three-domain system of classification?
(The black circle at the bottom of each tree represents the common ancestor of



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4. Explain how the three-domain system of classification both agrees and disagree
classification.

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5. With reference to the information you have read, describe the relationship b
and scientific discovery.

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6. Extension: Some recent research su[illegible] th[illegible] certain Archaea known as 'A
have eukaryote-like cytoske[illegible] s[illegible] have some membrane-bound intern
scientists to questi[illegible] domain system of classification. Explain:

i) w[illegible] fe[illegible]ures described are significant

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.....

ii) the implications this discovery could have for classification systems

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3.3 Evolution and phylogeny

1. Write a short definition for each of these terms.

   Adaptation: .....

   .....

   Taxonomy: .....

   .....

   Phylogenetic tree: .....

   .....

2. Describe the significance of reproductive success in the theory of evolution.

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3. The evidence for evolution in the PowerPoint presentation mentions that te
   land animals in the fossil record. Suggest why this provides evidence for the

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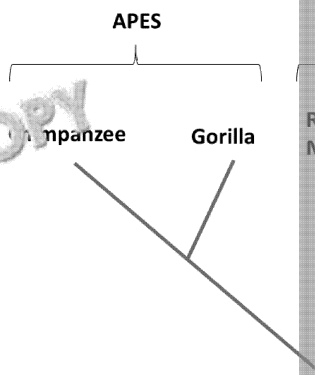
4. Look at the phylogenetic tree to the right.

   a) Identify:

      i) an outgroup to the Old World Monkeys

      ii) a sister group to the M[illegible]ques



b) The Rhesus Macaque and the Olive Baboon are in different genera. Exp
that the Olive Baboon and the Angola Colobus do not belong to the sa

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c) What does the diamond repres

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5. Open extension: You are trying to convince a sceptic that evolution has occu
argument which you would make to the sceptic. (You can include original re

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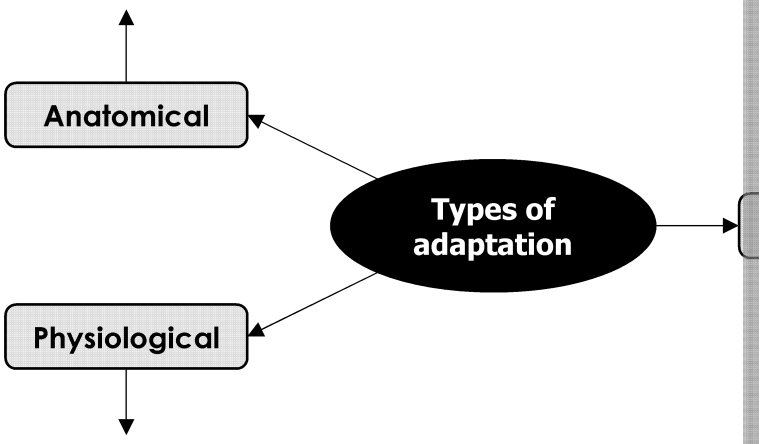
3.4 The mole's claws: variation and ac

1. Fill in the gaps to complete the table.

Intraspecific variation	Occurs between organisms from __
_____ **variation**	Occurs between organisms from _____ as _____ sha
Continuous variation	A trait or characteristic can tak _____, such
_____ **variation**	Variation fits into _____ blood type in humans is either

2. Fill in the adaptation diagram with your own examples.



3. Briefly ... in the relationship between types of variation and the number ...

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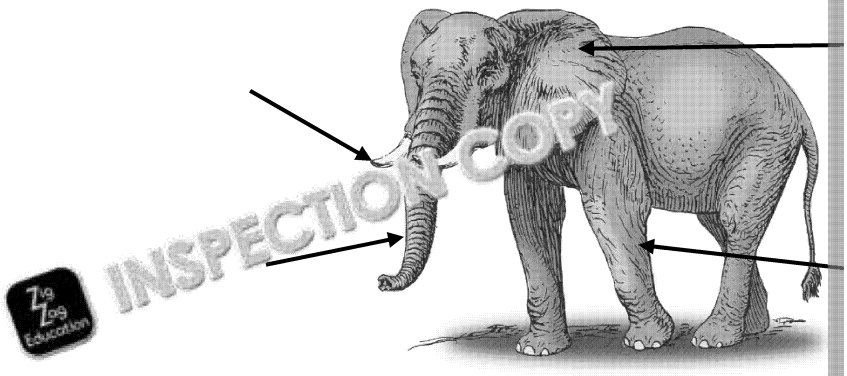
4. African elephants are adapted to a hot, dry climate; they also have adaptatic organisms and to compensate for their large size. Label the image of the ele anatomical adaptations, with a biological explanation for each.



5. Open extension: Research an example of convergent evolution. Describe the example species, and explain why they share similar adaptations.

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1. Two populations of skua (a migratory seabird) are studied; one population su
one population summers further north, in the Arctic Ocean.

The tail feather length is measured in the two populations of skua.

Pop. 1 tail feather length (cm)	22.2	24.2	19.0	26.4	28.1	20.8	21.4	22.7	
Pop. 2 tail feather length (cm)	21.1	28.5	27.6	23.8	25.	31.7	24.6	25.9	

a) Calculate the mean length of population 1's tail feathers.

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b) Calculate the standard deviation of population 2's tail feathers, using th

$$\sqrt{\frac{\sum(x - \bar{x})^2}{n - 1}}$$

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c) Carry out a t-test to compare the two populations.

$$t = \frac{\pm(\bar{x}_1 - \bar{x}_2)}{\sqrt{\frac{(\sigma_1)^2}{n_1} + \frac{(\sigma_2)^2}{n_2}}}$$

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d) Using the table in [illegible] or 1, suggest whether the difference between t
significant

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2. An animal breeder is investigating whether there is any correlation between
average weight of offspring (at birth) in cats. The data she gathers is shown

	Number of offspring	Mean weight (g
1	2	96
2	6	66
3	1	105
4	3	111
5	4	94
6	3	72
7	3	75
8	5	83
9	2	122
10	7	60

Calcul Spearman's rank correlation coefficient for the two variables.

$$r_s = 1 - \frac{6\sum D^2}{n(n^2-1)}$$

Number of offspring	Rank	Mean weight (g)	Rank	
2		96		
6		66		
1		105		
3		111		
4		94		
3		72		
3		75		
5		83		
2		122		
7		60		

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3. Extension: Explain the diff ence between a one-tailed t-test and a two-taile
circumstances in w h you would choose to use a one-tailed t-test.

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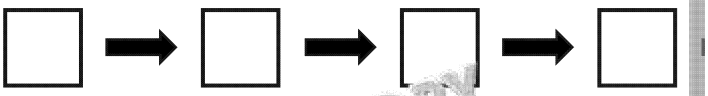
3.6 Evolution and its implicatio

1. Put the following sentences in order to describe natural selection.

   A) The characteristic is useful, and causes organisms which have it to outc
   B) Over time, the advantageous trait becomes more common in the popul
   C) Some offspring inherit the useful trait from their parents, and have mor
   D) These organisms, on average, produce more healthy young than their ri
   E) A trait arises due to a mutation, or already exists in a population but is n



2. Match each word to a definition, and w it in a definition for the unmatched

Antibioti	Something which favoured v
Selection pressure	Natural selection c in a
Adaptation	Ability to produc to
Resistance	Anything which spe environment
Reproductive success	
Evolution	Medicine which is use

3. Referring to what you have read, explain why pesticide resistance could pose farming community.

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4. Exten t precautions which GPs and hospital doctors could take to red resistan terial infections.

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Answers

1.1 Pathogens and disease transm

1. viruses, mutates, vaccination, HIV/AIDs, immune, mosaic

2. If a bacterium is duplicating, we can use the formula $N = 2^r$, where N is the tota number of duplication events.

   11 hours = 660 minutes

   r = $\frac{660}{30}$ = 22 duplication events

   N = 2^{22} = 4 194 304

   = 4.2 ×

3. i) Use log scale – this will make transmission throughout the first 80 days vi
   ii) Tangent drawn on graph to intercept curve at 110 days passes (roughly) thr (140, 115 000). Therefore, rate of infection is roughly $\frac{115\,000}{40}$ =2875 people pe you have drawn, your answer may reasonably range from 2700 to 3150 peo
   iii) As more people become infected, the number of people who have not prev person is less likely to come into contact with someone who has not been i of transmission falls.

4. Influenza is spread by direct transmission – droplets of mucus are spread throug coughs or sneezes, and the virus is directly ingested/inhaled by another person. organism such as a mosquito, which drinks blood from an infected person and th passing on the protoctist which causes the disease. The mosquito passes on the contract malaria, so this is indirect transmission.

5. Countries with warm, wet climates will tend to have more standing water becau higher. In addition, stagnant water will be warmer, allowing pathogens to grow also worth noting that many vectors, such as mosquitoes and dengue flies, lay th water.)

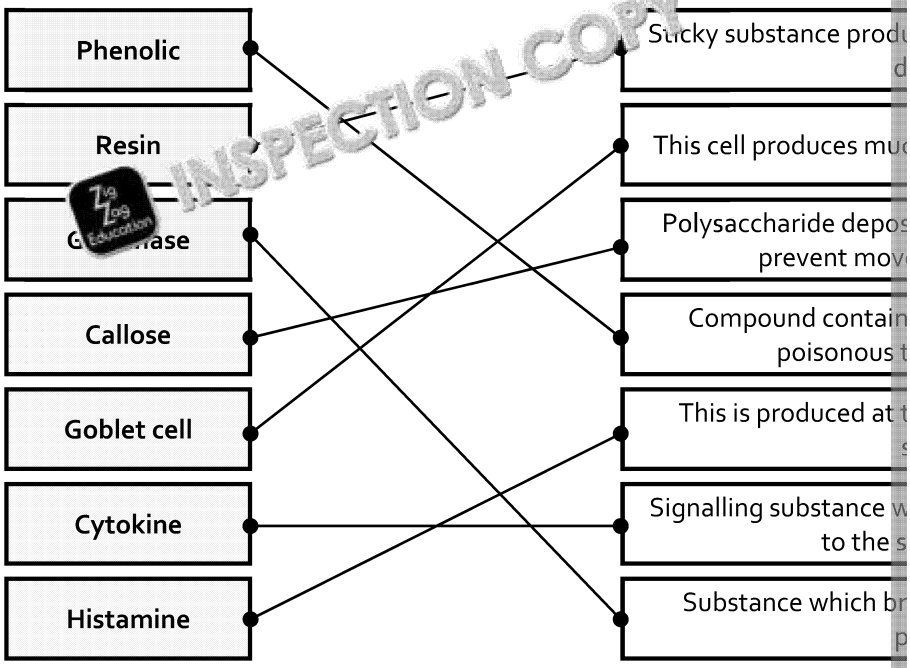
6. There are many possible reasons why poverty may be linked to communicable d
   - Overcrowding is more common in poor urban communities (e.g. favelas).
   - Poor communities may not have drainage systems to reduce quantities of s
   - Lower literacy and lack of awareness may also contribute.
   - Lack of facilities for treating water; lack of safe drinking water.
   - Healthcare facilities may be poorly funded, overstretched or absent.

1.2 First defences

1. • Produce an antifungal compound such as a phenol/terpenoid.
   • Thickening cell walls and increasing the quantity of lignin in the walls, to pr
   spreading/growing into the protoplast.

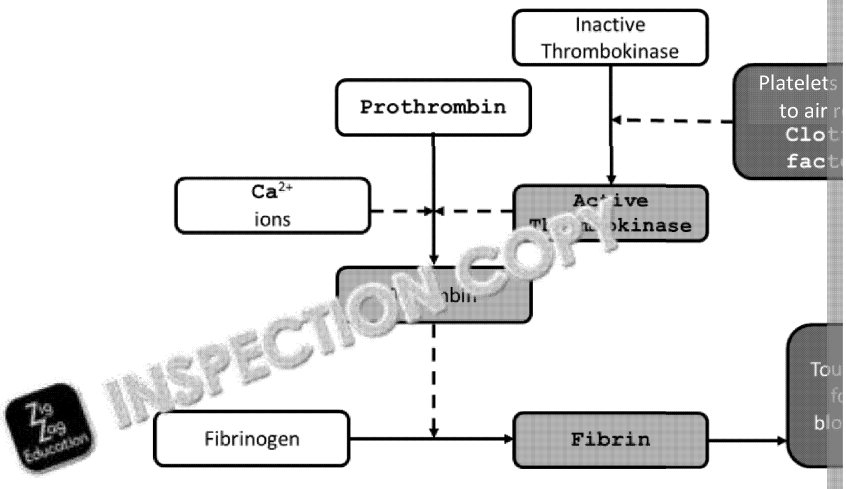
2. • Lignin in walls of xylem is waterproof or very difficult to break down.
   • Callose can be used to block dysfunctional/infected phloem sieve tubes, wh
   moving through the tree.

3.



4. goblet, ciliated, waft/brush, acidic, 1.5–3.5 (accept 1–3)

5.



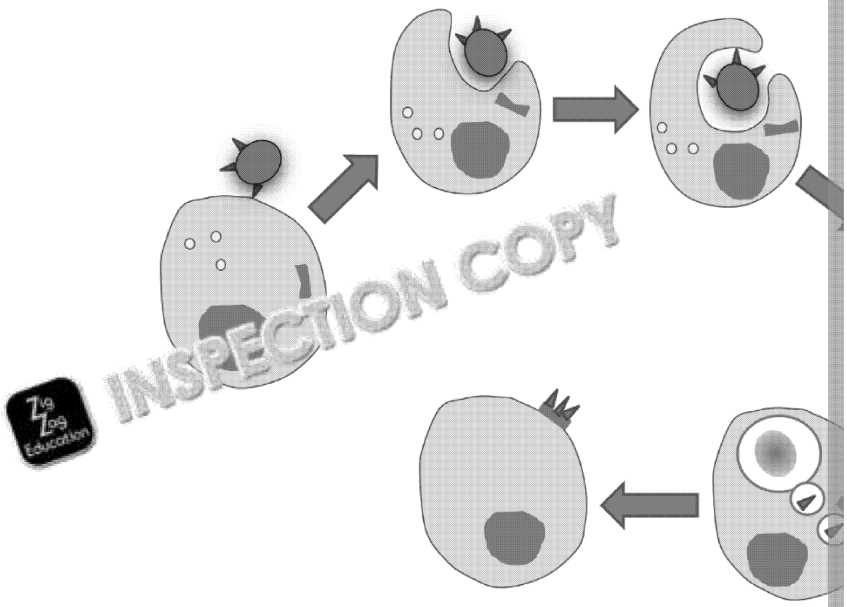
6. Mutation in a gene which creates one of the enzymes in the cascade – if any enz
would not form correctly.

   Reduced numbers of platelets in the blood- fewer clotting factors produced.

   Dietary calcium deficiency – fewer ions available for thrombin activation.

1.3 Phagocytosis

1. white, red, antigen, lysozymes, granular

2. 

3. If antibodies attached to a range of different antigens, they would be more likely own cellular antigens. This could cause the immune system to attack the body's

4. **Opsonin** – an antibody or other molecule which can attach to antigens on a path pathogen easier for phagocytes to recognise and engulf.

   Antigen-presenting cell – a phagocyte which presents antigens from engulf membrane, so that other lymphocytes recognise them.

1.4 Immune responses

1.

Where B-lymphocytes are made and mature.	
Cytokine produced by macrophages to promote B-cell expansion.	
Any cell surface molecule used to recognise a cell as non-self.	
Chemical made by T-helper cells to recruit other immune cells.	
T-cells produces perforin to rip cell membranes apart.	
A T-helper cell marks out a B-cell for activation.	

2. The B-cell divides rapidly and differentiates, producing many B-plasma cells and
The B-plasma cells produce antibodies, which attach to pathogenic antigens, lab
marking them out for destruction.

3. i) The primary immune response has a shallower curve because the immune r
because there are only a few B-cells which recognise the specific pathogen,
cells, such as APCs, it can take some time for a full immune response to be
response, B-memory cells quickly recognise a pathogen and divide to produ
cells, overwhelming the pathogen with antibodies.

   ii) 20 a.u. per day (accept 18–22 a.u.)

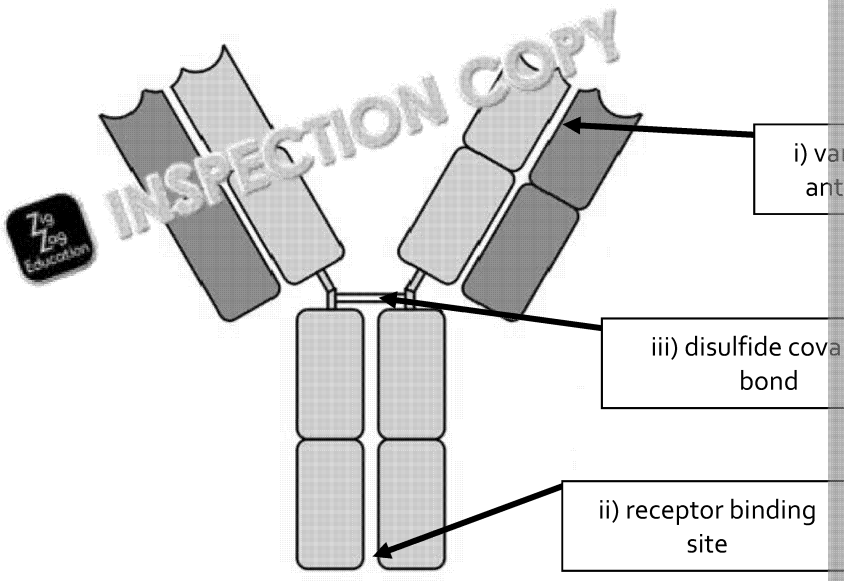
4. Negative feedback – a process causes an outcome which slows down the proces
There are many possible examples: to give just one, the production of insulin cau
which in turn inhibits the production of insulin.

   Positive feedback – a process causes an outcome which causes the process t
intensely. Again, there are many possible examples: e.g. during childbirth, th
hormone oxytocin to be produced, which in turn causes the cervix to dilate m

1.5 Antibodies and antigens

1. A) False – this is not how antibodies work, but they can bind to two pathogens t
   B) False – antibodies are made up of two heavy chains and two light chains
   C) True
   D) True
   E) False / Partly true – antibodies can be other molecules, such as polysaccharid

2.



3. An antibody has a variable 3D shape around its binding site, which is able to bin
same way, an enzyme has a specific 3D shape which determines the shape of its
site only binds to a specific substrate, or small group of substrates. In each case,
structural support.

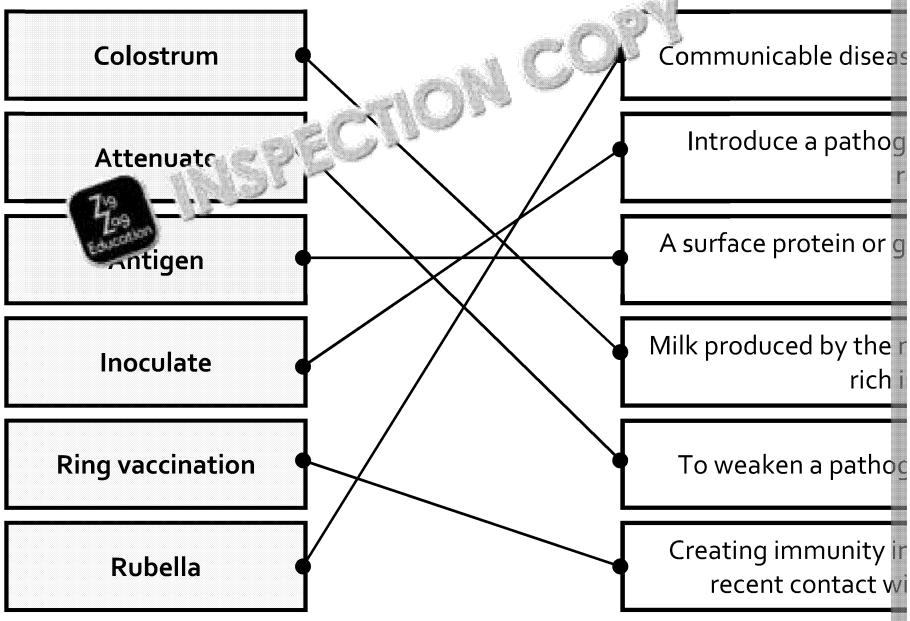
   Antibodies, however, don't catalyse a reaction in an antigen, as enzymes do
substrate. Instead, they bind to the antigen and allow the pathogenic cell to
killed by a T-helper cell.

1.6 Creating immunity

1. i) artificial, active; ii) artificial, passive; iii) natural, passive

2. This does not provide immunity to a disease; the pathogens are destroyed by ph
are not created so the body will not recognise the pathogen if infected again. Ac
effective unless an individual has already been infected by the pathogen.

3.



4. Jenner's technique actually used 'live' cowpox viruses, which meant that the patie
a risk to patients with a weak immune system, who would have suffered more sev
from cowpox blisters may have become infected by other pathogens, or containe

1.7 The frontiers of medicine

1. traditional; morphine; antibiotic; fungus; anthracimycin; spores

2. a) Yes; peptidoglycan cell walls are common to a wide range of bacterial cells,

   b) No; eukaryotes have 80S ribosomes, not bacteria. This would kill eukaryoti

   c) Yes; bacteria do not have organelles (this might also kill eukaryotic cells wh

3.

Type of drug	Effect
Immunosuppressant	Modifies the behaviour of the immune system; reduces the likelihood/intensity of immune responses.
Anti-inflammatory	Reduces inflammation; reduces the response to histamines; slows or halts damage to bones in arthritis.

4. Possible reasons include:
   - Bacteria are cheap to culture and nourish (using a nutrient broth).
   - No ethical issues around using/killing bacterial cells.
   - Bacteria grow and divide very quickly and can produce a substance in bulk.
   - Bacteria are easy to genetically modify because they can absorb small loop learn more about this in Module 6: Genetics, evolution and ecosystems).

5. An individual bacterium develops a mutation which makes it able to degrade or antibiotic. Any bacterium which develops resistance has a huge advantage in an particular antibiotic is commonly used, so it will tend to divide quickly and form reproduce asexually, the daughter cells will all be genetically identical (apart fro all carry the gene for antibiotic resistance.

6. Immune system cells involved in recognition (such as macrophages and B-mem α-cells as pathogens. Antibodies are produced, and an immune response is crea phagocytes then gradually destroy the α-cell tissue.

2.1 Biodiversity and fieldwor

1.

i. The place where an organism lives.

ii. All of the organisms, of all of the different species in a habitat, living an other.

iii. A self-contained, self-perpetuating system, made of all of the organism in which they live and interact.

iv. A group of organisms of the same species, living in the same place, at th

v. The variability among living organisms from all sources, including terres aquatic ecosystems, and the ecological complexes of which they are a p

vi. Group of organisms with similar characteristics, and potentially able to fertile offspring.

2. *Habitat diversity* – describes the range of habitats in an environment, and indicat niches can be filled by organisms.

Species diversity – describes the number of species which are found in an env each species is).

Genetic diversity – describes the variety of alleles present in the population o

3. i) Get a list of students in each year, and add up the number of students in ea of students in the school as a whole). Divide the number of students in each in the school to get a percentage, e.g. 1208 / 1300 = 16 %.

Then, give each student in a year a number, e.g. 1–182. Use a random nu students until they make up a correct proportion of the total sample size these students their opinion about school uniform.

ii) Opportunistic sampling

4. A) Stratified sampling; B) Random sampling; C) Opportunistic sampling; D) Syst

5. Sampling was carried out by collecting responses from the mailing list of *Literary* an appropriate sampling method because the sample selected to be representati Readers on the mailing list of the *Literary Digest* were older and richer than the a population, and these people were more likely to vote for the Republican candid people who did not respond may have had different attitudes than those who di

2.2 Sampling species

1. A point quadrat consists of a bar of wood with legs at each end, and holes at reg through each hole to choose a plant to sample. A frame quadrat is a two-dimens wires or string across it at regular distances to create a grid of squares.

2. Measure and lay out a section of rope 120 m long, running perpendicular to the s sand dunes. Place a second section of rope parallel to the first, one quadrat's wi regular intervals (e.g. every 10 m) along the transect, place a quadrat between th individual plants present in each quadrat.

3. pooter, filter, pitfall, sweep, riverbeds

4. i) Snails marked with bright paint [illegible] conspicuous than unmarked snail by predators. This means that [illegible]ked snails will be under-represented in th

   ii) First sample size = 40; second sample size = 60; number marked in second s

   Lincoln index = $\frac{n_1 \times n_2}{n_{marked}} = \frac{40 \times 60}{24}$

   Estimated snail population size = 100

2.3 Measuring biodiversity

1.

Observation	Mea
6 dandelions m^{-2}	Density
Tussock sedge grass – 13 of 30 quadrats, 43 %	Frequency
Marram grass – dominant (> 75 %)	Percentage cover
8 acorn barnacles per 50 × 50 cm quadrat	Percentage cover

2. A: 19 % cover (accept 17–21 %); B: 30 % (accept 28–32 %)

3. Both fields have the same species richness, since five species are counted in each greater species evenness, since it does not have one highly abundant species. In makes up a high proportion of all the plants present.

4.

Species	Field A			
	Number present	n/N	$(n/N)^2$	Number present
Perennial rye grass	71	0.71	0.49	30
Timothy grass	10	0.10	0.01	25
Dandelion	4	0.04	0.0016	7
Daisy	8	0.08	0.0064	6
White clover	3	0.03	0.0009	25
Meadow buttercup	4	0.04	0.0016	7
Total	100	1	0.5105	100

Field A: D = 1 – 0.5105 = 0.49 (2 sf)

Field B: D = 1 – 0.5105 = 0.77 (2 sf)

5. a) Genetic diversity = $\frac{\text{Number of polymorphic loci}}{\text{Total number of loci}}$

$D = \frac{339}{25\,518} = 0.0133$ or 1.33 %

b) Populations with high genetic diversity are more resilient, and are less likely contain alleles which will allow the population to thrive in a range of conditi endangered population is at high risk of extinction.

6. Agricultural systems in general score low on indices of diversity because they usual This species is the crop which is being grown. Other plant species will compete v nutrients in the soil, and farmers may actively remove these species by hand addition, because trees and shrubs are removed to create larger fields, the numb genetic diversity is typically low because crop plants may be cloned from a pare characteristics.

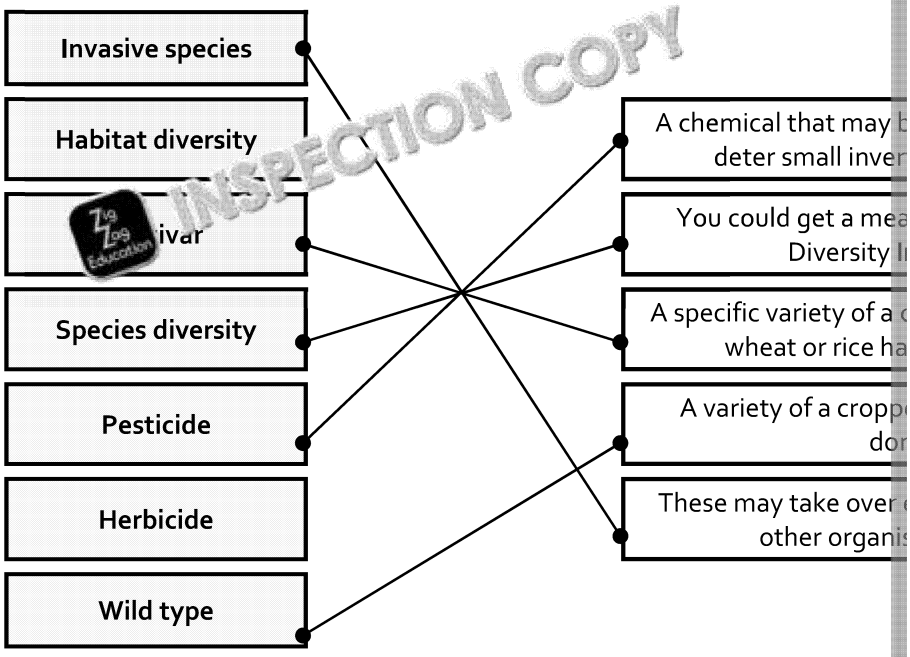
2.4 Diversity in danger

1. e.g. Agriculture causes climate change by removing trees which act as CO_2 sinks increases the need for new agricultural land by causing desertification and maki

   e.g. Climate change is a cause of biodiversity loss, since it leads to desertificatio and rainforests may also cause climate change, since it can make these ecosyste

2. habitat, agricultural, monoculture, populations, genetic

3.



4.

	Aesthetic	Ecological	
1	• The natural world is full of beauty which should be preserved for its own sake.	• Top predators are often keystone species; they are disproportionately affected by loss of biodiversity.	•
2	• Nature inspires spectacular and moving artworks.	• Biodiverse ecosystems such as rainforests reduce effects of climate change.	•

5. Populations with low genetic diversity are more likely to all be genetically susce chance. Because of this, they are at increased risk of mass mortality during epid unsustainably small and inbred, leading to extinction.

2.5 Protecting the wild

1. Stud book – a record of the relationships between animals living in captivity, use in small populations.

   Site of special scientific interest (SSSI) – an area which is not a national park development due to unique wildlife or geographical features.

   CITES – Convention on International Trade in Endangered Species of Wild Fa 1973, it protects 33,000 species from being traded except in accordance with

2.

Scheme	Conse
Berlin Zoological Garden	*Ex situ*
Grand Teton National Park, Wyoming	*In situ*
Watercress Nature Reserve, St Albans	*In situ*
UPM Botanic Garden, Madrid	*Ex situ*

3.

in situ – conserving in an area where the organism is natura	
Advantages	**Disa**
• Sustainable, long-term protection of species populations • Preserving species in their natural environment also reduces disruption to food webs	• Land use is subject may be ignored or • Some protections is heavily used • Governments may enforce authority c

ex situ – conserving outside the area where the organism na	
Advantages	**Disa**
• Allows much greater control over breeding pairs and conditions • Species may be rescued from extinction even if populations have become unsustainable • Allows easy access to genetic resources (e.g. seed banks and zoos)	• May be extremely zoos, hiring staff, p • Risk of inbreeding d • Primary goal of con species as functioni as human curiositie

4. Seed banks store seeds from a wide range of differ an s, including plants w which are endemic to one region, and wild-type equivalents of cultivated crops. a small area, and can be used to reintroduce genetic diversity into plants such as low genetic diversity. They may preserve genes for resistance to disease, which bred out of existing populations. Finally, in extreme circumstances, they may be which become extinct.

5. Increase the population through a dedicated breeding programme, using a stud outbreed the reptiles and reduce the risk of individuals inheriting recessive gene

   When the population is large enough, an agreed number of individuals can b natural former range. If the ecosystem is a small or isolated area, it could be park, or other form of conservation. The population should be monitored reg poach/capture the animals for trading should be penalised.

1. In a taxonomic system, groups cannot overlap in this way. For example, if a squa
Curcurbitaceae, it cannot also be a member of another plant family.

2.

Classification	Rank
Genus: ***Salmo*** (True salmon)	6
Class: Actinopte (Bony fish)	3
S **s:** *salar* (Atlantic salmon)	7
Family: Salmonidae (Salmon, trout and perch)	5
Phylum: Chordata (Vertebrates)	2
Order: Salmoniformes (Various salmon-like fish)	4
Kingdom: Animalia (Animals)	1

3. A) False – a single genus such as *Macropus* can contain many species
B) False – the animals in a single genus are fairly closely related, and will not d
layout
C) True
D) False – an organism in another genus may have the specific name *rufus*, wh
E) True

4. The main purpose of a taxonomic classification system is to systematise inform
knowing the classification of an organism provides information about its relatio
evolutionary history and its probable anatomy and biochemistry.

The main advantage of a taxonomic system is that each organism only belo
have two different classifications within the system. This means that a taxon
resembles an evolutionary tree showing the relationships between species.

Additionally, having multiple ranks allows scientists to split millions of organ

3.2 A new order: rethinking classifi

1.

Organisms without a nucleus – like one of the five kingdoms.	
A system of groups and ranks which is used to organise species scientifically.	
A slow-evolving gene which is involved in producing the body pattern of an organism.	
An organism which gets its nutrients by b[illegible] down organic compounds in [illegible] matter.	
A structure with s[illegible] within the same cell [illegible] membrane.	
Kin[illegible] of unicellular organisms which includes amoebas and green algae.	

2. a) Protoctista; b) Fungi; c) Bacteria; d) Plantae; e) Animalia

3. Tree 3 is the most accurate.

4. The systems agree that eukaryotes include animals, plants, fungi and protoctist[illegible] more closely related to each other than they are to other microorganisms.

   However, the five kingdom system groups Archaea as part of the Bacteria; th[illegible] Archaea as being more closely related to Eukarya than either group is to the[illegible]

5. Technological advancements often lead to new scientific discoveries, either beca[illegible] at the world in a new way, or because they allow a previously time-consuming an[illegible] quick and cheap. For example, the development of the microscope enabled the s[illegible]

6. i) The cytoskeleton is a feature of eukaryotic cells, and eukaryotic cells also h[illegible] and produce vesicles. Evidence of similar features in the Asgard archaea mi[illegible] microorganisms are more closely related to eukaryotes than they are to oth[illegible]

   ii) If it turns out to be true that Asgard archaea are more closely related to euk[illegible] would no longer accurately describe the evolutionary relationships betwee[illegible] Archaea would be split, with the Asgard archaea being a sister group to the[illegible] being an outgroup to both.

3.3 Evolution and phylogeny

1. *Adaptation* – anything which makes an organism more suited to the ecosystem i

   Taxonomy – the science of classification systems.

   Phylogenetic tree – a diagram which describes the evolutionary relationship b

2. Reproductive success is a measurement of how successful an individual is in pro others. Organisms which have traits giving them a competitive advantage, on a reproductive success. This is important to evolution because, over time, some tr while others will disappear, changing the population as a whole (this can create

3. This suggests that new species gradually arise in response to changing environm terrestrial plants create a new ecosystem producing large amounts of energy th be consumed by land animals. The delay in the fossil record suggests that it take to evolve and adapt to a terrestrial environment.

4. a) i) Olive Baboon

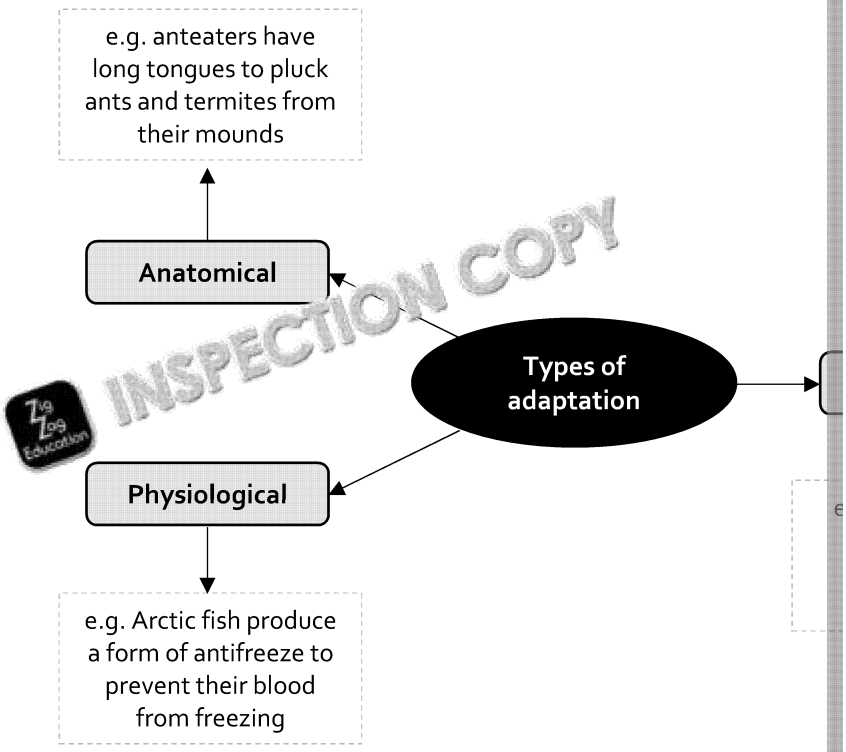
   b) The Olive Baboon is more closely related to the two Macaques than any of Colobus. In modern biological taxonomy, groups like genera and families d between species. Therefore, if the Angola Colobus were in the same genus would have to include the two Macaque species as well.

   c) The most recent common ancestor of the Old World Monkeys and the Apes

3.4 The mole's claws: variation and a

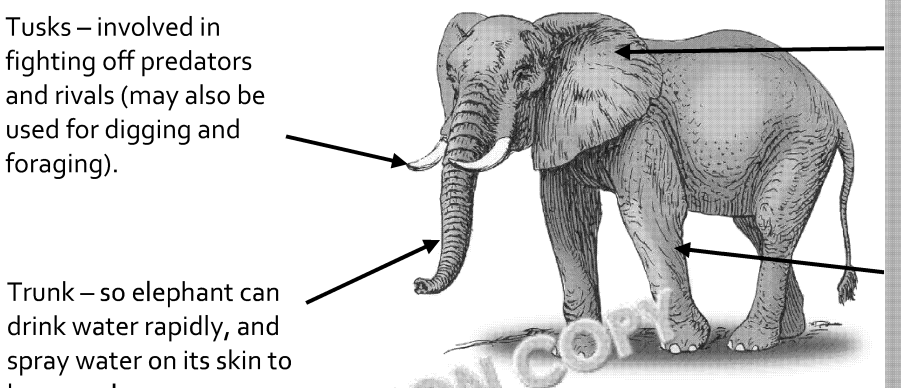
1. the same / one; interspecific; different; beak; range; discontinuous; discrete/dist

2.



3. Discontinuous variation tends to be controlled by a single gene (or a couple of g of different alleles, and so variation fits into a few discrete categories. Continuou (controlled by many genes), with environmental factors also playing a major ro

4.



3.5 Quantifying variation

1. a) 22.2 + 24.2 + 19.0 + 26.4 + 28.1 + 20.8 + 21.4 + 22.7 + 25.9 + 25.1 + 23.1 = 258.9

$\frac{258.9}{11}$ = 23.5 cm

b) Standard deviation formula: $\sqrt{\frac{\sum(x-\bar{x})^2}{n-1}}$, where x is each individual value, $\bar{x}$ is the number of data points in your data set.

Calculating the mean: 21.1 + 28.5 + 27.6 + 23.8 + 29.2 + 31.7 + 24.6 + 25.9 + 28.8

$\frac{300.5}{11}$ = 27.3 cm

Calculating $\sum(x-\bar{x})^2$: $(21.1-27.3)^2$ + (28.5 - 27.3)^2 + $(27.6-27.3)^2$ + $(23.8-27.3)^2$ + $(24.6-27.3)^2$ + $(25.9-27.3)^2$ + (28.8 – 27.3)^2 + $(30.0-27.3)^2$ + $(29.3-27.3)^2$ = 98.

n = 11 (there are 11 in the population 2 sample)

σ (standard deviation) = $\sqrt{\frac{97.98}{11-1}}$ = 3.13 (3 sf)

c) t-test formula: $t = \frac{\pm(\bar{x}_1-\bar{x}_2)}{\sqrt{\frac{(\sigma_1)^2}{n_1}+\frac{(\sigma_2)^2}{n_2}}}$, where σ_1 and σ_2 are the standard deviations of ea

the means of the two sets of data, and n_1 and n_2 refer to the number of individu already know the two means: $\bar{x}_1$= 23.5, $\bar{x}_2$ = 27.3, and the two standard deviatio equation:

$$t = \frac{\pm(23.5-27.3)}{\sqrt{\frac{(2.698)^2}{11}+\frac{(3.130)^2}{11}}}$$

Simplifying: $t = \frac{3.8}{\sqrt{(0.662+0.891)}} = \frac{3.8}{1.246}$ = 3.05 (3 sf)

d) The value for the t-test is greater than the critical value.

2.

Number of offspring	Rank	Mean weight (g)	Rank	
2	2.5	96	7	
6	9	66	2	
1	1	105	8	
3	5	111	9	
4	7	94	6	
3	5	72	3	
3	5	75	4	
5	8	83	5	
2	2.5	122	10	
7	10	60	1	

Σd^2 = 20.25 + 49 + 49 + 16 + 1 + 4 + 1 + 9 + 20.25 + 81 = 286.5

$6\Sigma d^2$ = 286.5 × 6 = 1719

$r_s = 1 - \frac{\quad}{n(n^2-1)}$

r_s = -0.74

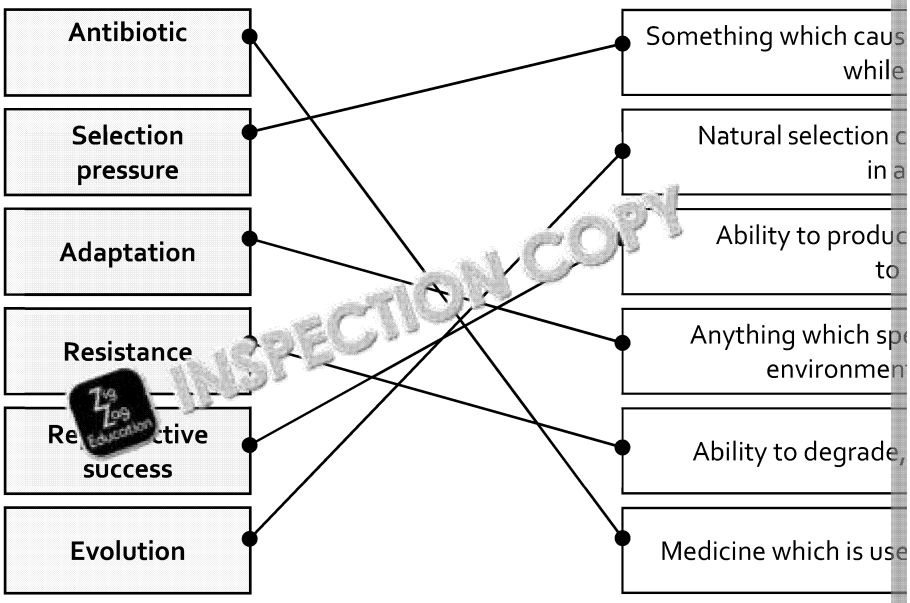
3. A two-tailed t-test assesses statistical significance in both directions; for example, w population A is significantly greater than, or less than, the tail length of population B statistical significance in one direction, but it is more powerful; for example, whethe significantly taller than the height of population B.

You should only use a one-tailed t-test if, before you collect your data, you already h difference between two sets of data will be in one direction and not in the other. You of the data you have collected.

3.6 Evolution and its implicatio

1. E), A), D), C), B)

2.



3. Pesticide resistance could reduce crop yields because insects which eat the crop pesticides if they are used. This makes it more difficult for farmers to stop small eating their crops.

   Pesticide resistance may also increase the risk of malaria spreading. Malaria one way of reducing the risk from malaria is to spray pesticides around stagn breed. If mosquitoes become resistant, they will be able to breed unchecked and spread malaria.

4. Examples:
   - Do not prescribe antibiotics for minor infections, or for infections which are
   - Where possible, avoid using the same antibiotic for long periods; this reduc resistance.
   - Keep good records of disease occurrence and transmission.
   - Quarantine any patients who are infected with an antibiotic-resistant infec
   - Ensure that hospital cleaning standards are high.
   - Check wounds regularly for any signs of infection.