BIOLOGY GRADE 12
CHAPTER 4
EVOLUTION
PART ONE

What is evolution?

Early definition

- ✓**Evolution** means change over a period of time. It proposes that living things might have evolved from relatively simple chemicals and explain what happens to organism over time

Present working definition

- ✓**Evolution** is change in genetic composition of a population over successive generation. which maybe caused by meiosis, hybridization, natural selection or mutation. This leads to sequence of events by which the population diverges from other populations of the same species and may leads to the origin of a new species

Cont....

✓The theory of evolution describes how the various forms of life on Earth (including humans) emerged and developed

- There are five main theories of the origin of life on Earth:
  - special creationism
  - spontaneous generation
  - eternity of life
  - cosmozoan theory
  - biochemical origin

Cont....

1. Special creationism

- ✓ Special creation states that at some stage, some supreme being created life on Earth.
- ✓Special creation is nearly always linked to religion, whereas an acceptance of evolution is linked to scientific thinking.

Cont....

- ✓ There are many different versions of special creation, linked with different religions.
- Young Earth creationism
- Old Earth creationism
- Day-age and gap creationism
- Progressive creationism
- Theistic evolution/Evolutionary creationism
- Intelligent design

Cont....

A) Young Earth creationism

- ✓This form of creationism today suggests that the Earth is only a few thousand years old.
- ✓Young Earth creationists often believe the Earth was created in six 24-hour days.
- ✓While they agree that the Earth is round and moves around the Sun
- ✓ they interpret all geology in the light of Noah’s flood

Cont....

B) Old Earth creationism

- ✓They vary in different aspects of how they explain the age of the Earth while still holding to the story found in Genesis.
- ✓It accepts that life was created by God as it was put in Genesis but explain that earth is very old

Cont....

C) Day-age and gap creationism

- ✓Gap creation discusses a large gap between the formation of the Earth and the creation of all the animals and humans.

  The gap could be millions or billions of years.

- ✓Day-age creationism is similar in the length of time but talks about each of the six ‘days’ as really meaning a billion years or so of geologic time; the ‘days’ are just symbolic.

Cont....

C) Progressive creationism

- ✓This type of creationism accepts the Big Bang as the origin of the Universe.
- ✓It accepts the fossil record of a series of creations for all of the organisms catalogued.
- ✓However, it does not accept these as part of a continuing process; each is seen as a unique creation.
- ✓Modern species are not seen as being genetically related to ancient ones.

Cont....

D) Theistic evolution/Evolutionary creationism

- ✓This view of evolution maintains that God ‘invented’ evolution and takes some form of an active part in the ongoing process of evolution.
- ✓It also invokes the role of God in areas not discussed by science, like the creation of the human soul.
- ✓Theistic evolution is promoted by the Pope for the Catholic Church and is also espoused by most mainline Protestants.

Cont....

E) Intelligent design

- ✓This is the newest or latest version of creationism and maintains that God's handiwork can be seen in all of creation if one knows where to look.
- ✓It claim that life developed due to the combination of natural force and the intervention of supernatural forces
- ✓The supporter of this theory give sophisticated arguments based on mathematics and cell biology

Cont....

2) Spontaneous generation

- Spontaneous generation suggests that life can evolve 'spontaneously' from non-living objects.
- For example, people believed that rotting meat turned into flies
- It took the work of **Francisco Redi** to disprove the idea of rotting meat producing flies and the work of **Louis Pasteur** to finally show that not even micro-organisms could be produced by spontaneous generation

Cont....

- ✓These two scientists showed that both macro-organisms (Redi) and micro-organisms (Pasteur) can only arise from pre-existing organisms, disproving the theory of spontaneous generation.

Cont....

3) eternity of life

- ✓eternity of life theory claims that the Universe has always existed and that there has always been life in the Universe
- ✓It had no beginning and end
- ✓Life is eternal
- ✓Albert Einstein – believed that the Universe was unchanging.

Cont....

4) Cosmozoan theory

Cosmozoan theory claims that life on Earth originally came from elsewhere in the Universe (possibly from another planet)

Cosmozoan theory have three versions

- ✓**The first version** was proposed by Richter in 1865 and supported by Arrhenius in 1908 and by other contemporary scientists.
- ✓ According to this theory, life has reached this planet Earth from other cosmological structures, such as meteorites, in the form of highly resistant spores.

Cont....

- ✓**The second version** In 1908, the Swedish physical chemist Svante Arrhenius put forward a new version of the cosmozoan theory, and gave it the name **panspermia**
- ✓He proposed the involvement of radiation pressure in the mechanism of carrying the bacterial spores to earth

Cont....

✓The third version is called **weak panspermia** or **pseudo-panspermia**

➢ This theory state that organic compounds arrived from outer space and added to the chemicals on Earth that gave rise to the first life

Cont....

5) Biochemical theory

- ✓biochemical theory suggests that life on Earth originated as a result of a number of biochemical reactions producing organic molecules which associated to form cells
- ➢Aleksandr Oparin a Russian biologist who first put forward his ideas in 1924, and
- ➢ John Haldane an English biologist independently put forward almost identical ideas in 1929 (before Oparin's book had been translated into English).

Cont....

❖**They both suggested that:**

✓The primitive atmosphere of the Earth was a reducing atmosphere with no free oxygen – as opposed to the oxygen-rich atmosphere of today

✓There was an appropriate supply of energy, such as lightning or ultraviolet light, and

✓This would provide the energy for reactions that would synthesis a wide range of organic compounds, such as amino acids, sugars and fatty acids.

Cont....

- Oparin suggested that the simple organic compounds were formed in the atmosphere and reacted to form more complex molecules.
- This formed colloidal aggregates, or 'coacervates', which absorb and assimilate organic compounds from the environment like metabolism of cells.
- Coacervates were subjected to natural selection and eventually gave rise to the first cell

Cont....

- **Haldane** proposed similar event in the sea according to him 'hot dilute soup' of organic monomers and small polymers were formed .He called this soap prebiotic soup
- **Oparin's** 'coacervates' and Haldane's 'prebiotic' soup gave us the combined biochemical theory of origin of life

BIOLOGY GRADE 12
CHAPTER 4
EVOLUTION
PART 2

Cont....

Evidence for Biochemical origin of life theory?

- In 1953, Stanley Miller conducted his now-famous spark-discharge experiment.
- In this investigation, he passed electric sparks repeatedly through a mixture of gases containing methane (CH_4), ammonia (NH_3), water (H_2O) and hydrogen (H_2) thought to represent the primitive atmosphere of the Earth.
- He was able to produce organic compounds such us amino acid ,pentose and hexose sugar ,hydrogen cyanide

Cont....

Problem of Oparin –Haldane hypothesis

- ✓Both left handed (levorotary) and the right side (dextrorotatory) amino acid can be produced but only left handed amino acids are found in living things
- ✓Purines (adenine and guanine) could not be produced in the laboratory under the same condition as pyrimidines (uracil, thymine and cytosine)
- ✓Miller could not produce polymers from his monomers but recently it has shown that polymerization can occur under appropriate condition

Cont....

- The biologist John Desmond Bernal suggested that there were a number of clearly defined ‘stages’ in explaining the origin of life:

Stage 1: the origin of biological monomers •

Stage 2: the origin of biological polymers •

Stage 3: the evolution from molecules to cell

- ✓Bernal suggested that evolution may have commenced at some time between stages 1 and 2.
- ✓The first two stages have been demonstrated as being possible in the conditions of the primitive Earth, and research on stage 3 is well advanced.

Cont....

How did autotrophs evolve on Earth?

Autotroph is an organism that produces organic molecules from inorganic material

- ✓ However the first organisms appeared – about 4 billion years ago – they were prokaryotes.
- ✓ **Prokaryote** an organism consisting of a prokaryotic cell. All bacteria are prokaryotes
- ➢ They had no true nucleus.
- ➢ It seems likely also that they had RNA rather than DNA as their genetic material.

Cont....

These first life forms might have given rise to 3 lines

a) **archaebacteria** – prokaryotes that survive locally ,or in unusual habitats.

Archaebacterium the first bacteria (and thus the first living organisms) to develop on Earth. They are now only found in extreme condition

Example-prokaryotes including thermophilic sulphobacteria, methanobacteria and halophilic bacteria

b) eubacteria – the vast majority of prokaryotes todays;

Example-ordinary bacteria and cyanobacteria (blue-green bacteria and sometimes known as blue-green algae)

eubacterium any bacteria that is not an archaebacterium is a eubacterium

Cont....

- ✓ C) eukaryotes –modern unicellulars or multicellulars that almost all aerobic

Eukaryote an organism consisting of one or more eukaryotic cells. All organisms other than bacteria are eukaryotes

- ✓ eventually evolving into protoctistans, fungi, plants, animals (nearly all are aerobic)

Cont....

- ✓Cyanobacteria are photo-autotrophs; they use light as a source of energy, and CO2 as a source of carbon (photosynthesis).
- ✓They are among the earliest of autotrophs, using, not chlorophyll, but another pigment, **phycocyanin** (which gives them their blue green appearance), to capture light energy.

Cont....

- ✓Other primitive autotrophs used not light as a source of energy but chemical reactions and are called **chemo-autotrophs.**
- ✓**Chemoautotrophs** use the energy from chemical reactions to synthesise all necessary organic compounds, starting from carbon dioxide.
- ✓They generally only use inorganic energy sources
- ✓They are called Archaebacteria and inhabit hostile environment such as dep sea vents, hot springs ,salty waters

Cont....

- ✓Scientists believe that the some of first organisms to inhabit Earth were **chemo-autotrophs**.
- ✓The primitive sulphobacteria use hydrogen sulphide as the energy source.

Cont....

- ✓Bacteria are the only life forms found in the rocks for a long time, 3.5 to 2.1 billion years ago.
- ✓Eukaryotes became numerous 1.9 to 2.1 billion years ago
- ✓Fungi-like organisms appeared about 0.9 billion years ago.
- ✓The animals evolve between 600 to 700 million years ago.

The rise of oxygen in the atmosphere due to photo-autotrophs led to the evolution of **aerobic respiration** as energy releasing path way

Aerobic respiration a means by which cells release energy from organic molecules using oxygen

Theories of evolution

- These try to explain a mechanism by which species gradually change
- For many years in Europe, the Christian belief had been that the Earth and all species had been created about 6000 years ago.
- In the mid 1700s, George Buffon challenged this idea, suggesting that:
- ✓the Earth was much older than this, and that organisms changed over time in response to environmental pressures and random events.

Cont....

Major theory of evolution

- Lamarckism
- Darwinism
- Neo -Darwinism

Cont….

Lamarckism (the theory of transformation)

- ✓It was proposed by a French biologist jean-Baptiste lamarck at the beginning of the 19th century
- ✓It claimed that the traits acquired by organisms during their lifetime can pass to the subsequent generation
- ✓In 1809 he published a paper entitled “philosophic zoologique” in this paper he described a two part mechanism by which species gradually change (transform) and pass the change to the coming generation
- ✓The two parts of his theory
- ➢Use and disuse
- ➢Inheritance of the acquired traits

Cont....

Use and disuse theory

- ✓According to Lamarck continuous use of structure or a process leads to the enlargement of the structure or to the development of the process and vise versa.
- ✓little use or disuse of the structure or a process leads to the size reduction or less development
- ✓He forwarded 3 examples to illustrate his argument
  - ➢The elongated neck of giraffe
  - ➢The elongated, webbed toes of water birds
  - ➢The smaller and undeveloped wings of penguins




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Cont....

Inheritance of acquired traits

- ✓Lamarck believed that traits acquired/changed during an individuals lifetime, could be passed down to its offspring
- ✓The body of an individual maybe built by exercise as muscle increases but this can never pass to the offspring
- ✓body changes resulting in phenotypic changes do not affect the gene in the gamete which give rise to the new generation.
- ✓Only genetic changes that occur in the gametes cell can pass to the offspring
- ✓So Lamarck's theory of inheritance of acquired traits was disproved by genetics

Cont....

Darwinism theory

- ✓in 1858, Charles Darwin published his famous paper on Natural Selection.
- ✓Darwin proposed that those organisms that were best adapted to their environment would have an advantage and be able to reproduce in greater number than the other types and pass on their advantageous adaptation to their offspring

Cont….

- Darwinism theory of Natural Selection has 4 core ideas
- Fecundity – all species tend to produce more offspring than can possibly survive
- **Variation**-there are difference among the offspring
- Struggle of the fittest-as there is limited resource there will be struggle among the offspring for existence
- Survival of the fittest -those member of a species that are better adapted to the environment will survive

So Darwin theory restated as follow

Those number of a species which are best adapted to their environment will survive and reproduce in greater numbers than others less adapted

Cont....

Comparison of Lamarck's theory of use and disuse with Darwin's theory of natural selection

Aspect of theory	Lamarck's theory of use and disuse	Darwin's theory of natural selection
Variation	Environment changes, creating a need for the organism to change	There is a natural variation in features and the variations are heritable
Survival	Development of new features (e.g. longer neck) in order to survive	Environment selects in favour of those traits that adapt the organism to the environment and against those that do not
Inheritance	New features acquired during lifetime of an individual are passed to the offspring	Individuals with advantageous variations of traits survive in greater numbers and pass on these advantageous variations to their offspring
Evolution	New species over time	New species over time

Cont….

Neo-Darwinism

- ✓**Neo-Darwinism** a revised version of Darwin's theory of evolution by means of natural selection. This theory, which is now accepted by most biologists, combines Darwin's original theory, genetic theory and theories about animal behavior
- ✓Genes or, more accurately, alleles of genes determine features.
- ✓A population evolves into new species when its gene pool is changed
- ✓Gene pool refers to all allele of all genes found in the organism

Cont....

If an allele is advantageous in an organism in a given environment

- ✓ The organism survive and reproduce in greater numbers than other types.
- ✓They will pass on their advantageous allele in greater numbers to the offspring of the organism
- ✓The frequency of the advantageous allele in the gene pool of the population will be higher in the next generation.

Cont....

Mutations are important in introducing variation into populations.

Any mutation could produce an allele which:

- Confers a selective advantage; the frequency of the allele will increase over time
- Is neutral in its overall effect; the frequency may increase slowly, remain stable or decrease (the change in frequency will depend on what other genes/alleles are associated with the mutant allele)
- Is disadvantageous; the frequency of the allele will be low and could disappear from the population.

THE END

THANK YOU

Cont….

The evidence for evolution

- Palaeontology
- Comparative anatomy
- Comparative embryology
- Comparative biochemistry
- Plant and animal breeding experiment

Cont….

palaeontology

❖How does palaeontology support the theory of evolution?

✓The word ‘palaeontology’ refers to the study of ancient life and comes from the Greek words palaios(ancient) and logos(study).

✓Fossils form the basis of this science as they are the main direct evidence about past life.

Cont....

- ✓**Fossils** (this word is derived from the Latin word **fossus**, meaning 'having been dug up') are the remains or traces of animals, plants and other organisms from the remote past.
- ✓We can group fossils into two categories:
- ✓**Category 1**: the remains of the dead animal or plant or the imprint left from the remains, including:
  - ➢bones , teeth, skin impressions ,hair
  - ➢the hardened shell of an ancient invertebrate such as a trilobite or an ammonite
  - ➢an impression of an animal or plant, even if the actual parts are missing

Cont....

- ✓**Category 2**: something that was made by the animal while it was living that has since hardened into stone; these are called trace
- ✓fossils and include:
- ➢footprints
- ➢burrows
- ➢coprolite (animal faeces)

Cont....

- ✓**Type I fossils** can be the actual organism or part of an organism, like a piece of bone or hair or feather as it actually was.
- ✓For example, this spider has been trapped, completely unchanged, inside the amber for millions of years.
- ✓Amber is fossilised resin from trees. This spider probably became stuck inside the sticky resin and could not escape.

Cont....

- ✓As the amber became fossilised, the spider was protected from micro-organisms and air which would have led to its decomposition
- ✓In many fossils like this, the soft parts of the body have been lost, but the exoskeleton is perfectly preserved. In some cases, however, the entire body remains

Cont....

- ✓But most of the time fossils are imprint of whole organisms or their parts after death.
- ✓Death is almost associated with decomposition. But sometimes dead bodies escape from this
- ✓There are four main stages of fossil formation

1. Death without decomposition
2. Sedimentation
3. Permineralisation
4. Uplift

Cont....

Death without decomposition

- ✓To start with, an animal or plant must die in or so close to water that it is covered by water immediately after, or shortly after, death.
- ✓The water insulates the remains from many of the elements that contribute to decomposition.
- ✓Bacteria will still decay the soft body parts over a long period but leave any hard body parts unaltered.

Cont....

Sedimentation

- ✓As time passes, sediments (tiny particles of solid matter settling out of the water) bury the remaining hard parts of the organism.
- ✓Fossilisation is more likely if this happens quickly than if it happens slowly. Sudden landslides and mudslides into the water help.
- ✓Sedimentation further insulates the organism from complete decay.

Cont....

- ✓The nature of the sediments themselves influences the nature and quality of the fossil.
- ✓Very fine-grained particles, like clays, will create a more detailed fossil than coarser-grained sediments like sand.
- ✓The chemical make-up of the sediments affects the color the fossil will be.
- ✓Iron-rich sediments could give the rock (and the fossil) a reddish colour.
- ✓Phosphates may darken the rock so that it is grey or black.

Cont....

Permineralisation

- ✓As the sediments accumulate, the lower layers become compacted by the weight of the layers on top. Over time, this pressure turns the sediments into rock.
- ✓If water rich in minerals percolates (seeps) through the sediments, the mineral particles stick to the particles of sediment, effectively gluing them together into a solid mass.
- ✓An important point here is that these minerals are probably not the same minerals that make up the sediments (now rock).

Cont....

- ✓Over the course of millions of years, these mineral particles dissolve away the original hard parts of the organism, replacing the molecules of exoskeleton with molecules of calcite (calcium carbonate) or another mineral.
- ✓In time, the entire shell is replaced by mineral particles and these also are compressed into rock in the shape of the original organism.
- ✓As this rock is not the same as the surrounding rock, it is visible as a fossil in the exact shape of the original organism

Cont....

Uplift

- ✓As the continental plates move around the Earth, colliding with each other, mountains are formed. What were sea floors are lifted up and become dry land.
- ✓Now the fossil is buried under hundreds or even thousands of feet of rock in different strata.
- ✓A stratum is a layer of sediment (or sedimentary rock) that is the same throughout the layer, but different from layers above and below.

Cont....

- ✓Earth movements cause rocks to slip and parts of different strata to become exposed.
- ✓When this happens, rock that contains fossils becomes lifted to the Earth’s surface.
- ✓Rain, wind, earthquakes, freeze and thaw erode rock and may expose a fossil

Cont....

How can we date fossils?

❖There are two ways of fossil dating

1. stratigraphy(relative dating)
2. Absolute(actual) dating

✓**stratigraphy(relative dating**)-in sedimentary rock layers(strata,) the oldest rocks(fossils) are found at the bottom and younger (recent) ones are at the top

✓Geological time period are divided into eras and periods

✓Periods are subdivision of eras

Cont....

eras	periods	Million years ago
Cenozoic era	Quaternary tertiary	65million years ago up to now
Mesozoic era	Cretaceous Jurassic Triassic	250-65 million years ago
Palaeozoic era	Permian Carboniferous Devonian Silurian Ordovician Cambrian	560-250 million years ago

Cont....

- ✓So Paleozoic era fossils or older than Mesozoic or Cenozoic fossils/rocks and they are located at the bottom most In the strata of sedimentary rocks.
- ✓On the other hand, teriatery fossils are older than quaternary fossils within the Cenozoic era
- ✓The most recent fossils and rocks are found nearest to the surface

Cont....

Absolute(actual) dating

- ✓Uses radioactive elements to determine the actual age of rocks or fossils
- ✓Basically the amount of a radioactive element in a fossil is measured and compared to the estimated amount in the organism before death
- ✓The difference is translated into the age of the fossil
- ✓There are two techniques
- ➢Radioactive dating
- ➢Potassium-argon dating

Cont....

Radiocarbon(C-14)

- ✓Is radioactive carbon decay into non-radioactive nitrogen element into decay.
- ✓Fifty percent of the existing C-14 will decay after each successive half-life
- ✓half-life the time needed for half the atoms of a radioactive substance to decay. After two half-lives, three quarters of the atoms will have decayed, and so on
- ✓After one half life 50% of the orginal element will be decayed and 50% remains
- ✓After two half life 75% will have been decayed and 25% remain

Cont....

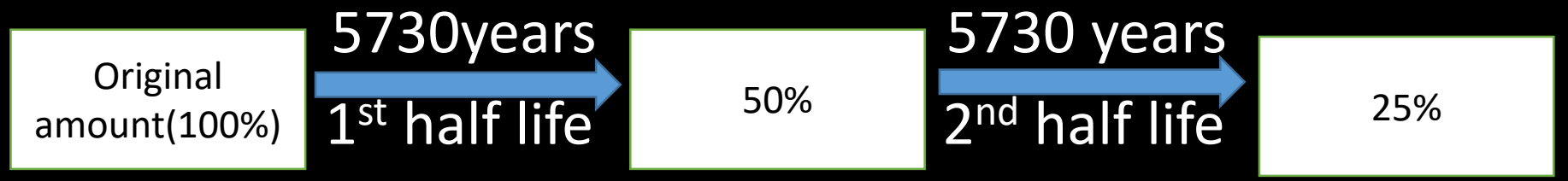
- ✓The ratio of carbon 14 (radioactive carbon) to carbon 12 (ordinary carbon) in living things is about 1 to 1 trillion and we believe that this ratio has always been the same.
- ✓During their lives, living things lose carbon 14 (as carbon dioxide and other excretory products) and also gain it in the food they eat (or make in the case of autotrophs).

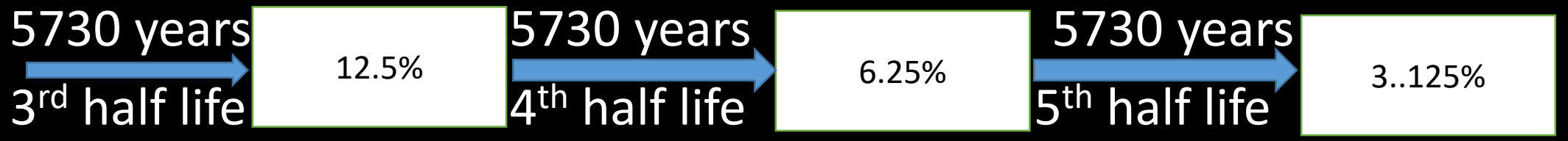
Cont....

- ✓But when living things die, the carbon 14 starts to decay into non-radioactive nitrogen and, clearly, is not replaced.
- ✓So after 5730 years (one half-life of carbon 14), only 50% of the original carbon 14 atoms will remain and the ratio of carbon 14 to carbon 12 will be 1 to 2 trillion (or 0.5 to 1 trillion).
- ✓After 11 460 years, 25% of the original carbon 14 atoms remain and the ratio is 1 to 4 trillion (or 0.25 to 1 trillion).
- ✓The percentage of carbon 14 atoms and the ratio of carbon 14 to carbon 12 keeps halving with each half-life that passes.

Cont....

✓The following shows the amount of C-14 that remain after each successive half –life starting from the original amount considered as 100%





Cont....

Potassium–argon dating

- ✓Potassium–argon dating works in the same way, but the half-life in this case is 1.3 million years.
- ✓This makes potassium–argon dating suitable for dating rocks millions of years old, whereas radiocarbon dating is really only accurate with rocks up to 60 000 years old

Cont....

What is the age of fossil containing 25% of the original carbon-14 atoms?

Cont....

What percentage of the amount of carbon-14 originally present in a fossil what would be left after its second half-life?

Cont....

Carbon-14 has a half-life 5730 years. Suppose a fossils contain only 12% of the amount of carbon-14 normally present in living organism how old is the fossil?

Cont....

How does comparative anatomy support the theory of evolution?

- ✓This is one of the strongest forms of evidence for evolution.
- ✓Comparative anatomy looks at structural similarities of organisms and uses these to determine their possible evolutionary relationships.
- ✓It assumes that organisms with similar anatomical features are closely related evolutionarily, and that they probably share a common ancestor.

Cont....

- ✓Some organisms have anatomical structures that are very similar in form, but very different in function. We call such structures homologous structures.
- ✓Because they are so similar, they indicate an evolutionary relationship and a common ancestor of the species that possess them.
- ✓Perhaps the best-known example of homologous structures is the forelimb of mammals.
- ✓When examined closely, the forelimbs of humans, whales, cats and bats are all very similar in structure

Cont....

- ✓Sometimes organisms have structures that function in very similar ways.
- ✓However, morphologically and developmentally these structures are very different. We call these analogous structures.
- ✓Because they are so different structurally, even though they have the same function, they cannot indicate that two species share a common ancestor.
- ✓For example, although the wings of a bird and a mosquito both serve the same function their anatomies are very different.
- ✓The bird wing has bones inside and is covered with feathers, while the mosquito wing has neither of these.

Cont....

- ✓homologous structures structures with the same basic anatomy and a common evolutionary origin but having a different function
- ✓analagous structures struactures having the same function but different anatomy and different evolutionary origin

Cont....

How does comparative embryology support the theory of evolution?

- ✓Comparative embryology studies the way in which the embryos of vertebrates develop before they hatch or are born.
- ✓This development shows similarities which supports a common ancestry
- ✓Vertebrate embryo resemble at early stages ,they all have gill silts and tails at early stages

Cont....

How does comparative biochemistry support the theory of evolution?

- ✓organisms that share similar molecules and chemical pathways are closely related evolutionary
- ✓Comparative biochemistry studies this.two types molecules have been used so far. these are
- ➢DNA
- ➢Protein

Cont....

- ✓DNA – the base sequences of DNA from different organisms is compared
- ✓proteins such as:
  - cytochrome c (found in the electron transport chain of respiration) and
  - haemoglobin
- ✓which are compared in terms of amino acid sequences
- ✓More closely related species have most similar DNA and protein and vice versa

Cont....

- ✓To measure the similarity of one species' DNA with another species, we use a technique called DNA hybridisation.
- ✓To measure the similarity between two species,DNA is extracted from both species and heated to change it into single stranded one.Then they are mixed and cooled
- ✓The DNA of the species bind or hybridize at areas where their base are complementary
- ✓There will be mismatch in the areas which base are not complementary

Cont....

- ✓The haemoglobin molecule is similar in all animals that possess it, but there are differences.
- ✓hemoglobin the molecule found in red blood cells that carries oxygen to where it is needed
- ✓For example, the haemoglobin of the lamprey (a primitive fish-like animal) has only one polypeptide chain, not four.
- ✓Most animals have haemoglobin with four chains, but the chains do vary.

Cont....

How does plant and animal breeding support the theory of evolution?

✓For thousands of years, humans have been trying to improve the yields of their crop plants and stock animals.

They have done this by selective breeding, in which:

➢those animals (or plants) that show the desired trait (for example, high milk yield or large number of seeds per pod) are selected and mated, and

➢the offspring are monitored carefully and, again, only those with the desired trait are allowed to breed.

✓Over many generations, selective breeding can bring about significant changes to the organisms involved.

Cont....

The processes of evolution

What are the different types of natural selection?

The modern view of natural selection is stated briefly below:

- ✓Those members of a species which are best adapted to their environment will survive and reproduce in greater numbers than others less well adapted. They will pass on their advantageous alleles to their offspring and, in successive generations, the frequency of these alleles will increase in their gene pool. The advantageous types will, therefore, increase in frequency in successive generations

Cont....

- ✓Natural selection is the ‘driving force’ behind evolution.
- ✓It is the process that brings about changes (over time) in populations that can, eventually, lead to different populations of the same species becoming different species.
- ✓To appreciate how natural selection can eventually lead to speciation(the formation of new species), we must be clear what we mean by a species.
- ✓**Speciation** the process by which a new species evolves
- ✓**Species** is a group of related organisms that can reproduce with each other so that they produce fertile offspring

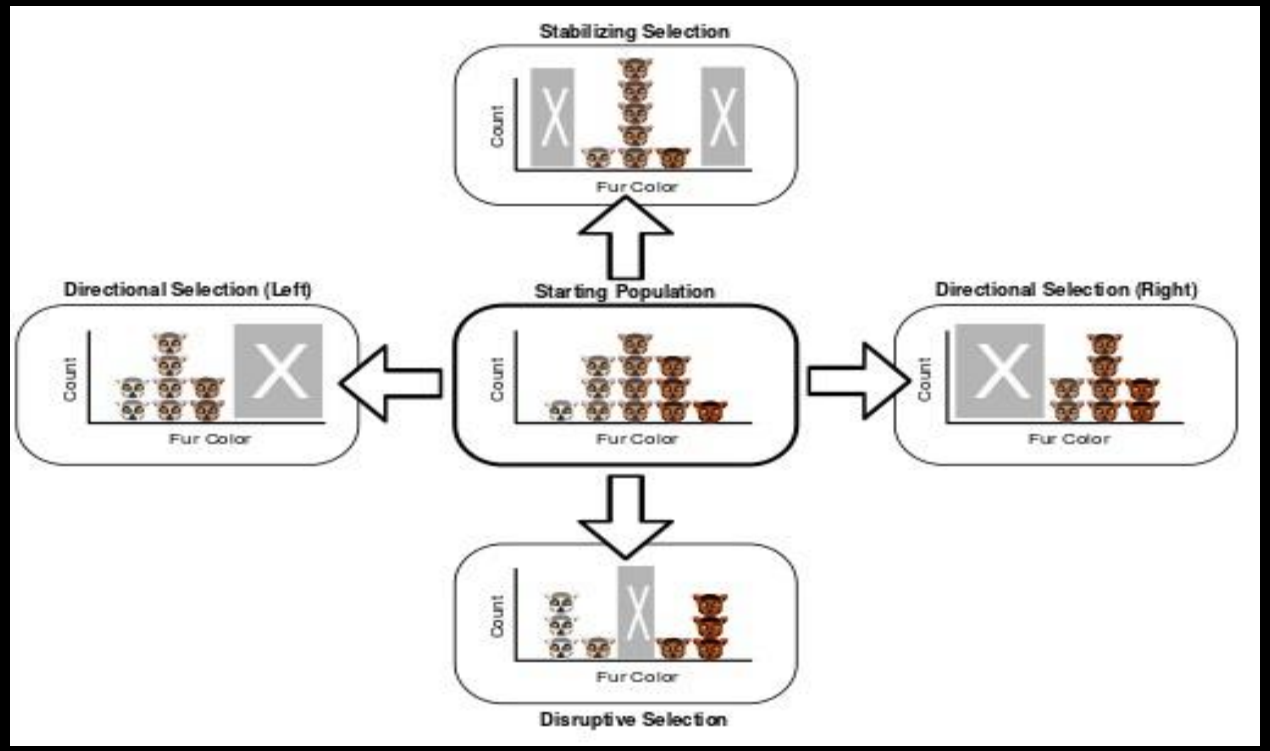
Cont....

- Our current definition of a species is:
- ✓A group of similar organisms with a similar biochemistry, physiology and evolutionary history that can interbreed to produce offspring that are fertile.
- how can there be different types of natural selection?
- All types of natural selection work in the same manner), but their influence on a population is different. The different types of selection include:
  - directional selection
  - stabilising selection
  - disruptive selection

Cont....

1. Directional selection

✓Is a types of selection that works in favor of one extreme feature of a population and it works against the other features



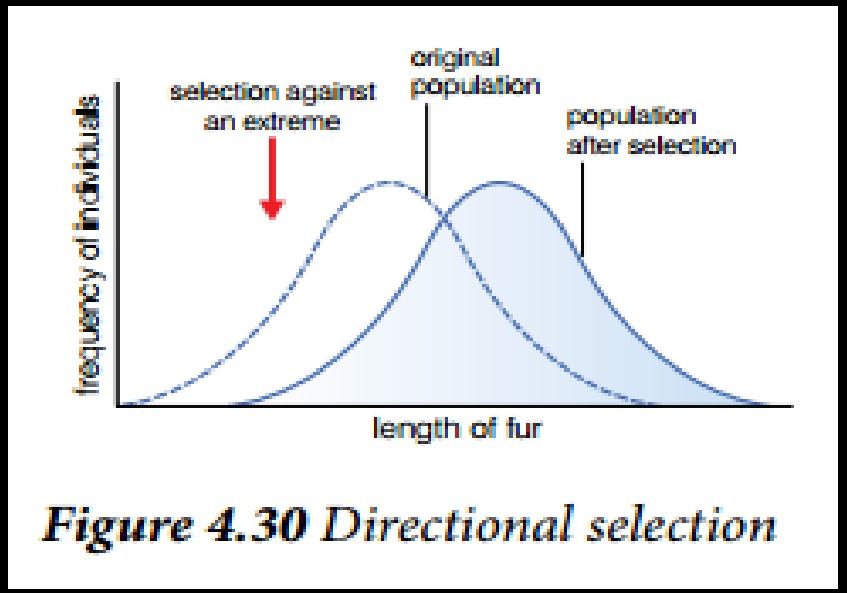


***Figure 4.30** Directional selection*

Cont....

2. Stabilising selection

- ✓Works in favour of the mean features and works in against the extreme features
- ✓It operates in a stable environment

Example birth mass in humans :

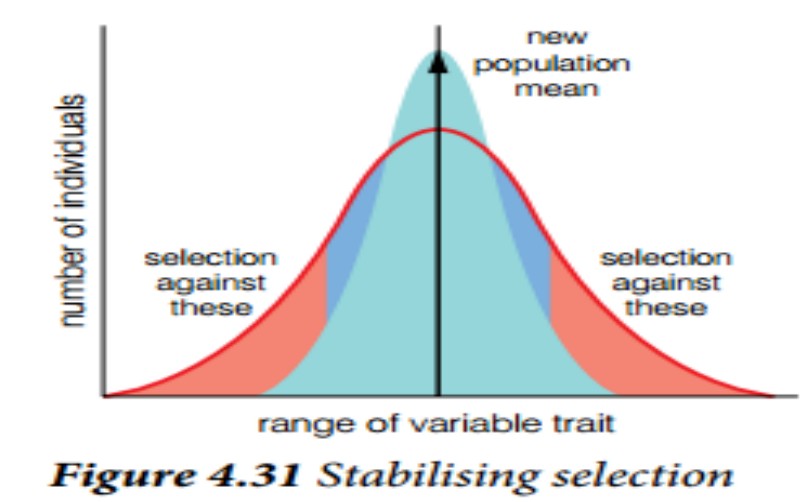
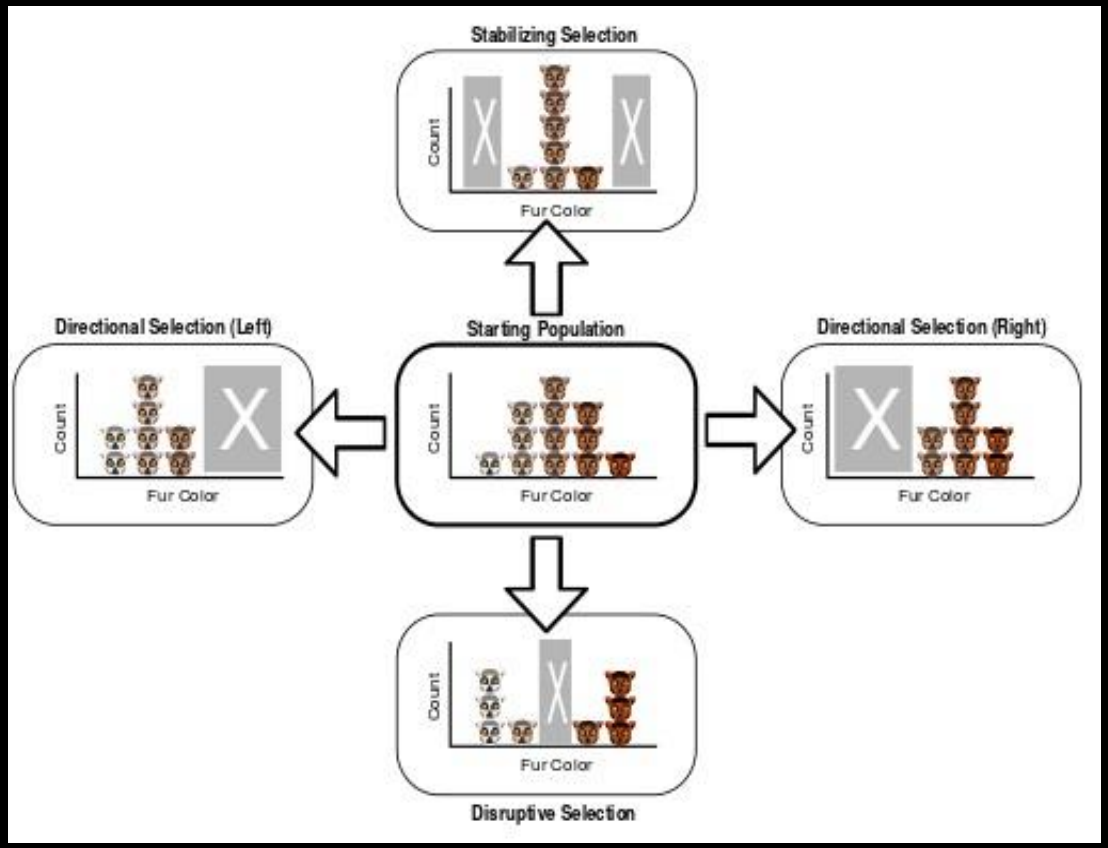


Figure 4.31 Stabilising selection



Cont....

Disruptive selection

✓Works against of the mean features and works in in favour the extreme features

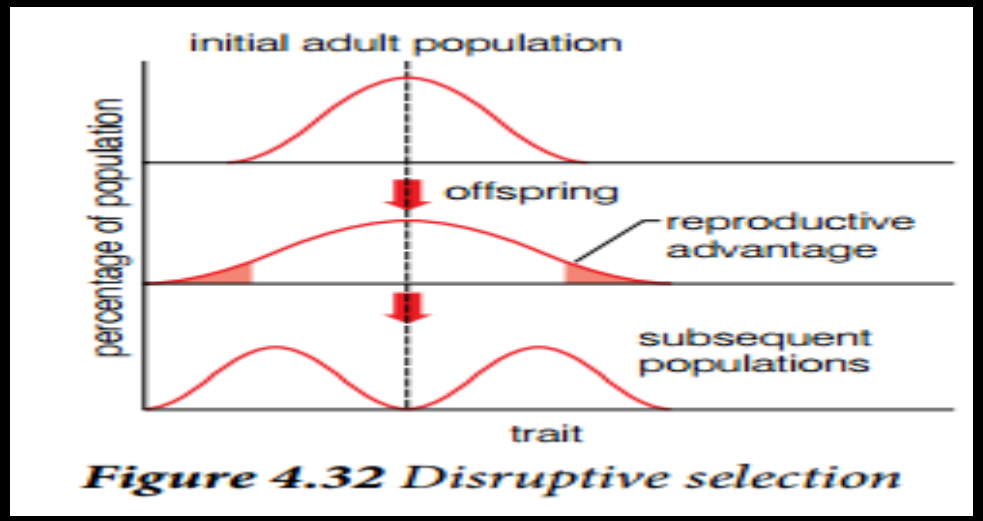
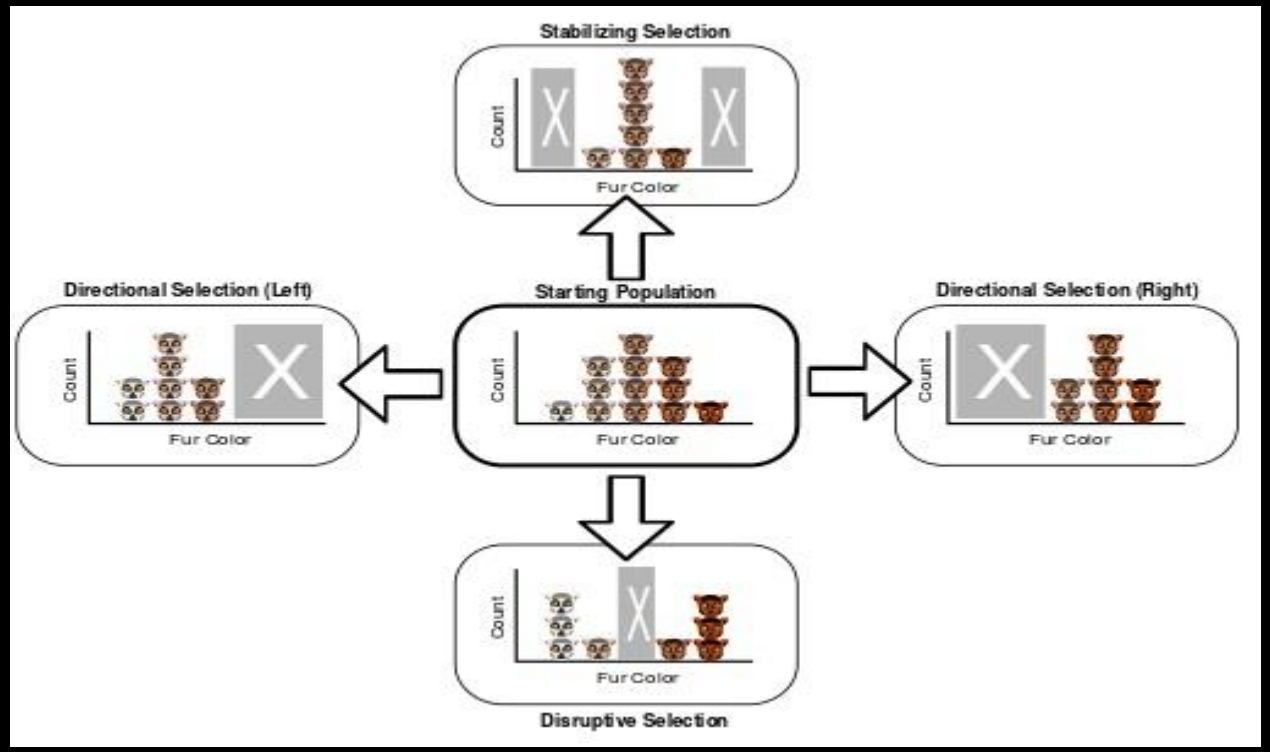


Figure 4.32 Disruptive selection



Cont....

How can natural selection lead to the formation of new species?

- ✓Natural selection provides a mechanism by which new populations of a species can arise.
- ✓But at what point can these populations be considered as distinct species? We have described a species as:
- ➢A group of similar, interbreeding organisms that produce fertile offspring.

Cont....

- ✓If two populations become so different that individuals from different populations cannot interbreed to produce fertile offspring, then we must think of them as different species.
- ✓There are a number of ways in which this can occur. The two main ways are:
- ➢allopatric speciation
- ➢sympatric speciation

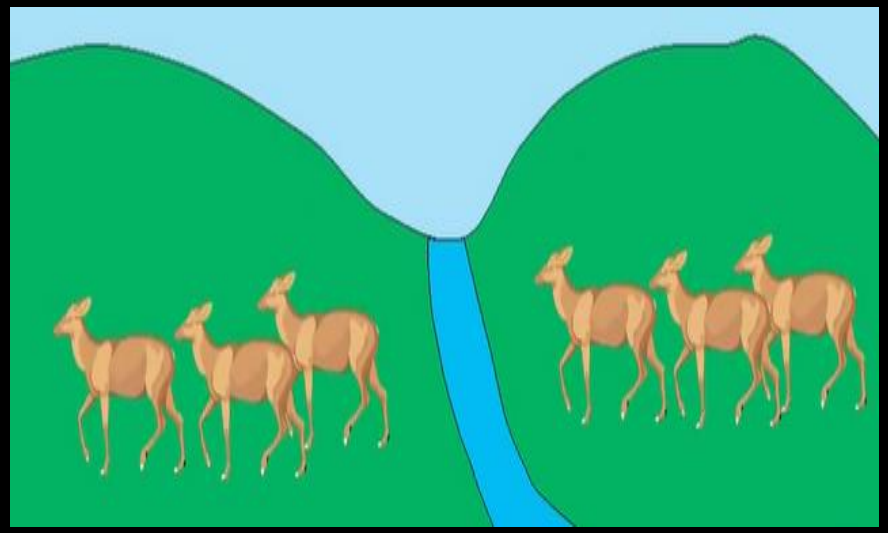
Cont....

- ✓Both allopatric and sympatric speciation involve isolating mechanisms that prevent different populations from interbreeding for a period of time.
- ✓Eventually, the two populations will become so different that they will be unable to interbreed and, at this point, we say that they are ‘reproductively isolated’. Effectively, they will have become distinct species.

Cont....

What is allopatric speciation?

- ✓allopatric speciation occurs when a population from an existing species becomes geographically isolated and the isolated population develops into a new species





Cont….

- ✓Examples of this could include:
- ➢a river changing course
- ➢a mountain range being created
- ➢a land mass separating two bodies of water

Cont....

What is sympatric speciation?

- ✓**sympatric speciation-**occurs when a population from an existing species develops into a new species without becoming geographically isolated from other members of the original species



Cont....

- ✓The two diverging populations may inhabit the same area, but be prevented from breeding in a number of ways, including:
- ➢seasonal isolation– members of the two populations reproduce at different times of the year
- ➢temporal isolation – members of the two populations reproduce at different times of the day
- ➢behavioural isolation– members of the two populations have different courtship patterns
- ✓Speciation following any of these methods of isolation is referred to as sympatric speciation.

Cont....

What is polyploidy and why is it important in plant evolution?

- ✓diploid (chromosomes in pairs – there are two sets of chromosomes in a cell) and haploid (chromosomes are single – there is just one set of chromosomes in a cell).
- ✓Poly- means many. Polyploidcells have many sets of chromosomes per cell – sometimes four sets, sometimes eight or more.
- ✓Some human liver cells have 92 chromosomes per cell – they are tetraploid– they have four sets of chromosomes per cell.

Cont....

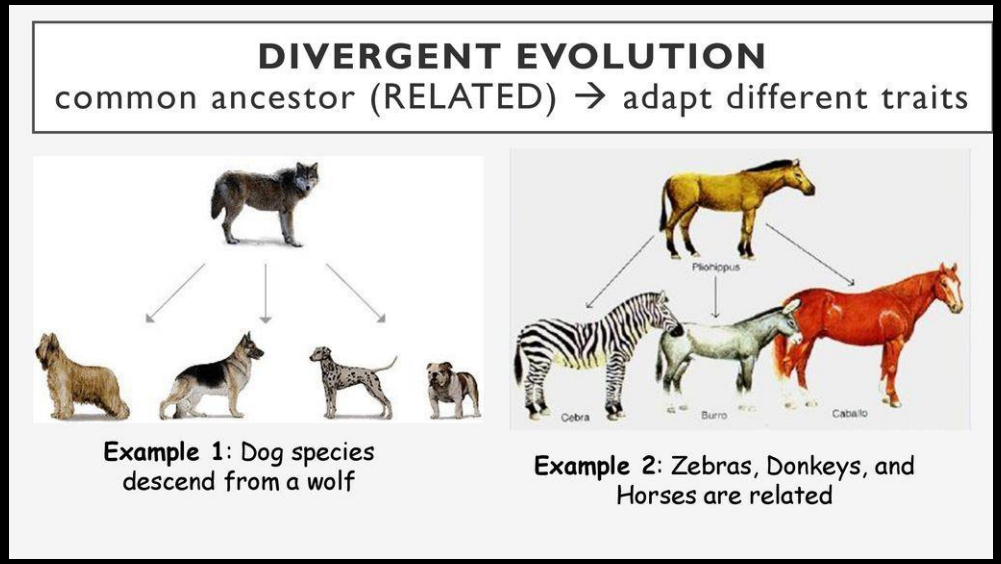
- ✓Polyploidy has been important in plant evolution because it has allowed otherwise infertile hybrids to become fertile again.
- ✓When different species form hybrids, very often the hybrid cannot produce offspring because all the chromosomes cannot form bivalents (homologous pairs) in meiosis.

Cont....

What are divergent evolution and convergent evolution?

What is divergent evolution?

- ✓Divergent evolution-is a process by which population of species evolve into different species due to differing selection pressures on each of them in their respective environments.
- ✓It is adaptive radiation



Cont....

What is Convergent evolution?

- ✓Convergent evolution-is a process in which unrelated species evolve similar structure adapted for the same function
- ✓convergent evolution the process by which unrelated organisms evolve similar structures, adapted for the same function

