thebiotutor

Unit F212: Molecules, biodiversity, food and health

Module 2.3 Biodiversity

Notes & Questions

Define the terms *species*, *habitat* and *biodiversity.*

- **Species**
  - A species consists of individual organisms that are very similar in appearance, anatomy, physiology, biochemistry and genetics.
  - A group of similar organisms capable of breeding to produce fertile offspring.
  - Species are given a double latin name (binomial) *Felis leo* (lion) *Homo sapiens* (human)
    - '*Homo'* = genus, '*sapiens'* = species.
    - When writing these, you should use italics or underline them and use a capital letter for the genus and small letter for the species.

- **Population**
  - The total number of individuals of a single species in a defined area

- **Community**
  - All the organisms living in a particular ecosystem

- **Ecosystem**
  - A section of the living world characterised by a particular set of environmental conditions together with an interacting community of organisms e.g. fresh water pond, tropical grassland.

- **Habitat**
  - A place where an organism lives. It provides resources for food, protection and breeding. Can vary in size enormously ranging from the bark of a tree (beetle) to part of a mountain range (eagle)

- **Biodiversity**
  - It is the biological diversity on earth, including the genes they contain. It also accounts for species numbers and geographical spread.
  - Biodiversity is often used to refer to species diversity and species richness
  - The variety of life as defined on three levels:
    - Variety of species
    - Genetic variety
    - Variety of habitats

Fill in the blank spaces using the following words: biodiversity, population, species, community, habitat, genetic, ecosystem

Turdus philomelos is a ……. of bird whose ……. is broadleaf woodland. The entire ……. of *T. philomelos* is under threat. Together with other members of its food web which make up the ……. of living organisms in the wood it is declining in numbers as more and more of the …… is destroyed in the process of urbanisation. As the ……. of *T. Philomelos* diminishes, so does the …… variation. The woodland ……. .. is reaching a critical point for conservation. This is measured as an overall reduction in ……..

- It is important to note that Biodiversity is not just a count of how many species exist.
- It is also important to consider:
    - How many individuals of each species
    - The amount of variation within or between species

Explain how biodiversity may be considered at different levels; habitat, species and genetic.

- Biodiversity can be considered on 3 levels:
- Ecosystem diversity
    - Diversity of all possible habitats or ecosystems

- Species diversity
    - Diversity of species in an area. Can be structural (i.e. Two different species) or functional diversity (i.e similar species performing different roles).

- Genetic diversity
    - Diversity of genetic characteristics of a species. Variation within a species.

Explain the importance of sampling in measuring the biodiversity of a habitat.

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Describe how random samples can be taken when measuring biodiversity.

- It is impossible to count all organisms of all species in an area, town, country or world. So sampling must be carried out.
- Sampling is the process of recording in a few locations and using this to estimate the values for the entire area.

Random Sampling

- What is random sampling?
    - Random sampling means studying a small part of the habitat and assuming it contains a representative set of species that can be applied to the whole habitat.
    - The sample sites must be chosen at random.

- Why should random sampling be used?
    - It excludes any bias in quantitative measurements

- How could you go about sampling in a random way?
    - Take samples at regular distances across the habitat
    - Use random numbers, generated by a computer, or random number table to generate coordinates across the habitat
    - Select coordinates from a map of the area and use a global positioning satellite system to find the exact position inside the habitat

- How many samples should you take?
    - Should be sufficient to give an accurate measure of the number of species and their abundance.
    - Depends on:
        - size
        - Amount of species
        - If you are comparing more than one site

Plants

- Estimates of plant populations are made in **numbers**, **percentage cover** or **percentage frequency**

- How could you measure the number of tree species?
    - Count individuals
- How could you measure the number of small herb species?
    - % cover using quadrats
    - Point quadrats
- How could account for plants that are found at the site but are so infrequent that they are missed by your samples?
    - Note their presence but you cannot record their abundance.

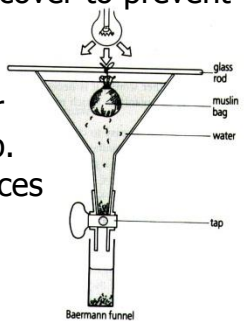
- Recording your results
    - ACFOR scale
        - Not completely quantitative
    - % Cover
        - Can be underestimated – though easier if quadrat is sub-divided
        - Point framed quadrat – count species only if they touch a needle.
        - Number of needles touching / total needles X 100
        - You must remember to count bare ground

Animals

- Estimates of animal populations are made in **numbers**
- Problems you may experience with animals?
  - Run away
  - The move
  - You may disturb habitat trying to sample them.

- Solution?
  - Catch them and then estimate the numbers from your trapped sample.

- What techniques have you come across for catching animals?
  - Sweep netting
    - Wide arcs through veg
    - Empty onto white sheet to identify – Pooters can be used to stop animals from crawling or flying away
    - Suitable for low vegetation that is not too woody
    - Suitable also for streams
  - Collecting from trees
    - White sheet under a branch and shake the branch
    - Study on white sheet to identify – Pooters can be used to stop animals from crawling or flying away.
  - Pitfall trap
    - Small container sunken into ground
    - Any animals moving along the soil surface will fall into the trap
    - Should have smooth side to prevent escape and a cover to prevent flooding in rain.
  - Tulgren funnel
    - A device for collecting small animals from leaf litter
    - Place leaf litter inside and turn on a light at the top.
    - Heat from the light dries out the leaf litter and forces animals into a collecting pot at the bottom



  - A light trap
    - Light can be used to attract flying insects at night.
    - Under the light is a reservoir of alcohol and eventually the moths and other insects tire and fall into the alcohol.
    - The alcohol subdues the insect.

- **Capture / recapture**

  - a method for measuring populations of moving organisms e.g. birds, moths, sharks

- set a trap and catch sample of population
- count them (C1), mark them and release them
- set trap again and catch a second sample
- count number of individuals in the second sample (C2)
- count the numbers of marked individuals in the second sample (C3)

$$\text{Estimate total number in population} = \frac{C1 \times C2}{C3}$$

Systematic sampling

Transects

- line transect

- belt transect

Describe how to measure species richness, species evenness in a habitat.

Species Richness - Qualitative

- Number of species present in a habitat
- The more species the greater the richness
- It is not sufficiently quantitative to be a measure of diversity on its own
- It does not take account of the number of individuals in each species
- Estimated by making observations within the habitat and record all the different species you see.

Species Evenness - Quantitative

- A measure of the relative numbers of abundance of individuals in each species
- A habitat where there is a more even distribution of individuals in each species is more likely to be more diverse than one in which individuals of one species greatly outnumber all the others
- Estimated by counting individuals or measuring percentage cover

Use Simpson's Index (D) to calculate the biodiversity of a habitat, using the formula $D = \Sigma(n/N)^2$.

- It is calculated using the formula

  D (biodiversity index) = 1 – (sum of $(n/N)^2$)

- Where
  - D= diversity of habitat
  - n = no. of individuals of each species.
  - N= total no. of individuals present
  - Σ = sum of

An example for you to calculate taken from two freshwater ponds

Species observed	Population count pond A	Population count pond B
Freshwater shrimps	35	52
Mayfly larvae	11	2
Dragonfly larvae	3	0
snails	12	4
Caddis fly larvae	3	0
Water boatmen	6	2
Tube worms	0	200
total	**70**	**260**

Species	Pond A			Pond B		
	n	n/N	$(n/N)^2$	n	n/N	$(n/N)^2$
Freshwater shrimps						
Mayfly larvae						
Dragonfly larvae						
snails						
Caddis fly larvae						
Water boatmen						
Tube worms						
sum						
1-sum						

Outline the significance of both high and low values of Simpson's Index (D).

- A high value of D
  - Indicates a diverse habitat.
  - A small change to the environment may affect one species.
  - If that species is a small part of the environment, the total number of individuals is a small proportion of the total number present
  - Therefore the total impact on the environment is small
  - Habitat tends to be stable and bale to withstand change.

- What can you conclude from your calculations?

Discuss current estimates of global biodiversity.

- Current Biodiversity
  - 1,730,000 + species on Earth
  - What Is the problem with this figure?
    - Evolution
    - Endangered or extinction
    - Unfound species
    - Future species
    - It doesn't tell us how many living organisms there are.

Define the terms classification, phylogeny and taxonomy.

- **Classification** The process of sorting living things into groups.
- **Phylogeny** The study of evolutionary relationships between organisms. (Making ancestral trees)
- **Taxonomy** The study of the principals of classification

Explain the relationship between classification and phylogeny.

Natural Classification

- Grouping species according to;
  - Appearance
  - Anatomy
  - Physiology
  - Biochemistry
  - Genetics
- Organisms of the same species can
  - Breed together and produce offspring
  - The offspring must be fertile
- Organisms of the same species can show variation

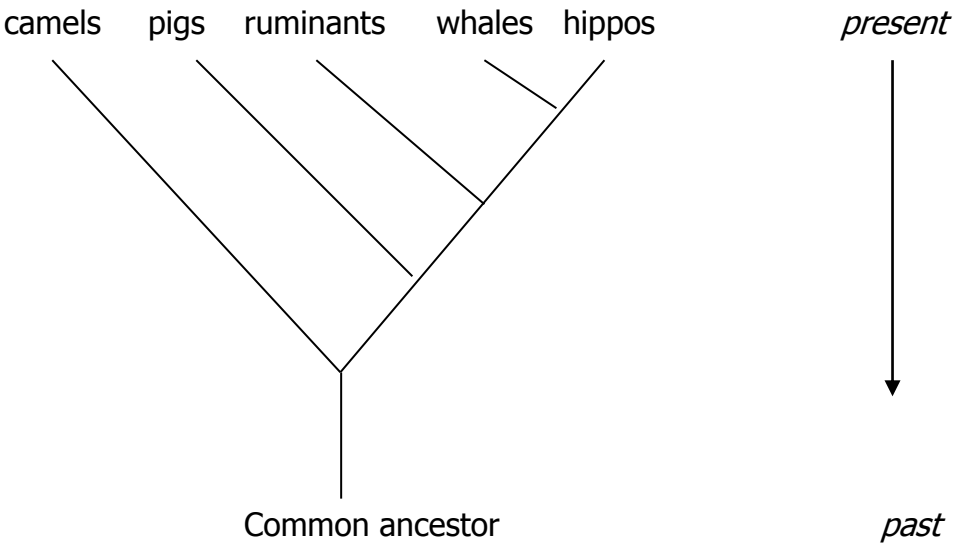
Artificial Classification

- Created for human convenience.
- Keys for flowering plants generally group plants together by obvious characteristics like colour or leaves for quick reference rather than by species.

Phylogeny

- The study of how closely different species are related to each other.
- Reflects evolutionary relationships between species.
- Generally presented in phylogentic (or evolutionary) trees.
- Used to inform natural classification
  - it is based on the evolutionary relationships between organisms (phylogeny)
  - it classifies species into groups using shared features derived from their ancestors
  - it arranges the groups into a **hierarchy**

example:

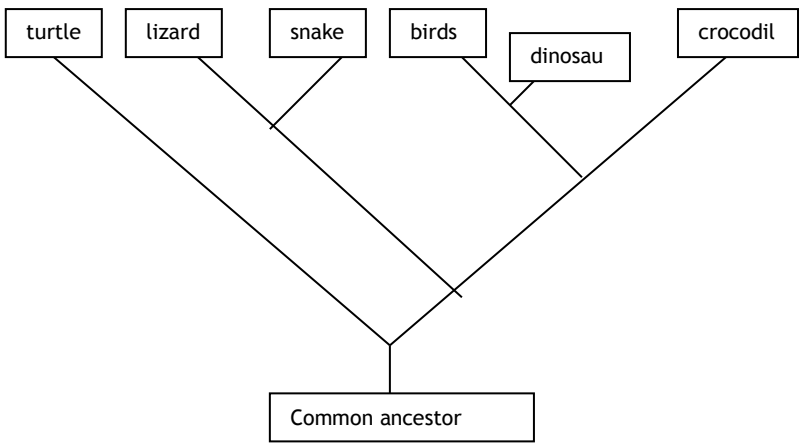


The closer the branches, the closer the evolutionary relationship

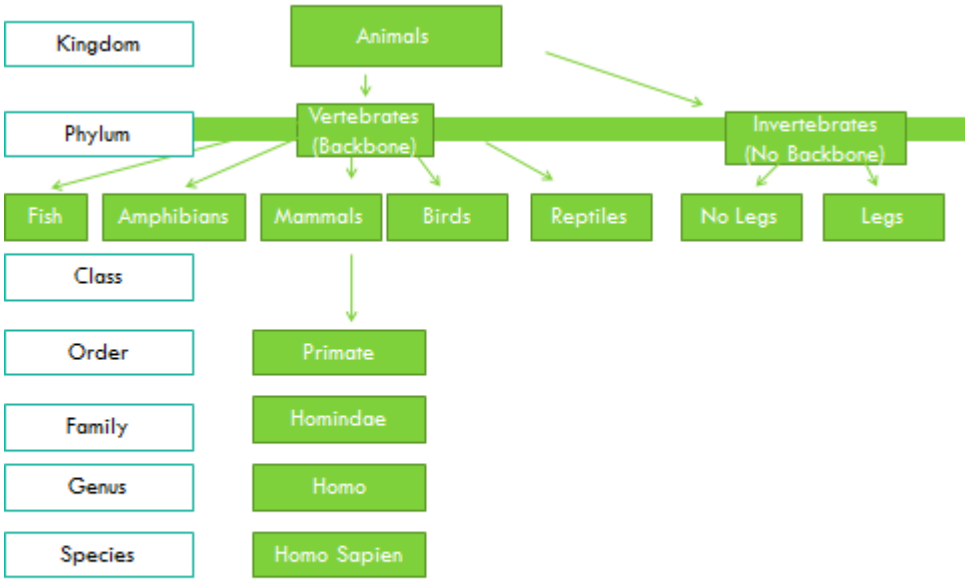
Hippos and whales are more closely related than hippos and ruminants (cud chewing animals)

Look at the **phylogenetic tree** below for birds and certain reptiles

- Which group is the closest relative of the snake?
- Are dinosaurs more closely related to crocodiles or birds?
- Suggest a reason why dinosaurs are not shown along the time line like the other groups



Describe the classification of species into the taxonomic hierarchy of domain, kingdom, phylum, class, order, family, genus and species.

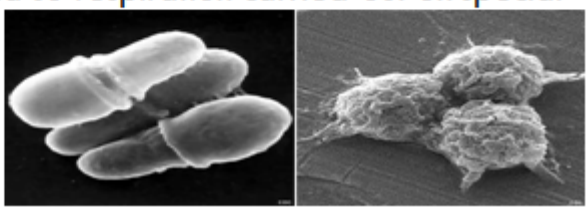


Taxonomic rank			
Domain	eukaryote	eukaryote	eukaryote
Kingdom	animal	animal	animal
Phylum	chordate	chordate	arthropod
Class	mammal	mammal	insect
Order	primate	primate	diptera
Family	hominidae	Hominidae	drosophilidae
Genus	*Homo*	*Gorilla*	*Drosophila*
species	*sapiens*	*gorilla*	*melanogaster*
Common name	human	gorilla	Fruit fly

Outline the characteristic features of the following five kingdoms: Prokaryotae (Monera), Protoctista, Fungi, Plantae, Animalia.

Prokaryotes

- Prokaryote means "before nucleus" and so prokaryotes do not have a nucleus to house their DNA
- Looped DNA
- No membrane bound organelles
- Smaller cell size than Eukaryotes
- Free living or parasitic
- No mitochondria so respiration carried out on special membranes



Plantae

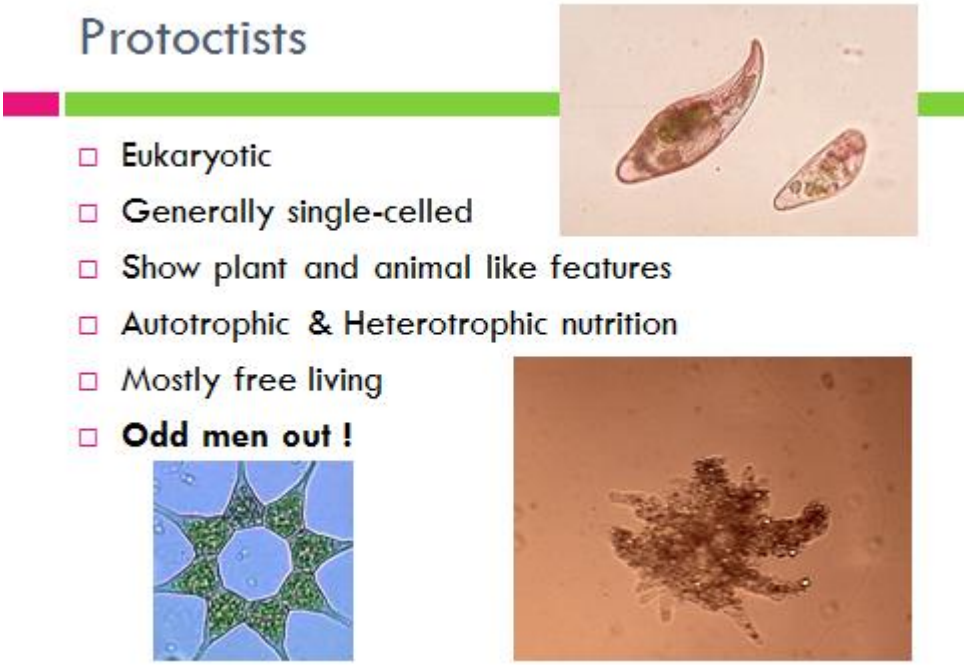
- Eukaryotes
- Multi-cellular
- Autotrophic nutrition
- Cells have a cellulose cell wall
- Produce embryos from fertilised eggs

Animalia

- Eukaryotes
- Multi-cellular
- Heterotrophic nutrition
- Usually mobile
- fertilised eggs create a blastula

Fungi

- Eukaryotes
- Mycelium consisting of many hyphae
- Chitin walls
- Cytoplasm is usually not divided into cells but is multinucleate
- Sacrophytic



Outline the binomial system of nomenclature and the use of scientific (Latin) names for species.

- Species are given a double latin name (binomial)
  - *Felis leo* (lion)
  - *Homo sapiens* (human)
  - '*Homo'* = genus,
  - '*sapiens'* = species.
  - When writing these, you should use ***italics*** or **<u>underline</u>** them and use a
  - Capital letter for the Genus and small letter for the species.

Use a dichotomous key to identify a group of at least six plants, animals or microorganisms.

Below are pictures of 10 Illinois fish. See if you can identify them using this simple key.

1. a) Whiskerlike barbels present on head (catfishes)—Go to 2
   b) No whiskerlike barbels present on head—Go to 3

2. a) Caudal fin forked—channel catfish
   b) Caudal fin rounded—tadpole madtom

3. a) Mouth facing downward (suckers)—Go to 4
   b) Mouth not facing downward—Go to 5

4. a) Front edge of dorsal fin at least 4 times longer than back edge—quillback
   b) Front edge of dorsal fin less than 4 times longer than back edge—black redhorse

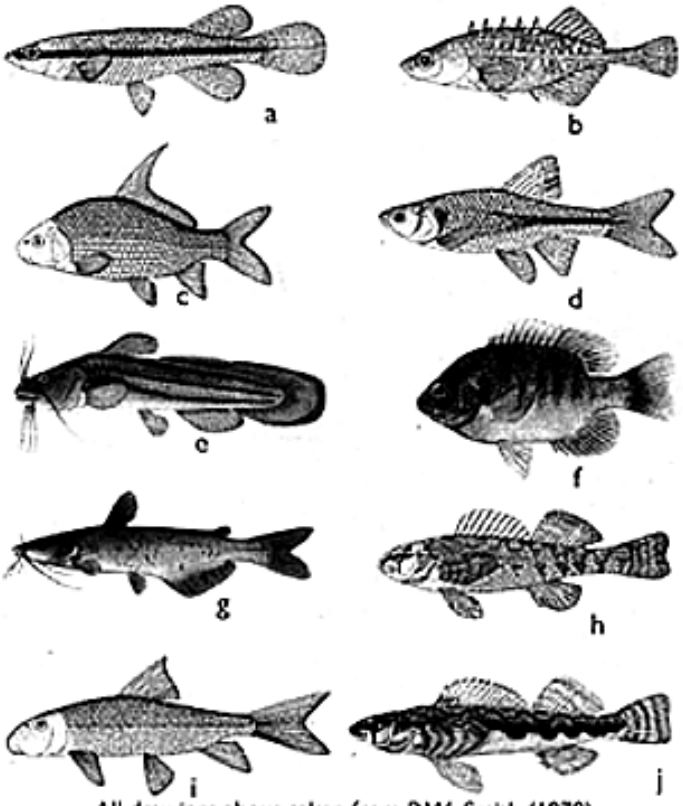
5. a) Body elongate, more than twice as long as tall—Go to 6
   b) Body not elongate, but slab-sided. Not more than twice as long as tall—bluegill

6. a) First five rays of dorsal fin spikelike—brook stickelback
   b) First five rays of dorsal fin not spikelike—Go to 7

7. a) Two dorsal fins. (darters)—Go to 8
   b) Only one dorsal fin—Go to 9

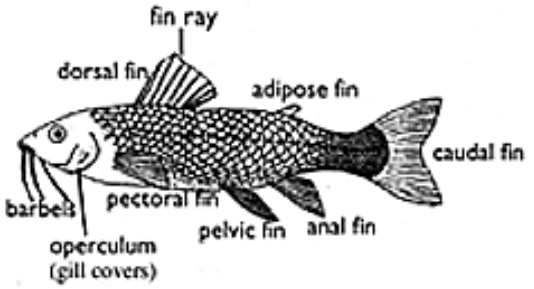
8. a) Bold irregular black stripe on side, like a series of connected blotches—blackside darter
   b) No bold black markings on side. Markings are narrow vertical bars—orangethroat darter

9. a) Caudal fin forked—spotfin shiner
   b) Caudal fin rounded—blackspotted topminnow



All drawings above taken from P.W. Smith (1979). The Fishes of Illinois.

Fish Anatomy



a. _____

b. _____

c. _____

d. _____

e. _____

f. _____

g. _____

h. _____

i. _____

j. _____

Discuss the fact that classification systems were based originally on observable features but that more recent approaches draw on a wider range of evidence to clarify relationships between organisms, including molecular evidence.

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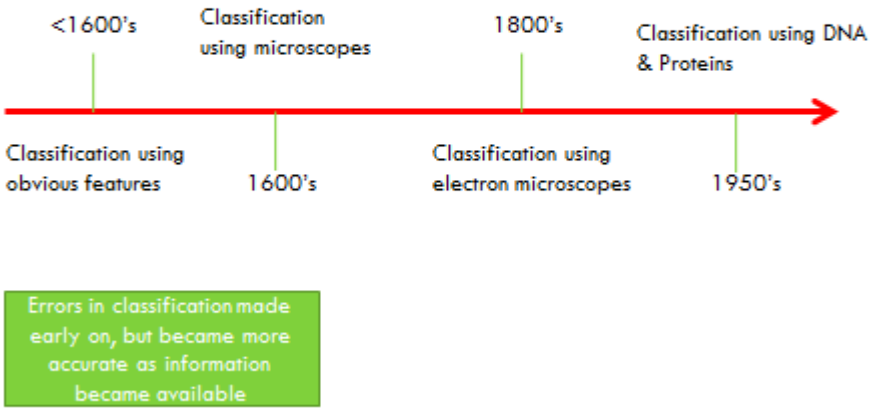
Compare and contrast the five kingdom and three domain classification systems.

Kingdoms and Domains

- Originally , living organisms were grouped into two kingdoms, namely **animalia** and **plantae.**
- As techniques of microscopy, DNA analysis etc have advanced, so it has become clear that there are significant differences, for example between green plants, fungi and bacteria.
- Furthermore, the single celled organisms with mixed plant and animal characteristics require a separate grouping.

5 kingdoms: **Prokaryota**
Proctoctista
Fungi
Plantae
Animalia remember PPFPA



- Another basic separation was recently made between three groups of organisms, based on the sub cellular structure, in particular, their RNA. These are the three **domains**

3 Domains: **Bacteria** unicellular prokaryotic
Archaea unicellular prokaryotic
Eukaryota (protista) unicellular and multicellular, eukaryotic

- The Bacteria and Archaea are both prokaryotes but there are differences in cell membrane structure, the internal structure of flagella, the enzymes associated with RNA and DNA synthesis. It is suggested that Archaea are more closely related to eukaryotes (e.g. there have proteins bound to their DNA)

- **Cytochrome C**
  - Cytochrome C is a protein used in respiration.
  - All living organisms respire so all living things will have Cytochrome C. (except chemosynthetic prokaryotes).
  - Cytochrome C is not identical and the amino acid polypeptide sequence will differ between organisms.
  - We can compare these polypeptide sequences and calculate how related species are.
  - The more differences between the sequences the further related they are.

- 5 kingdoms System
  - Bacteria & Archea in separate Domains

- 3 Domains System
  - Bacteria & Archea in Kingdom Prokaryota

- **Bacteria.**
  - Different cell membranes
  - Different internal structures to Flagella
  - Different enzymes (RNA polymerase) for building RNA.
  - Different mechanisms for DNA replication and building RNA.

- **Archaea & Eukaryotae.**
  - Similar enzymes (RNA polymerase) for building RNA.
  - Similar mechanisms for DNA replication and building RNA.

Classification is a fluid and dynamic business. These groups are not fixed forever.

Define the term *variation.*

- Variation
  - Differences between individuals of the same or different species.

- Genetic variation
  - Caused by the difference between the genes and the combination of genes or alleles

Discuss the fact that variation occurs within as well as between species.

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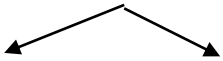
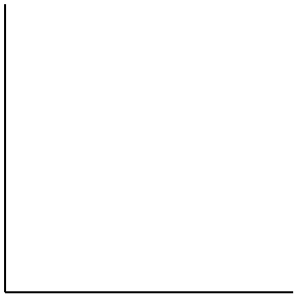
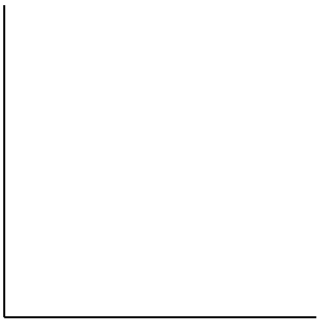
Describe the differences between continuous and discontinuous variation, using examples of a range of characteristics found in plants, animals and microorganisms.

- Continuous variation
  - A full range of intermediate phenotypes between two extremes
  - Most individuals are close to the mean

- Discontinuous variation
  - Discrete groups of phenotypes with no individuals between them.
  - Members of the species are randomly or evenly distributed between the different phenotypes.

Continuous or discontinuous variation?



Continuous variation	Discontinuous variation
- a full range of intermediate forms between two extremes e.g. height, leaf length	2 or more distinct categories with no intermediate values e.g. blood groups, sex
	
Causes: environmental and genetic	Causes: Genetic – different alleles

List 2 human characteristic features which show continuous variation and 2 which show discontinuous variation

Continuous	**Discontinuous**
1.	1.
2.	2.

List 1 microorganism characteristic features which show continuous variation and 1 which show discontinuous variation

Continuous	**Discontinuous**
1.	1.

List 1 plant characteristic features which show continuous variation and 1 which show discontinuous variation

Continuous	**Discontinuous**
1.	1.

Explain both genetic and environmental causes of variation.

- **Genetic Variation**
  - The genes we inherit from our parents provide information that is used to define our charactoristics.
  - The genes code for polypeptides that help define our phenotype.
  - For each gene there are multiple alleles.
  - Although organisms of the same species all have the same genes they do not have all the same alleles.
  - Different alleles code for slightly different polypeptides and hence different phenotypes.
  - This is genetic variation

- **Environmental variation**
  - Many charactoristics can be affected by the environment
    - E.g. underfed pet would become underweight.
    - E.g. skin colour in different light intensities
    - E.g Hawthorn trees grow branches sideways in windy conditions
  - **'Genes load the gun, environment pulls trigger'**

Outline the behavioural, physiological and anatomical (structural) adaptations of organisms to their environments.

- Living organisms show adaptations related to

  1. feeding
  2. protection
  3. reproduction

- Behavioural Adaptations
  - Aspect of an organisms behaviour that enables it to survive in the conditions it lives in.
  - E.g Earthworm recoiling into it burrow.

- Physiological Adaptations
  - An adaptation that can be biochemical or physiological which ensures the correct functioning of cell processes.
  - E.g. Yeast can respire sugars anaerobically or aerobically by procducing the correct enzymes to respire the sugars.

- Anatomical Adaptations
  - Any structure that enhances the survival of the organism is an adaptation.
  - E.g Flagella on bacteria enable them to move independently.

- Adaptations may be A. structural (anatomical) B. physiological or C. behavioural

  - Using the numbers and letters above, label the following adaptations of plants and animals (you may use more than one if appropriate)

  - Peacocks have feathers which are so ornate that the bird cannot fly

  - Xerophytic plants have long roots and thick cuticles

  - Horses have only one digit on each foot

  - Migratory salmon are able to locate the river in which they were born by a sense of smell.

  - Deciduous trees leave their leaves in winter

  - Desert animals excrete very concentrated urine to conserve water.

  - Wildebeest migrate every year with the rain to find grazing pasture.

Adaptations of Xerophytes

- Behavioural
  - Close stomata when little water is available
  - Open stomata at night when temperatures are lower
  - Rolls and folds leaves

- Physiological
  - Saguaro cactus has a stem with an accordion-fold structure. In dry conditions the folds tighten into ridges. In wet conditions the folds become almost invisible.

- Anatomical
  - Shallow roots
  - Very deep roots
  - Leaves of a reduced size
  - Fleshy leaves
  - Wax leaves

Explain the consequences of the four observations made by Darwin in proposing his theory of natural selection.

1. Offspring generally appear similar to their parents.

2. No two individuals are identical.

3. Organisms have the ability to produce large numbers of offspring.

4. Populations in nature tend to remain fairly stable in size.

- Darwin concluded
  - There is a struggle to survive
  - Better adapted individuals survive and pass on their characteristics
  - Over time, a number of changes may give rise to a new species

Define the term *speciation*

- Speciation
    - The formation of a new species from an existing one

- The raw material for variation = **GENE MUTATION**

- This produces new **ALLELES** (variant of a gene, often due to a single base sequence change in the DNA code)

- The **GENE POOL** of a population is constantly expanding in this way as long as there is sufficient opportunity for outbreeding.

- It is subject to the following two influences:

    - **Natural selection:** (see earlier section) Different environmental pressures will tend to select individuals best suited to the changing conditions.
    - **Genetic drift:** An entirely random process of genetic change over a number of generations due to the chance recombination of genes in the process of fertilisation.

Speciation takes a long time where lots of very small changes occur. These changes result in the species no longer being able t interbreed freely to produce viable offspring.

Speciation can occur faster in organisms with short generation times. E.g. Bacteria.

For speciation to occur there must also be some reproductive barrier. This barrier can be geographical, behavioural, ecological, temporal or mechanical.

ISOLATION

- Speciation depends on the different varieties within a population becoming isolated

Geographic isolation

- Both of these processes operate most strikingly when an interbreeding population becomes separated by a river, mountain range or other natural barrier. The two isolated groups diverge from each other over hundreds and thousands of generations to produces very different features.

- Give three examples of geographic isolation

    •

    •

    •

Reproductive isolation

- If the differences prevent interbreeding between the two groups then **speciation** occurs. Factors preventing reproduction include

    - Changes in breeding season
    - Changes in courtship behaviour
    - Physiological changes preventing fertilisation, conception or implantation
    - Structural / anatomical changes

Discuss the evidence supporting the theory of evolution, with reference to fossil, DNA and molecular evidence.

- Fossils
    - Similarities found between living species and fossils
    - The evolution of the modern horse over the last 55 million years is well documented in fossils
    - The evolution of Humans over the last 3-4 million years is documented in fossils, however there are gaps
    - The fossil of *Archaeopteryx* (earliest known bird) clearly has both bird and reptilian features, explain the link between birds and reptiles.

- DNA
    - Genes can be compared by sequencing the bases in the DNA
    - This shows how closely related species are and therefore how recently they became new species
    - 98.8% human DNA is the same as Chimpanzees

- Molecular evidence
    - Cytochrome C is a protein that enables ATP to be made in oxidative phosphorylation
    - Similarities in this molecule shows how closely related two species are.

Outline how variation, adaptation and selection are major components of evolution.

- The process of evolution
    - Variation must exist
    - Environment selects individuals whose variations give them an advantage
    - Individuals witht the advantage survive and reproduce
    - They pass on the advantageous variations
    - The next generation are better adapted to the environment.

Discuss why the evolution of pesticide resistance in insects and drug resistance in microorganisms has implications for humans.

- Pesticide resistance in Insects
  - The pesticide applies a very strong selective pressure
  - Any susceptible insects will die
  - If any insects have resistance they survive
  - The survivors are the only individuals that can breed
  - All offspring have resistance to the pesticide
  - Resistance spreads through the population quickly

- What does pesticide resistance actually require
  - Resistance can come from the insects being able to break down the pesticide by having enzymes which work on the chemical
  - The protein receptor that the pesticide binds to may change and the pesticide can no longer bind to it.

- Problems with pesticide resistance
  - Insects can destroy crops E.g. Locusts
  - Insects can carry diseases E.g. Mosquitos and Malaria
  - Bioaccumulation of the pesticide up the food web can occur.

- Drug resistance in microorganisms
  - Antibiotics are a strong selective pressure on microorganisms
  - Any susceptible microorganisms will die
  - If any microorganisms have resistance they survive
  - The survivors are the only individuals that can breed
  - All offspring have resistance to the antibiotic
  - Resistance spreads through the population quickly

- How to reduce antibiotic resistance
  - Always complete the course of antibiotics
  - Only take antibiotics when necessary (Not for viral infections)

- Problems with antibiotic resistance
  - MRSA has developed resistance to an ever increasing range of stronger and stronger antibiotics.
  - This is an evolutionary arms race and medical researchers are struggling to develop new effective drugs, but the bacteria are rapidly becoming resistant.

Outline the reasons for the conservation of animal and plant species, with reference to economic, ecological, ethical and aesthetic reasons.

- Human impacts on the environment
  - We have learnt to use the environment to our advantage
  - Our population has risen rapidly and is continuing to rise
  - We are using more and more of the earth's resources
  - Our activities harm other organisms directly and indirectly
  - Loss of biodiversity
  - Extinction may occur

- Directly affecting organisms
  - Hunting or over harvesting
  - Killing for protection
  - Killing to remove competition

- Indirectly affecting organisms
  - Pollution or climate change
  - Habitat destruction
  - Inadvertent addition of new predators/competition/disease

- Reasons for conservation
  - Economic
    - Detoxification
    - Technological advances
    - Purification and retention of water
    - Recycling nutrients
    - Pollination of crops
    - Fuel
    - Regulate the atmosphere

  - Ethical
    - All organisms have the right to live
    - Religious beliefs

  - Aesthetic
    - Natural beauty
    - Patients have recovered faster when exposed to natural environmental conditions

  - Ecological
    - Loss of species will disturb the ecosystems and therefore humans as we are also a part of the ecosystem

Discuss the consequences of global climate change on the biodiversity of plants and animals, with reference to changing patterns of agriculture and spread of disease.

- Climate change forces migration which can be damaging because:
  - Into farmers land
  - New predators
  - New diseases
  - New pests
  - Loss of food
  - Out of protection zones
  - Out of space

- Effects of climate change on Agriculture
  - Increase growing season
  - Increase growth
  - Increase CO_2 = increases photosynthesis
  - Different rain patterns
  - Increases evaporation = increases rainfall
  - Increases sea levels = decreases land for crops
  - Farmers need to change crops
  - Change farming methods

- Diseases
  - Increasing growing season also increases populations of pests
  - New pests and diseases in an area.

Explain the benefits for agriculture of maintaining the biodiversity of animal and plant species.

- A decrease in biodiversity means a decline in genetic diversity
- This could lead to a loss of a natural solution to some of our problems
- Wild plants have evolved over thousands of years. They have adapted to overcome the problems presented by the environment. They have overcome pests and diseases found in the area
- Careful selection and breeding from wild species, we may be able to breed new crop varieties that can cope with new conditions created by the climate change.
- The range of potential medicines and vaccines that could be developed from species is unknown.

Describe the conservation of endangered plant and animal species, both *in situ* and *ex situ*, with reference to the advantages and disadvantages of these two approaches.

&

Discuss the role of botanic gardens in the *ex situ* conservation of rare plant species or plant species extinct in the wild, with reference to seed banks.

- **In-situ Conservation**

- Conserving species in their natural habitat
- Using conservation Parks
    - Principles
        - Adequacy
            - Large enough are for all species, communities and populations
        - Comprehensiveness
            - How many species are represented.
            - What environmental conditions exist
        - Representativeness
            - Is there a full range of diversity?
            - Is there a full set of environmental conditions?
    - Advantages
        - Species are in their natural environment
        - Facilitates scientific research
        - Maintains and or restores environmental integrity
        - Permanently protects natural and cultural heritage
        - Permanently protects biodiversity and ecosystems
    - Cannot exclude human activity
        - Land is also important for traditional hunting and religious reasons
        - Protecting animals that may migrate and raid nearby farms and destroy crops
        - Tourists may feed protected animals or litter
        - May lead to illegal hunting or harvesting

- **Ex-stu conservation**
- Conserving species outside their natural habitat as a result of the organism being endangered.

- **Animals**
  - Advantages
    - Breeding programs
    - Repopulate areas by reintroduction
    - Health can be maintained by vets
    - Protected from hunting and predators

  - Disadvantages
    - Expensive
    - Animals fail to breed due to being outside of their natural habitat.
    - Limited space = limits population size = decreases genetic diversity
    - Little genetic variation
    - Loss of natural instincts for food and survival
    - Loss of acceptance by wild members when reintroduced.

- **Plants**
  - Advantages
    - Collecting seeds has little disturbance to plants or ecosystem
    - Stored and germinated under specific protected environment
    - Seeds are easily stored
    - Plants can be reproduced asexually through cuttings and tissue culture
    - Huge seed numbers for research

  - Disadvantages
    - There will be some disturbance even if limited
    - Shelf life of seeds
    - Asexual cloning can lead to genetic uniformity
    - Seeds can deteriorate over time when stored
    - Collected seeds may not represent all genetic variation

Discuss the importance of international cooperation in species conservation with reference to the Convention in International Trade in Endangered Species (CITES) and the Rio Convention on Biodiversity.

- **CITES** - **C**onvention of **I**nternational **T**rade in **E**ndangered **S**pecies (of wild flora and fauna) - Established in 1973
    - Aims
        - Regulate and moniter International trade
        - Ensure trade does not endanger species
        - Prohibits trade of wild species for commercial
        - Regualtes permits of srtificially propagated plants and less endangered species
    - Problems
        - Smuggling and black markets

- Rio Convention on Biological Diversity (1992)
    - Aims
        - Conserve biodiversity
        - Share access to genetic resources
        - Share scientific knowledge
        - 150 members must adopt in-situ and ex-situ facilities
        - All members must carry out their own Environmental Impact Assessment (EIA) before any development

- Zoological and Botanical gardens
    - Swap genetic material to increase genetic diversity

Discuss the significance of environmental impact assessments (including biodiversity estimates) for local authority planning decisions.

- Environmental Impact Assessment – EIA
    - Avoid/minimise adverse effects on biodiversity of an area
    - Take into account potential environmental consequences
    - Consultations and exchange of information with partner states
    - Notification of procedures to partner states
    - Emergency responses for danger to biodiversity

- An EIA is undertaken depending on:
    - The size of the development
    - The environmental sensitivity of the area
    - Types of expected impacts

- 3 procedures when creating an EIA
    - Assessment of the local biodiversity and effect of the development
    - Publish the assessment
    - Considered before any planning decision

- Benefits
    - Problems are identified at an early stage and can be dealt with
    - Improves environmental acceptance.

1. A group of students carried out some fieldwork to investigate the diversity of insects in three habitats:

- a field of barley
- a field of wheat
- the vegetation under a hedge.

Their results are shown in the table below. The table also shows how they used their data to calculate Simpson's Index of Diversity (D) for each habitat.

$$D = 1 - (\Sigma(n/N)^2)$$

where N = the total number of insects found, and n is the number of individuals of a particular species.

	number of individuals of each species in each habitat		
species	barley field	wheat field	under hedge
a	32	4	0
b	78	0	1
c	0	126	2
d	0	5	12
e	0	0	8
f	0	0	9
g	0	25	3
h	0	10	3
i	0	0	2
j	0	0	5
k	86	56	0
l	0	0	7
species richness	3	6	10
total number of insects (N)	196	226	52
Simpson's Index of Diversity (D)		0.61	0.86

(a) State what is meant by the term *species richness*.

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.....

[1]

(b) (i) Calculate the value for Simpson's Index of Diversity (D) for the barley field.

Show your working and write your answer **in the shaded box in the table**.

[2]

(ii) Using the data in the table, suggest why the value of Simpson's Index of Diversity (D) for the vegetation under the hedge is so much higher than that for the wheat field.

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[3]

(c) Describe how the students may have determined the numbers of individuals of each species in each habitat.

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[5]

[Total 11 marks]

2. Hedgerows are important in farming as they act as sites of refuge for beneficial insects, provide protection for the crop from adverse weather conditions and act as wildlife corridors.

Farmers are advised to leave strips of land between hedgerows and the crops in the fields to encourage biodiversity.

Describe how you would investigate whether leaving strips of land around fields encourages **plant** biodiversity.

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[Total 5 marks]

3. In this question, one mark is available for the quality of spelling, punctuation and grammar.

Zoos and botanic gardens, such as Kew Gardens, are involved in many conservation projects throughout the world.

Outline the problems experienced by zoos and botanic gardens in managing such projects **and** explain why it is important for such projects to be successful.

[7]

Quality of Written Communication [1]

2.3

[Total 8 marks]

4. Musk deer occur throughout forested mountain habitats in Asia and eastern Russia. They live in small groups, normally three individuals in a group, and are primarily active at night.

The deer are hunted illegally for traditional medicine and also threatened by habitat destruction. Populations of musk deer in China and Mongolia are listed in Appendix II of the Convention for International Trade in Endangered Species (CITES).

Explain what is meant by the term *endangered species*.

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[Total 2 marks]