



EVOLUTION

Diversity, Change and Continuity

- ▶ Diversity
 - Biodiversity (5 Kingdoms)
 - Biodiversity does not remain the same over time
- ▶ Change
 - Organisms of same species look different
 - Sources of variation
 - Environmental conditions change
 - Species become extinct
 - New species arise
- ▶ Continuity
 - Reproduction
 - Reproductive strategies

CHANGE = EVOLUTION

- ▶ **Evolution** refers to changes that occur over time
- ▶ **Biological evolution** refers to the changes that occur to living organisms over time
- ▶ What factor influences these changes?
- ▶ What evidence is there of the influence of this factor?

Biological Evolution

- ▶ Influenced largely by changes in the environmental conditions
- ▶ A study of the different rock strata provides evidence that the environmental conditions changed over time
- ▶ Different organisms are differently suited to the environmental conditions

Biodiversity

- ▶ Classification
- ▶ Various taxa
- ▶ Kingdom; Phyla; Order; Family; Genus; Species

Species

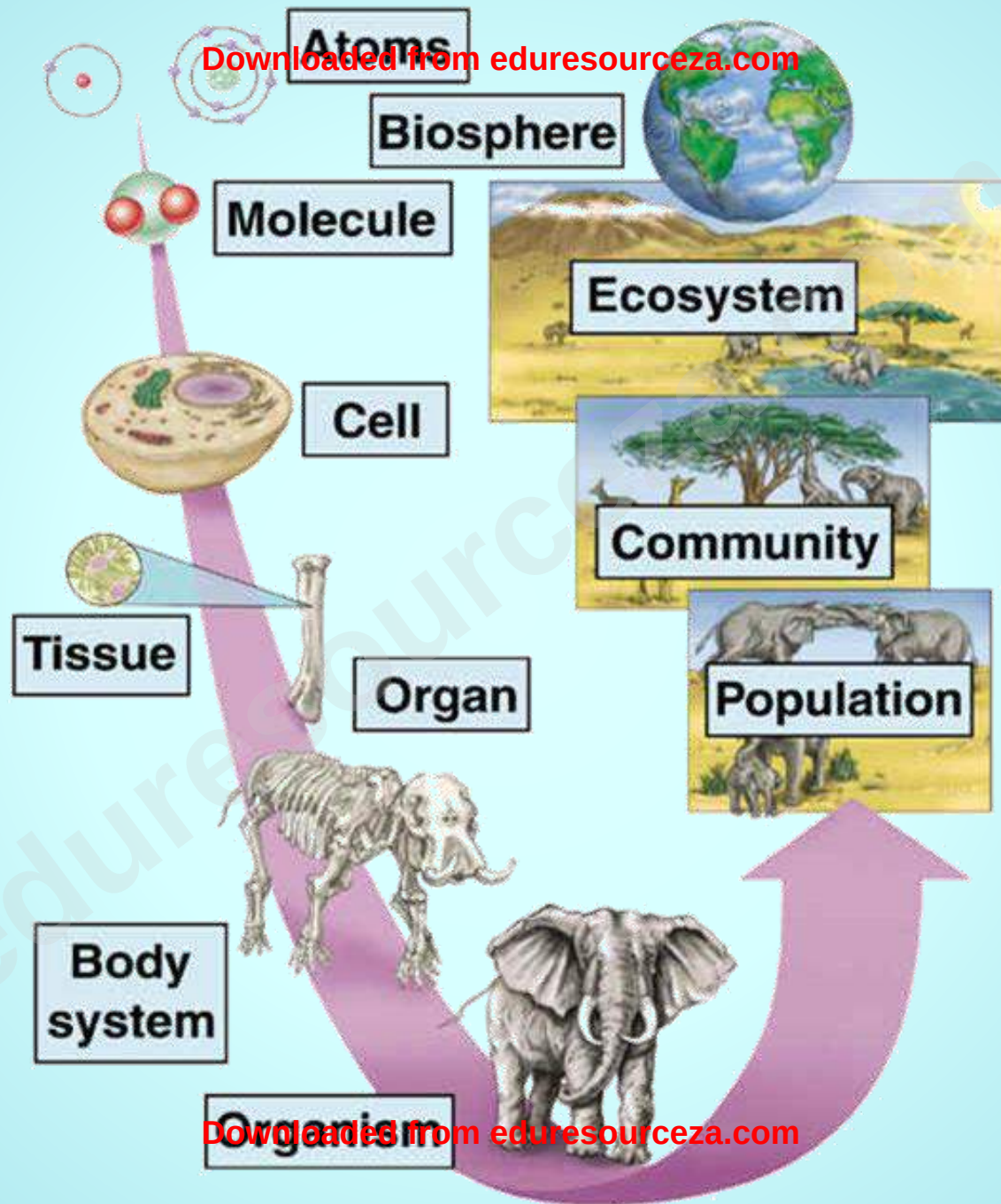
- ▶ According to the biological species concept:
 - A species refers to a group of **similar organisms**
 - that are capable of **interbreeding** (reproducing)
 - to produce **fertile offspring**
- E.g. *Homo sapiens* in all parts of the world represent a single species.

Population

- ▶ A species may exist in different habitats
- ▶ A population is described as:
 - A group of organisms of the same species
 - that occupy the same habitat
- E.g. Ants of a particular species in your garden

Community

- ▶ Different species may exist in the same habitat
- ▶ A community is described as:
 - A group of **different species**
 - that occupy the **same habitat**
- E.g. Ants, earthworms, rose plants and grass in your garden
- or even different species of ants in your garden



With regard to species...

- ▶ Over time
 - Some species may become extinct
 - Some species that existed in the past do not exist today
 - The disappearance of a species is called **extinction**
 - New species may arise
 - Some species that exist today did not exist in the past
 - The emergence of a new species is termed **speciation**
- ▶ How do we know all of the above?
- ▶ Biodiversity changes according to the rates of extinction and speciation

Theory of Biological Evolution

- ▶ Provides an explanation for:
 - Extinction
 - Speciation
 - Changes in Biodiversity

According to the Theory of Evolution ...

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- ▶ All present day life-forms have descended from and are related to those that lived in the past
- ▶ but may look different because of gradual changes that have occurred over time
- ▶ due to changes in the environmental conditions

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Theory of Evolution

- ▶ Sometimes the changes are so great that it is difficult to see a relationship between the modern form and its ancestor
- ▶ But can be more easily understood using the example of metamorphosis in the frog when it changes from a tadpole to an adult
 - Tadpole : aquatic, has a tail, breathes by gills, looks like a fish
 - Adult frog: mainly terrestrial; no tail; breathes by lungs and skin; does not resemble a fish

Tadpole and Adult Frog

- ▶ This change has occurred over a matter of weeks



Activity 1

- ▶ Terminology
- ▶ Activity Manual
- ▶ Page 11–12

Different Theories of Evolution

- ▶ A theory is supported by evidence
- ▶ A theory can be used to explain different observations
- ▶ Why do theories sometimes change?
- ▶ What are examples of other theories that have changed over time?

Different Ideas on Evolution

- ▶ Erasmus Darwin
- ▶ Jean Baptiste de Lamarck
- ▶ Charles Darwin
- ▶ Alfred Russell Wallace

Erasmus Darwin

- ▶ Grandfather of Charles Darwin
- ▶ He stated that
 - All life developed from simple forms
 - There are similarities amongst various organisms
 - Artificial selection and metamorphosis show how changes may have occurred



Lamarck

- ▶ Used two 'laws' to explain how organisms change over time:
 - Law of use and disuse
 - Law of the inheritance of acquired characteristics



Lamarck

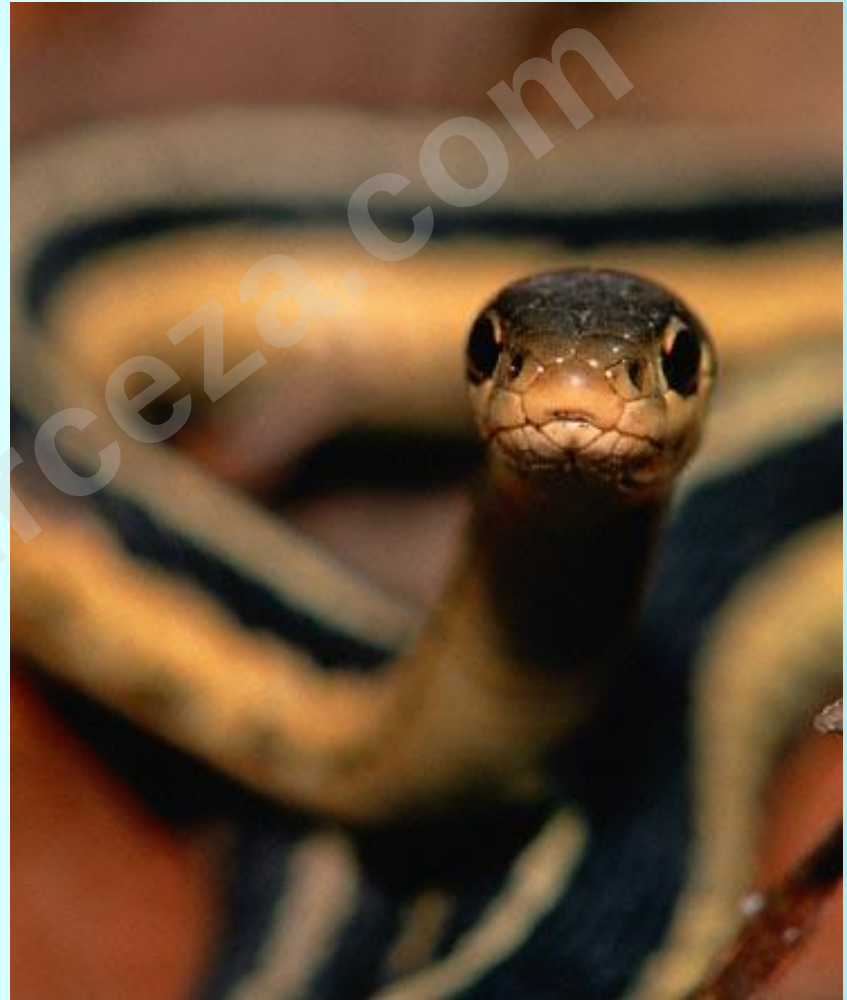
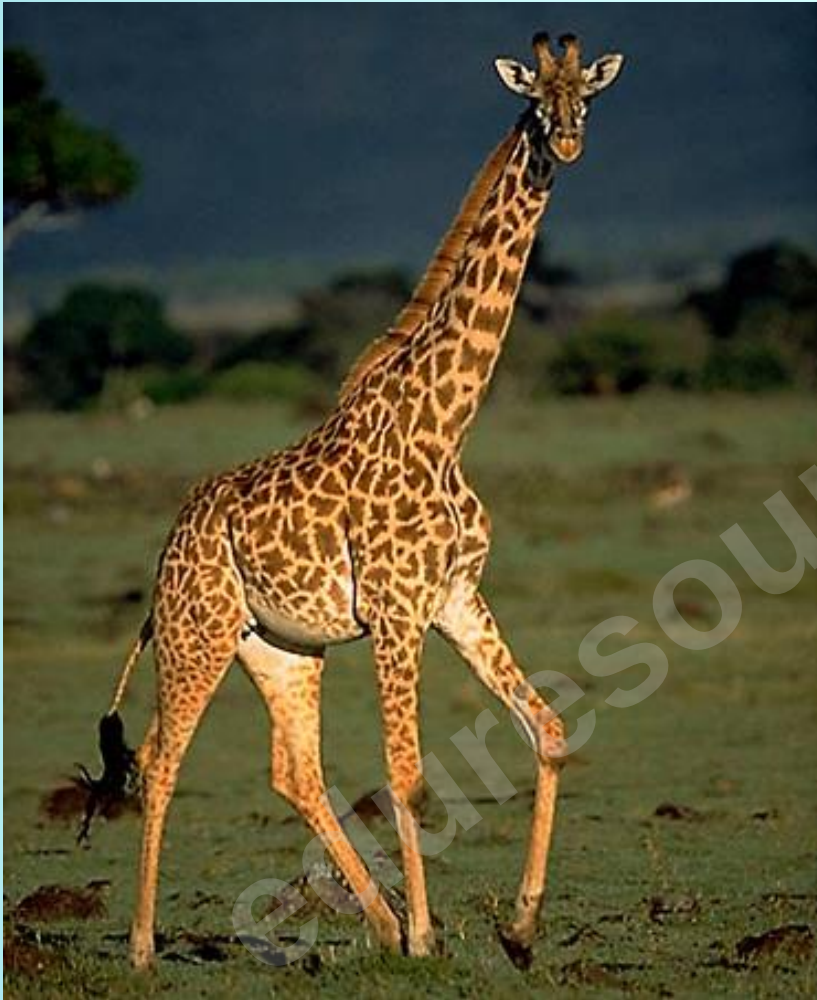
- Law of use and disuse
 - Organs become modified according to the frequency of use
 - Frequent use causes an organ to become larger, stronger or more efficient in its function
 - Disuse causes an organ to become smaller, weaker, less efficient in its function and the organ may eventually disappear altogether

Lamarck

- Law of inheritance of acquired characteristics
 - Structural changes that occur in the life of an organism can be passed on to the offspring in the next generation

Lamarck

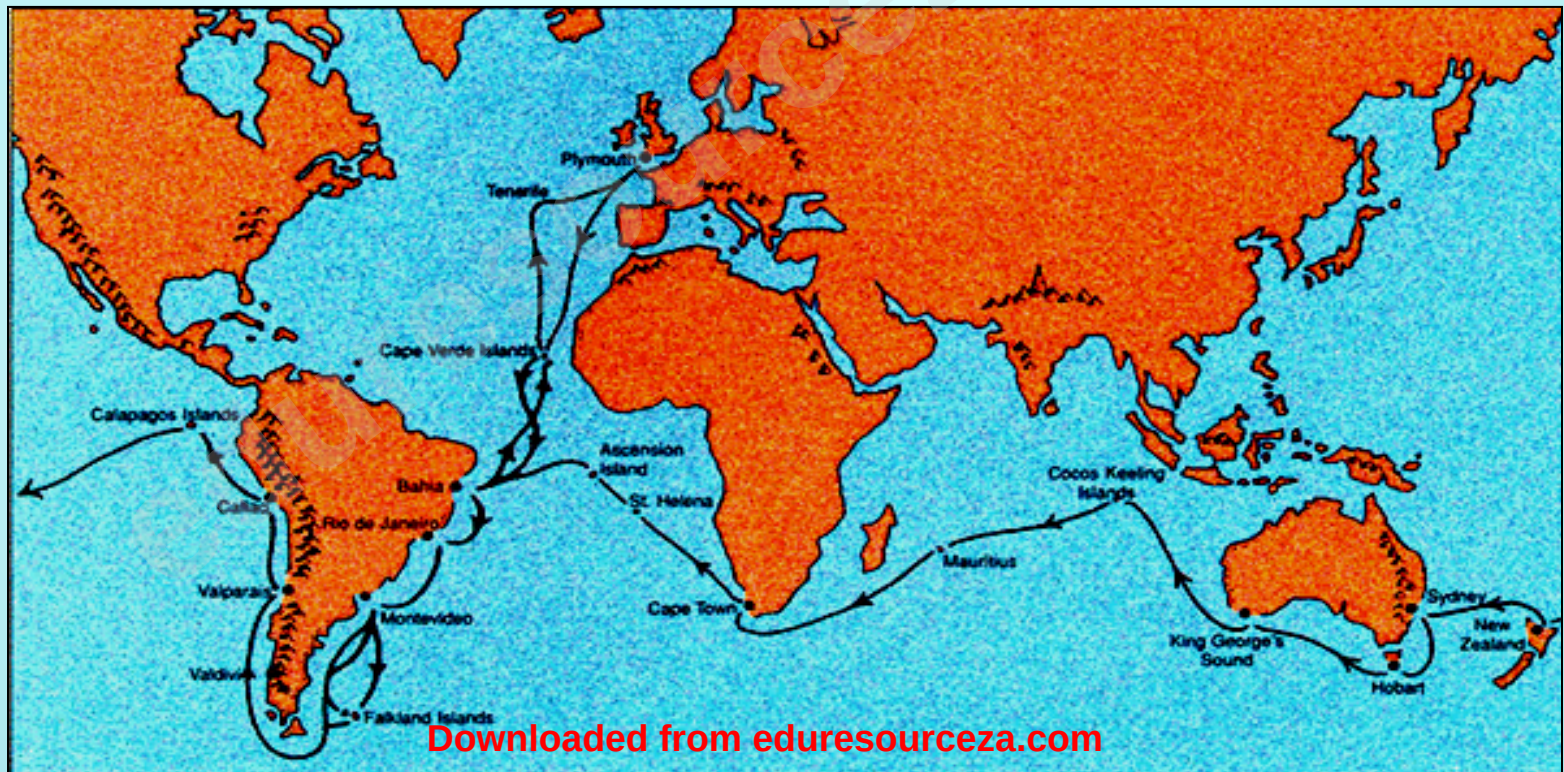
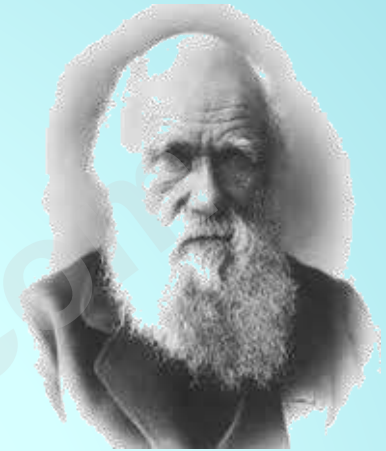
- Two examples
 - USE: The long neck of the giraffe arose out of attempts to stretch its neck to reach the leaves of tall trees
 - DISUSE: The legs of the snake disappeared due to disuse in its gliding motion



Lamarck

- Why was his theory rejected
 - There is no evidence to show that acquired characteristics can be passed onto the offspring
 - There is no evidence to support the idea that organs become modified by the frequency of use

Charles Darwin

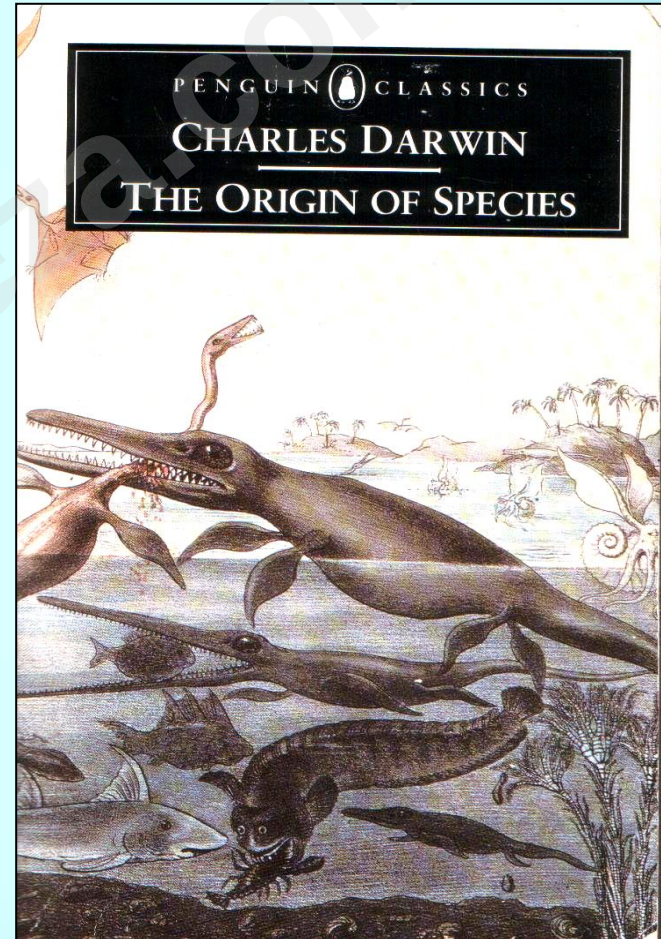


Charles Darwin

- Collected specimens and kept detailed notes on plants, animals and geography of the countries he visited while on a 5-yr voyage in the HMS Beagle round the world
- In 1844 wrote out his theory of evolution by natural selection in 231 pages – not published
- In 1858 he received a manuscript from Alfred Russell Wallace who put forward the exact same theory as his own
- Darwin was afraid that if now made his ideas public, he would be accused of stealing Wallace's ideas

Charles Darwin

- His friends convinced him to write a journal article on his ideas
- This article, together with the one by Wallace was read at the Linnaean Society on 1st July 1858
- Darwin then started writing his 'On the Origin of Species' – published in 1859



Charles Darwin

- ▶ What were the observations upon which Darwin based his theory?

Charles Darwin

- ▶ Darwin based his theory on the following observations:
 - Organisms of a species produce a **large number** of offspring
 - The offspring show a great deal of **variation**
 - Of the large number of offspring produced, **only a few survive**
 - **Characteristics are inherited** from surviving parents to offspring

Charles Darwin

- ▶ Through our current knowledge we now know the sources of variation:
 - Crossing over in meiosis
 - Random assortment in meiosis
 - Mutations
 - Random mating
 - Random fertilisation

Activity

- ▶ Variation
- ▶ Question Book
- ▶ Page 26

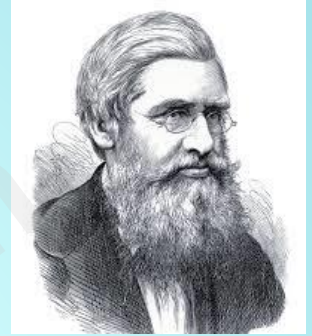
Charles Darwin

Darwin's Theory of Evolution by Natural Selection

- Organisms of a species produce a **large number** of offspring
- The offspring show a great deal of **variation**
- Organisms with characteristics that make them **more suited** to the environment, **survive**
- Organisms with characteristics that make them **less suited** to the environment, **die**
- This is termed **natural selection**
- The surviving organisms **reproduce**
- **passing the desirable characteristics** to their offspring
- In the next generation there would be a **larger proportion** of individuals with desirable characteristics
- As natural selection occurs time, there is therefore a continual, **gradual change in populations**, which may eventually lead to the evolution of new **species**.

Charles Darwin

- ▶ Are the environmental conditions always the same in a habitat
- ▶ Are the characteristics which make organisms suited to the environment always the same?
- ▶ Is the natural selection pressure always the same?
- ▶ Are the environmental conditions always the same in adjacent habitats?
- ▶ Can natural selection occur differently/independently in two adjacent habitats?



Alfred Russel Wallace

- ▶ Wallace also based his theory of evolution on natural selection
- ▶ Wallace made a big contribution to our understanding of biogeography

Lamarck and Darwin

Lamarck	Darwin
Individuals change	Populations change
Organisms survive because they change their characteristics to make them suited to the environment	Organisms survive since they have inherited characteristics that are suited to the environment
Acquired characteristics are passed on to the offspring	Inherited characteristics are passed on to the offspring

Artificial Selection

- ▶ Refers to the breeding of plants and animals for desirable characteristics – it is also known as selective breeding
- ▶ A specific plant or animal is chosen because it has a specific characteristic that the breeder desires.
- ▶ The plant or animal is then bred with another of its kind with a similar characteristic,
- ▶ This results in offspring with a higher potential to display the specific characteristic.
- ▶ This is repeated until the specific characteristic is achieved at the desired level.

Artificial Selection – Example 1

- ▶ By selecting cows which produce large amounts of milk and whose mothers and grand-mothers were also high milk producers, and allowing them to mate with bulls whose mothers and grandmothers were also high milk producers, cows which produce more milk than their ancestors, have been developed.

Artificial Selection

- ▶ Artificial selection can also ensure that a combination of desirable characteristics, which may sometimes appear independently in different organisms, appears in the same set of offspring.

Artificial Selection – Example 2

- ▶ For example, a breeder may cross a meaty male sheep with a wooly female sheep
- ▶ Some of the offspring would show a combination of these two desirable characteristics
- ▶ These offspring are then bred with each other.
- ▶ This process is continued until sheep with a large amount of meat and a large amount of wool is produced.

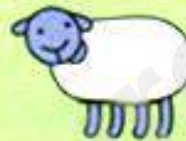
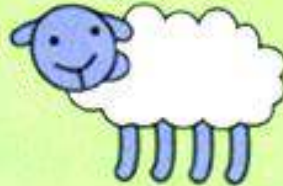
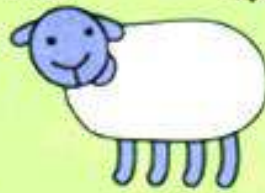
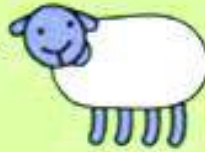


Big, meaty
male

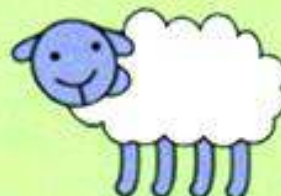


Wooly
female

From his flock
the farmer
selects a big
male and a
woolly female;
He breeds
them together



The best offspring are chosen and bred together



The farmer keeps doing this to get a flock of
big, wooly sheep

Natural vs Artificial Selection

▶ Similarities

- Desirable characteristics are selected
- The selected characteristics are passed onto the offspring during reproduction

▶ Differences

Natural selection	Artificial selection
The environment/nature is the selective force	Human represent the selective force
Selection is in response to suitability to the environment	Selection is in response to satisfying human needs
Occurs within a species	May involve one or more species (as in cross breeding)

Activity 2

- ▶ Darwin and Lamarck
- ▶ Activity Manual – Page 13 – tortoise
- ▶ QB – Page 28
- ▶ QB – Page 27 – LO1

Evolution in Present Times

- ▶ Evolution does not necessarily take place over millions of years
- ▶ Evolution by natural selection is happening presently
- ▶ The development of resistance to insecticides, the way bacteria have developed resistance to antibiotics, can be explained in terms of Natural Selection

Evolution in Present times – example

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- ▶ The mosquito populations show **variation**
- ▶ Most of the mosquitoes will **die of DDT poisoning** but a small number of these mosquitoes will have the ability to **survive the insecticide**.
- ▶ When sprayed with DDT, most of the mosquitoes **die**,
- ▶ but the few DDT resistant mosquitoes **survive**.
- ▶ This is **natural selection**.
- ▶ These DDT-resistant mosquitoes **breed rapidly** and increase in numbers since they have less competition because of the reduced population size.
- ▶ The next time DDT is applied in the same area **most mosquitoes will survive**, but a few will die.
- ▶ In this way, mosquitoes become **more and more resistant to DDT**,
- ▶ and there will come a time when the DDT is totally ineffective in killing mosquitoes.

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Activity 3

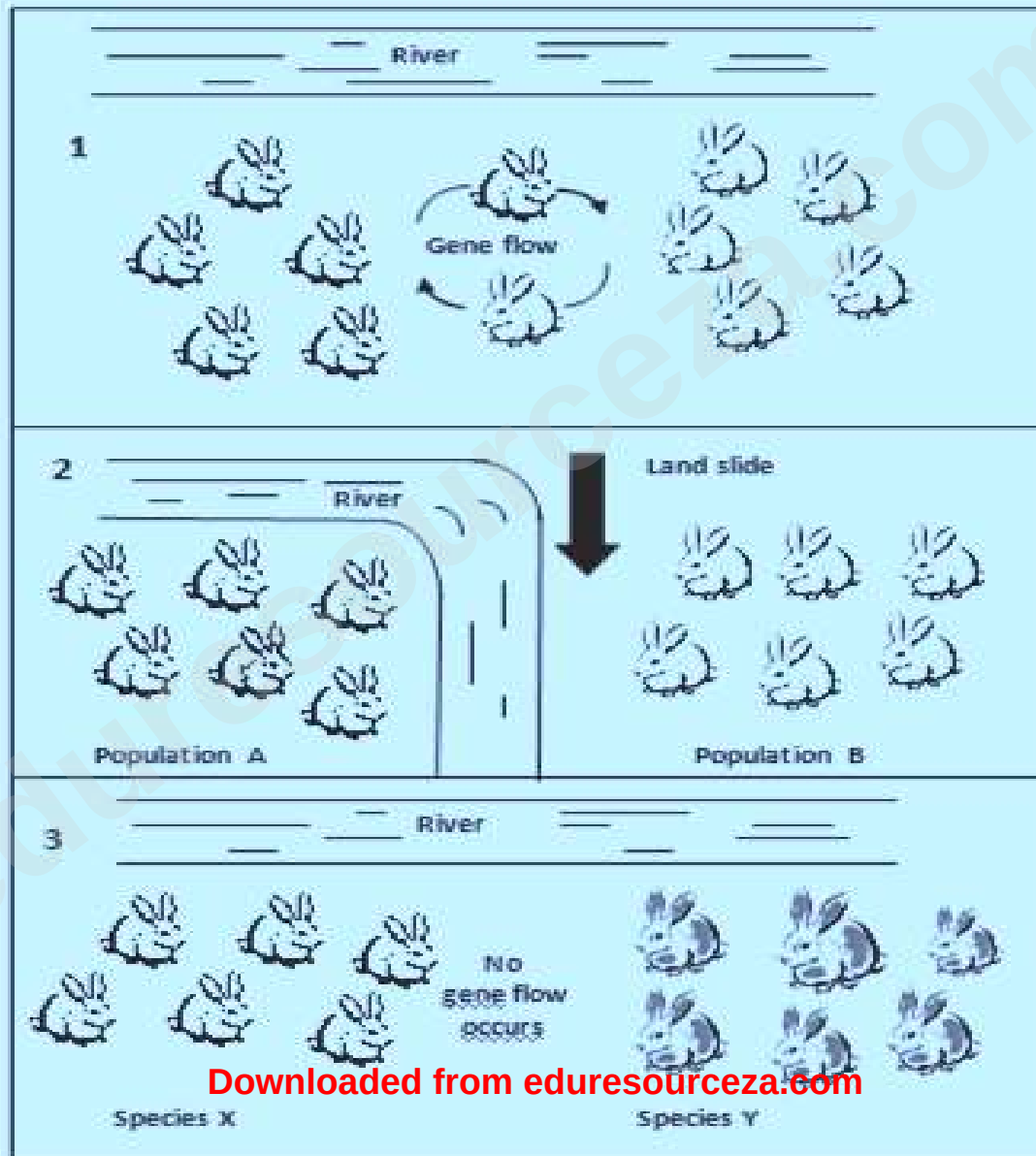
- ▶ Evolution in Present Times
- ▶ Activity Manual
- ▶ Page 14

Speciation

- ▶ Refers to the process by which new species are formed
- ▶ There are two types of speciation
 - **Allopatric speciation:** due to a population (in a habitat) being *split into two habitats by a geographical barrier*
 - **Sympatric speciation:** due to a population becoming separated *within a single habitat*

Allopatric Speciation

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Allopatric Speciation – Example

- ▶ A population of rabbits become **split**
- ▶ by a **geographical barrier**/river
- ▶ As a result, the two parts of the population **cannot interbreed**
- ▶ There is **no gene flow** between the two populations
- ▶ Natural selection occurs **independently** in each population
- ▶ due to **different environmental conditions** on either side of the river
- ▶ As a result, the two populations become genotypically and phenotypically **different** over a period of time
- ▶ Even if the geographical **barrier is removed** (i.e. the river returns to its normal course at some later time)
- ▶ the rabbits **will not interbreed** again
- ▶ We say that one or both parts of the rabbit population have become a **new species**

Sympatric speciation

- ▶ A population of a particular species may become separated
- ▶ **because of differences in behaviour, e.g. different feeding times**
- ▶ As a result, the **two parts of the population** cannot interbreed
- ▶ There is **no gene flow** between the two parts of the population
- ▶ Natural selection occurs **independently** in each part of the population
- ▶ This is due to **different environmental conditions** (at different times of the day)
- ▶ As a result, the two parts of the population become genotypically and phenotypically **different** over a period of time
- ▶ Even if the two parts of the **population mix** at a later time,
- ▶ they will **not be able to interbreed** again
- ▶ We say that one or both parts of the population have become a **new species**

What keeps species distinct?

- ▶ Reproductive isolation mechanisms
 - Breeding at different times of the year
 - Species-specific courtship behaviour (animals)
 - Adaptation to different pollinators (plants)
 - Infertile offspring (e.g. mules)

New Taxa

- ▶ When many new species form over time that become very different from the ancestral species,
- ▶ The new group of species may be considered as a new genus
- ▶ In a similar way, larger taxa (groups) of life such as the different phyla, classes, orders, families may form

Activity 4

- ▶ Mind the Gap – Page 31
- ▶ Activity Manual – Page 14

Activity 5

- ▶ Essay Writing
- ▶ Activity Manual – Page 14

New Taxa

- ▶ Scientists think that the different animal groups appeared as follows :
 - ☐ Invertebrates (543 million years ago)
 - ☐ Fish (438 million years ago)
 - ☐ Amphibians (380 million years ago)
 - ☐ Reptiles (385 million years ago)
 - ☐ Birds (180 million years ago)
 - ☐ Mammals (144 million years ago)
 - ☐ Humans (150 –200 thousand years ago)
- ▶ What is the evidence?
- ▶ Can this sequence change in the future?
- ▶ Why are there gaps in the fossil record?

New Taxa

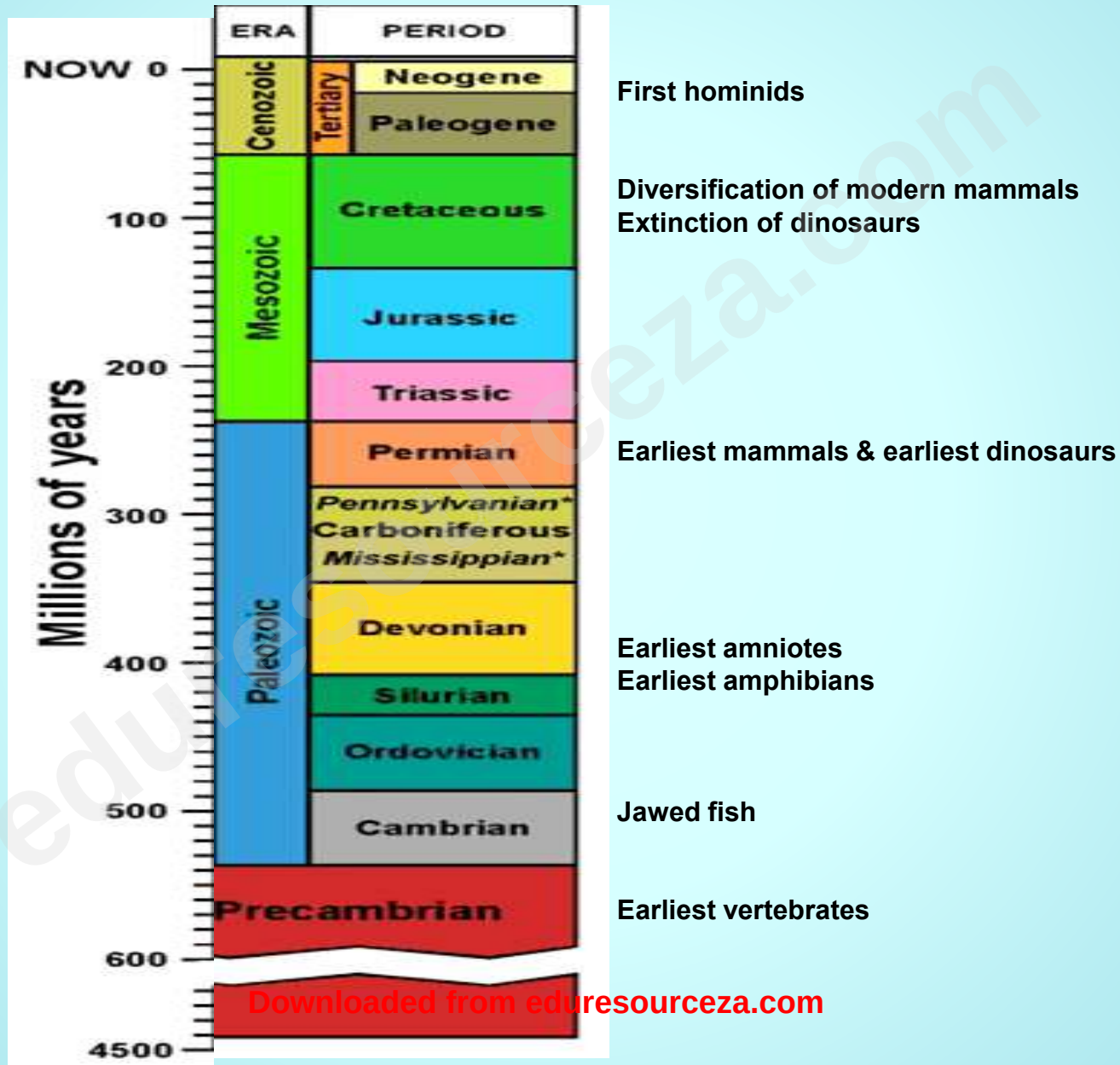
- ▶ Since these changes have taken place over millions of years to form the different groups of organisms
- ▶ it has become more convenient for scientists to develop a **geological time scale**

Geological Time-scale

- ▶ The geological time scale divides the Earth's history into three main **eras** viz. the Paleozoic, Mesozoic and Coenozoic eras
- ▶ Each of these eras is in turn divided into **periods**.

For example, the Mesozoic Era is divided into the Triassic, Jurassic and Cretaceous Periods.

- ▶ We are now living in the Holocene Period of the of the Coenozoic Era.
- ▶ The Holocene Period started 10 000 years ago.

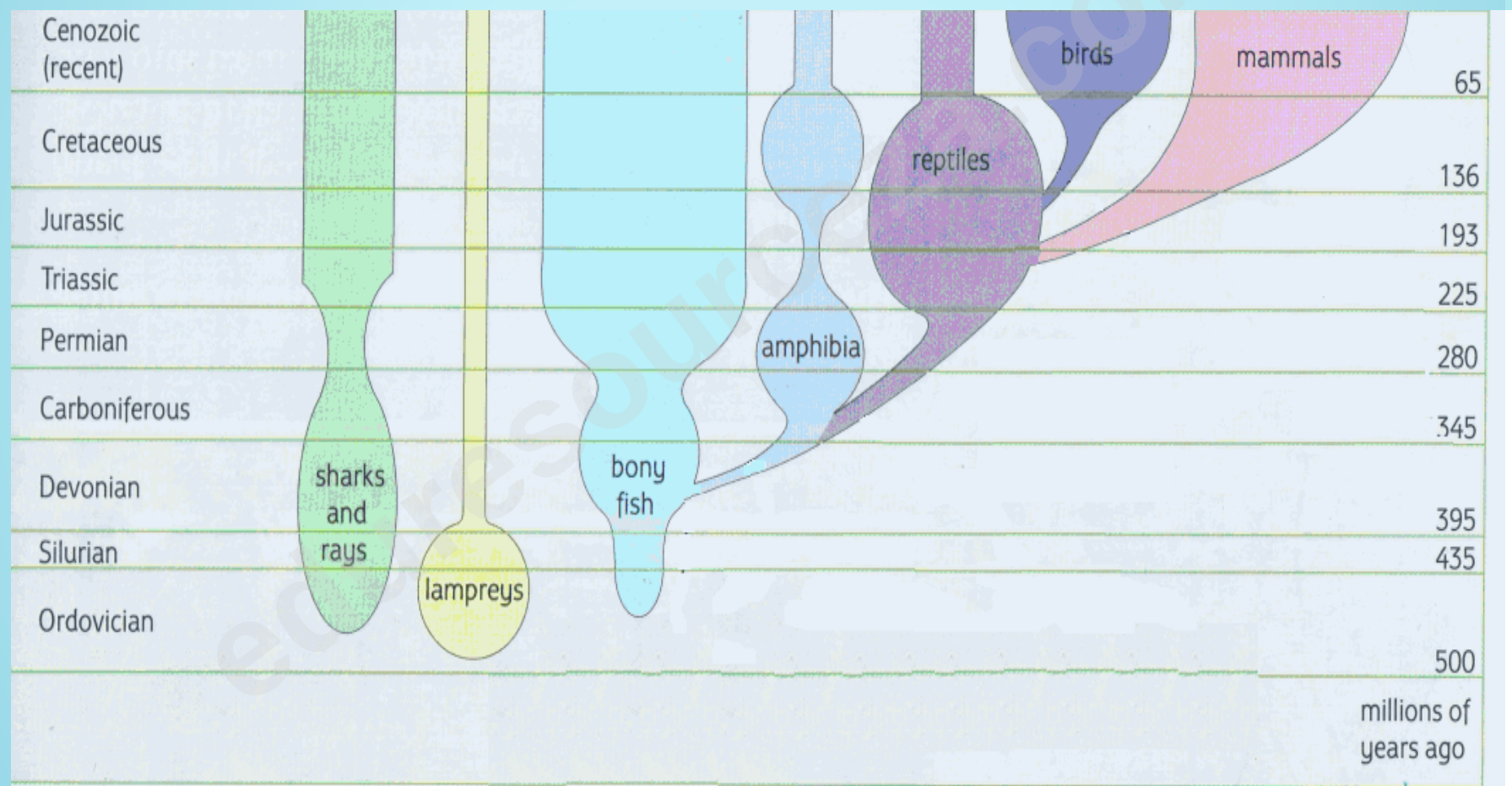


Phylogenetic Tree

- Scientists accept that evidence from paleontology, molecular biology & genetics, comparative anatomy, and comparative embryology shows that various life forms are related
- **Phylogenetic trees** show how various groups of life forms may be related
- We also use a kind of phylogenetic tree called a **cladogram** which shows the common characteristics shared by a group of organisms.
- A cladogram also indicates when different characteristics first appeared in the history of life

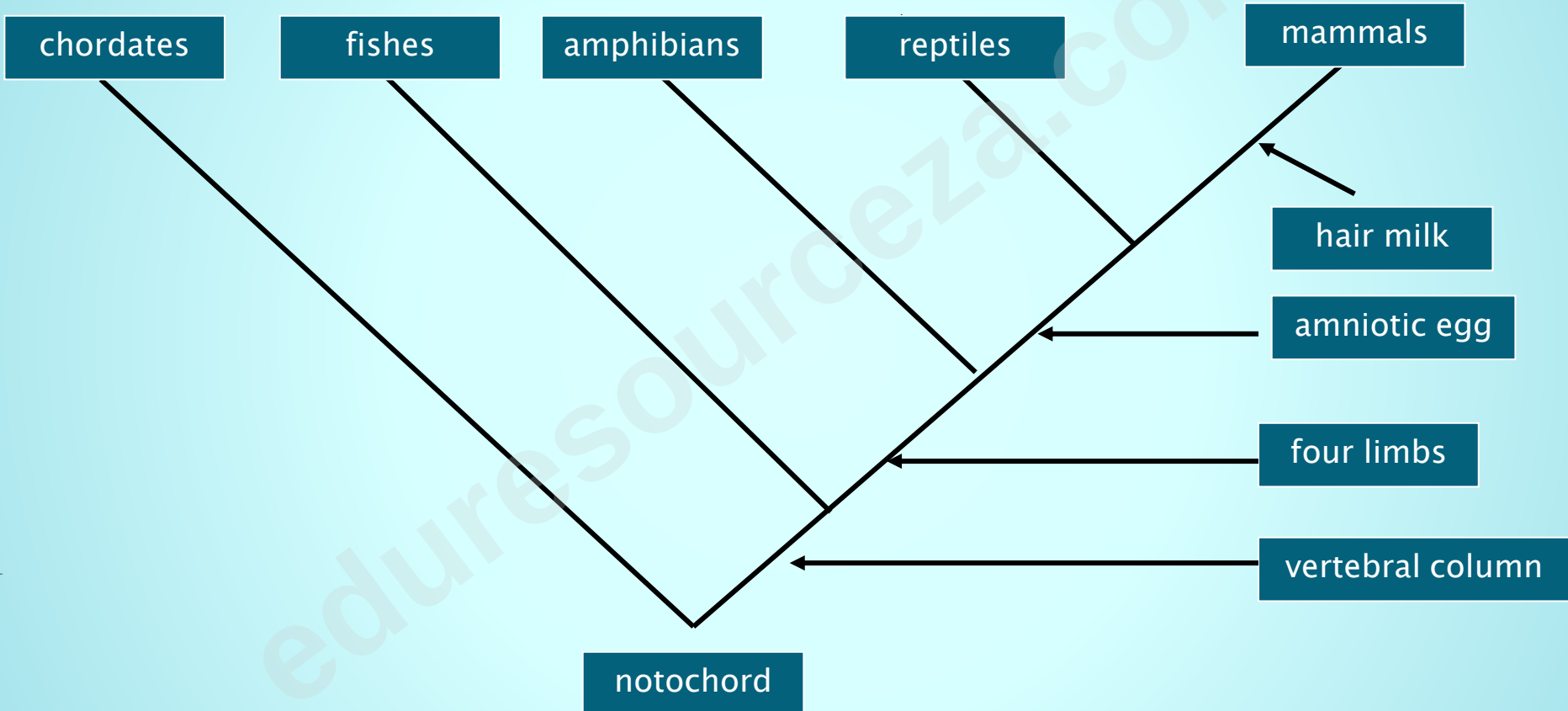
Geological Time-scale and Phylogenetic Tree

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Cladogram



Evidence for Evolution

- ▶ Fossil Evidence
- ▶ Comparative Embryology
- ▶ Comparative Anatomy
- ▶ Biochemistry
- ▶ Biogeography

Activity

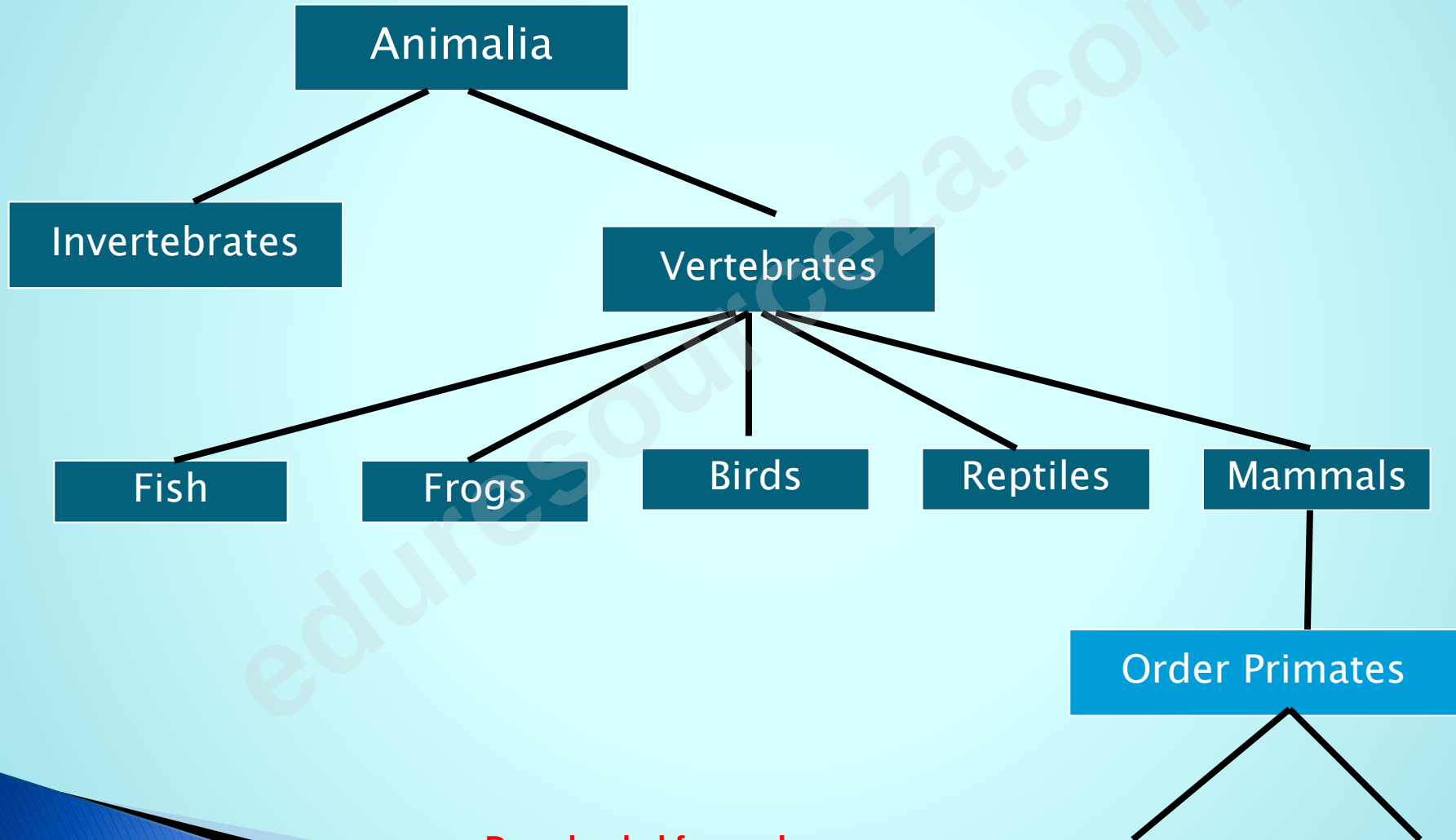
- ▶ Phylogenetic Tree
- ▶ QB – Page 32

Human Evolution

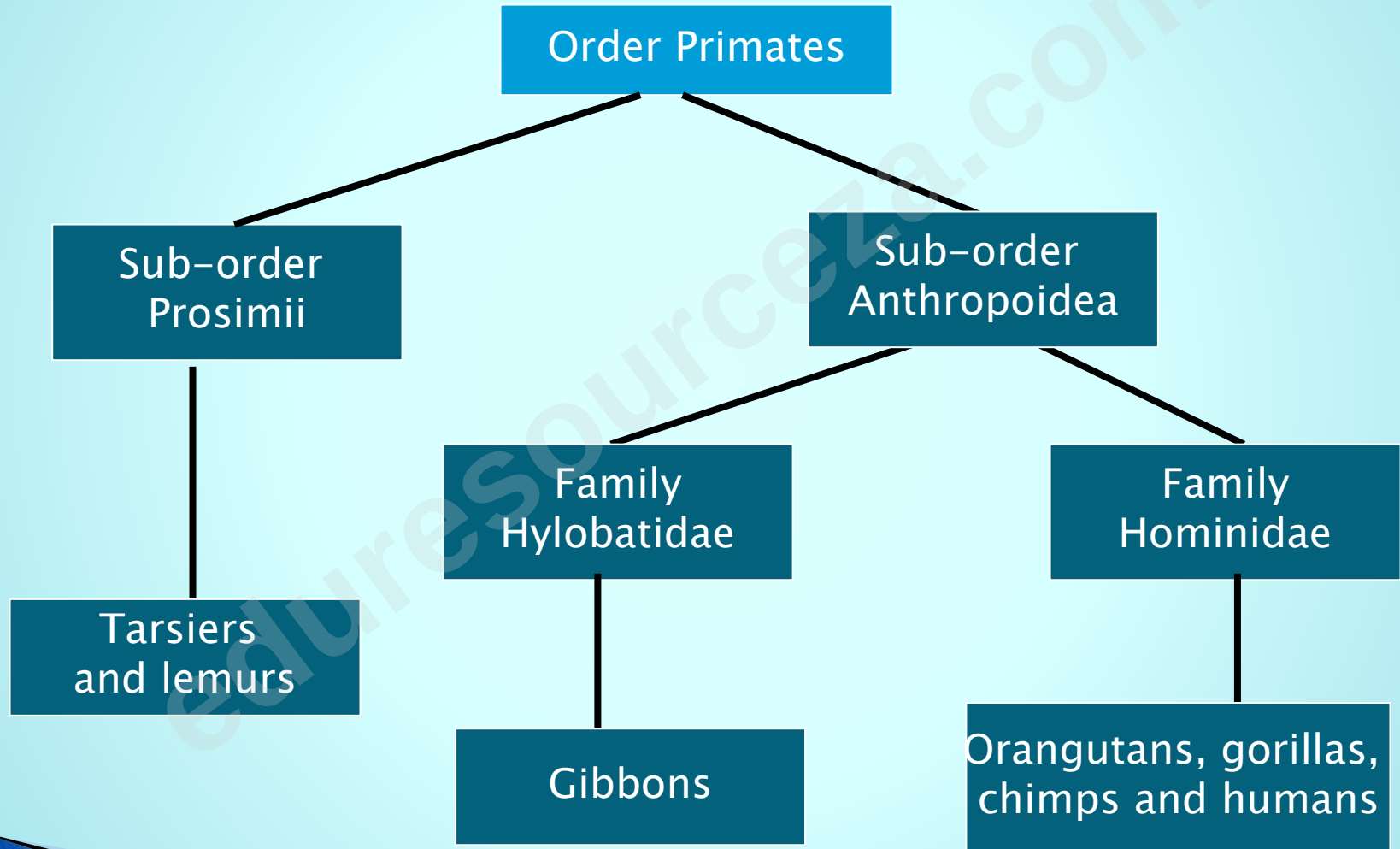
Most scientists accept that:

- ▶ The forces of evolution that have resulted in the development of all other species also worked in the same way in human development
- ▶ i.e. the human species evolved in the same way that other species evolved
- ▶ Chimpanzees and humans share a common ancestor i.e. they are our closest living relatives since we share 98% of our DNA sequences with chimps

Our Place in the Animal Kingdom



Our Place in the Animal Kingdom

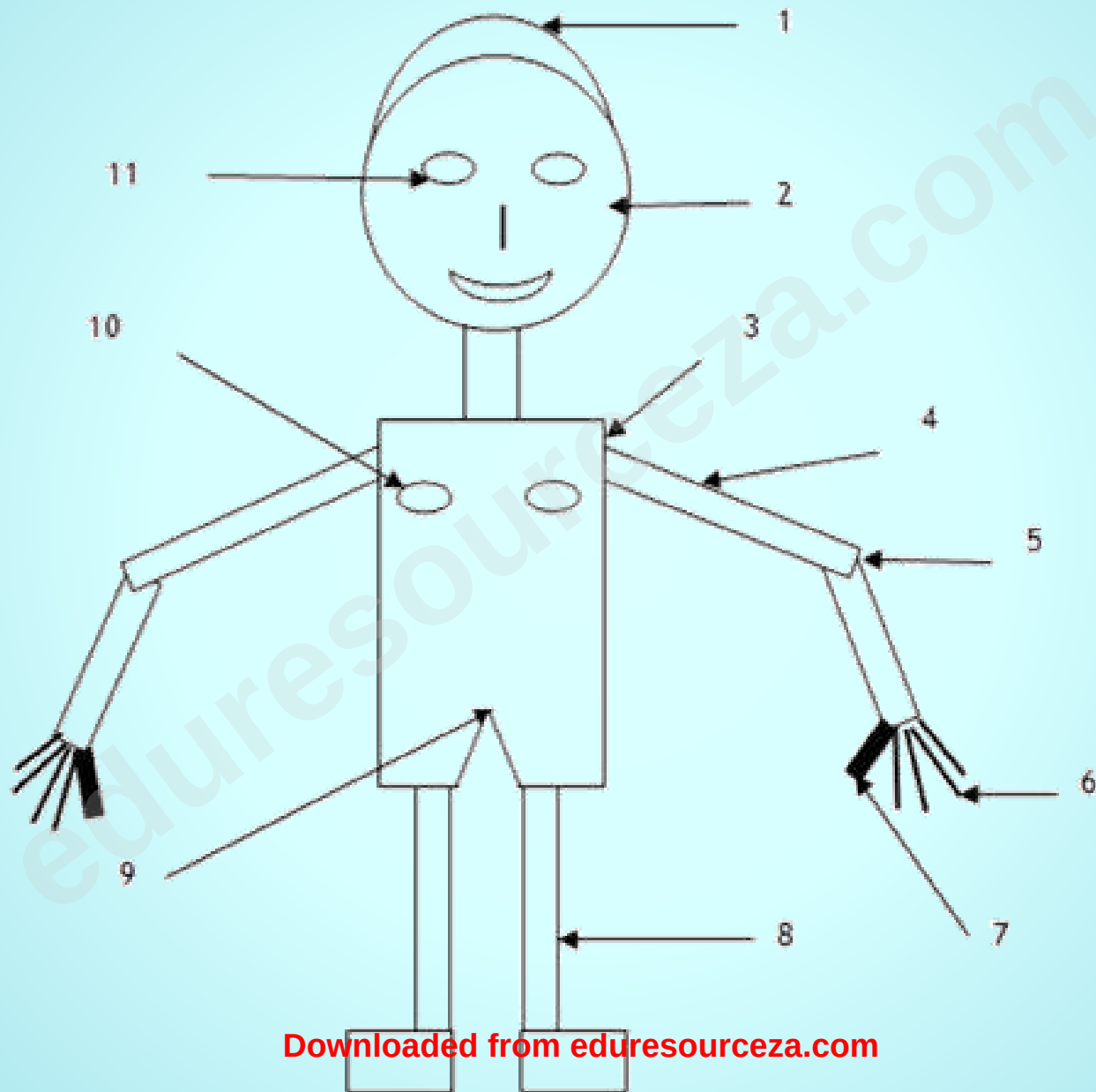


Hominids and Hominins

- ▶ **Hominid** – the group consisting of modern humans, chimpanzees, gorillas and orangutans plus all their immediate ancestors). It includes all members of the family Hominidae.
- ▶ **Hominin** – the group consisting of modern humans, extinct human species and all our immediate ancestors (including members of the genera *Homo*, *Australopithecus*, *Paranthropus* and *Ardipithecus*).

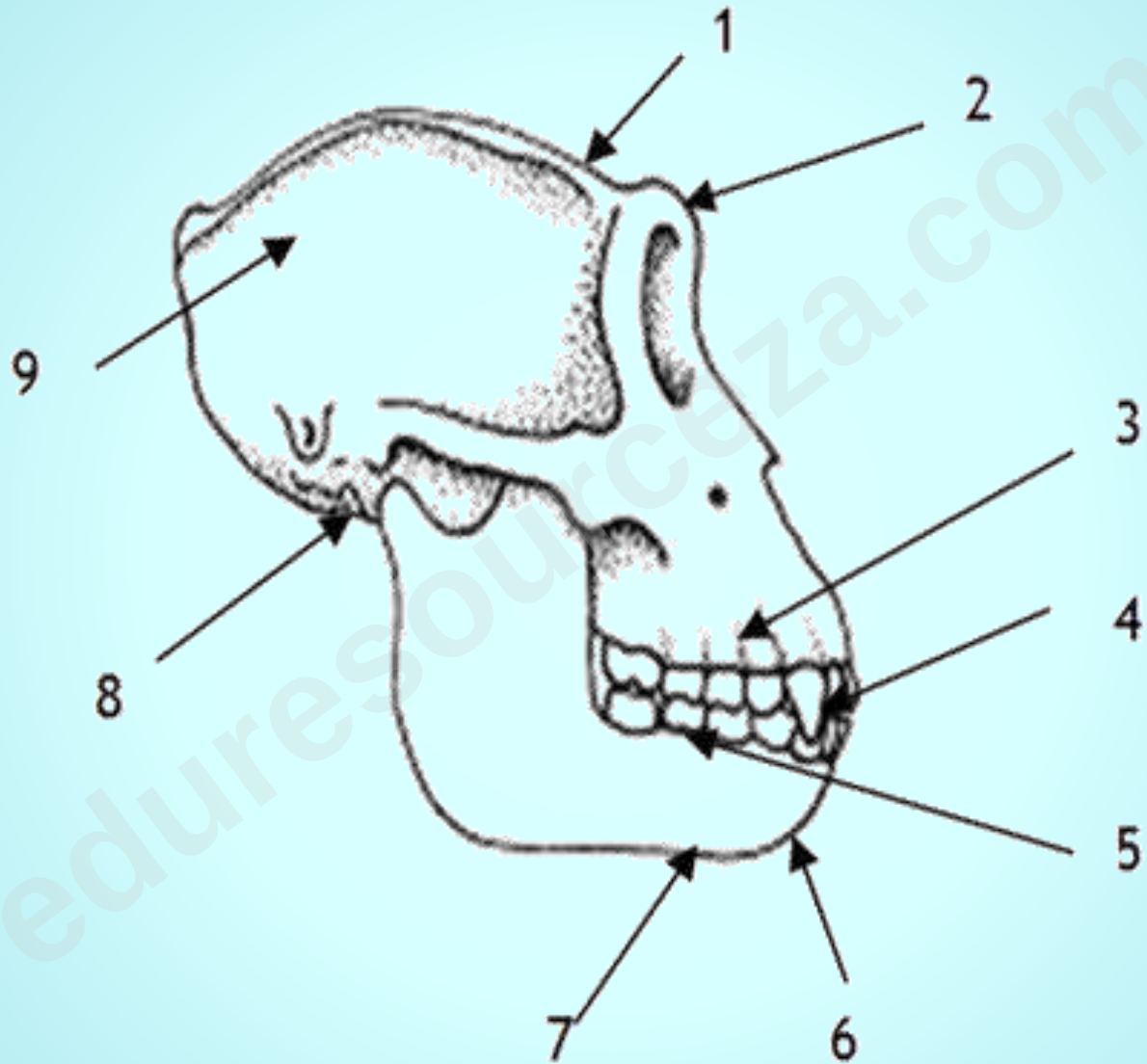
Characteristics we share with other primates

- ▶ Large brain
- ▶ Eyes in front
- ▶ Stereoscopic/Binocular vision
- ▶ Eyes with cones (in addition to rods) for colour vision
- ▶ Freely rotating arms
- ▶ Long upper arms
- ▶ Elbow joints allow rotation of the fore-arm
- ▶ Opposable thumb
- ▶ Bare fingertips (ends in flat nails instead of claws)
- ▶ Upright posture
- ▶ Sexual dimorphism (distinct male and female)
- ▶ Mammary glands end in two teats only
- ▶ Produce few offspring



Characteristics that make us different from other primates

- ▶ Shift of foramen magnum to a more forward position
- ▶ A more rounded skull and increased cranium size
- ▶ A flatter face due to:
 - Less sloping forehead
 - Less protruding jaws (decreased prognathous)
 - A more developed chin
 - Less pronounced brow ridges
- ▶ A more rounded jaw
- ▶ Increased size of skeleton
- ▶ Change in dentition – smaller canines
- ▶ Artificial Language

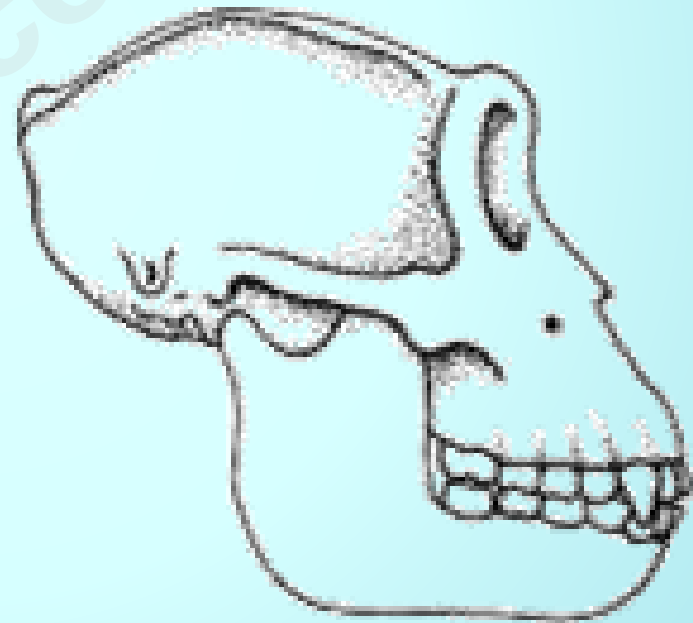
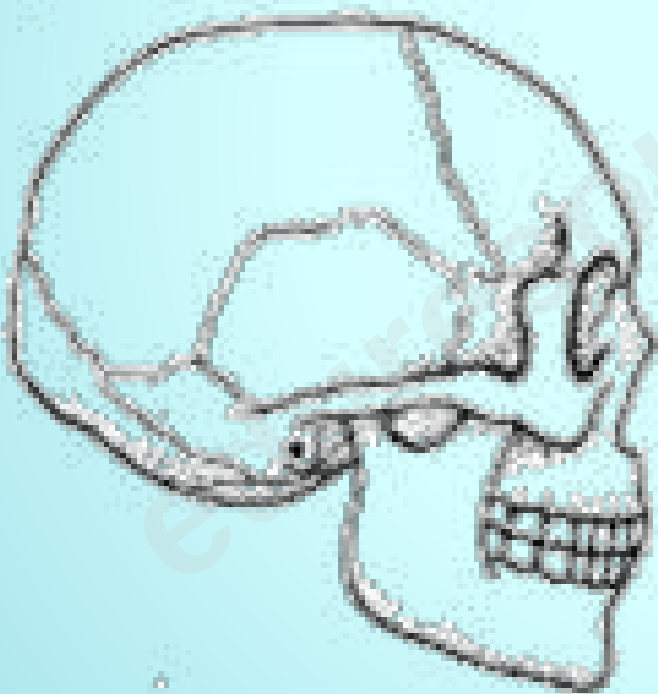


Homo sapiens and other Primates

FEATURE	Homo sapiens	Other primates
Cranium	Larger cranium	Smaller cranium
Forehead	Forehead slope less backwards	Foreheads slope much backwards
Foramen Magnum	Foramen magnum forward/bottom of the skull	Foramen magnum at the back of the skull
Brow Ridges	Brow ridges are not as pronounced	Brow ridges pronounced
Canines	Smaller canines	Larger canines
Spaces between teeth	Smaller spaces between the teeth	Larger spaces between the teeth
Arrangement of teeth	Jaws with teeth on a gentle/round curve	Jaws with teeth in a rectangular/U shape
Jaws	Less protruding jaws/non-prognathous	More protruding jaws/prognathous
Chin	Well developed chin	Poorly developed chin

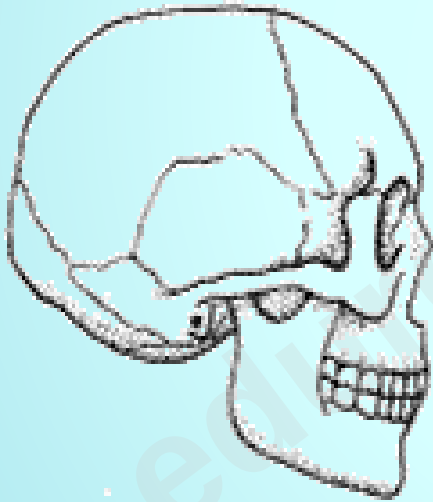
Humans and other Primates

- ▶ Visible Differences

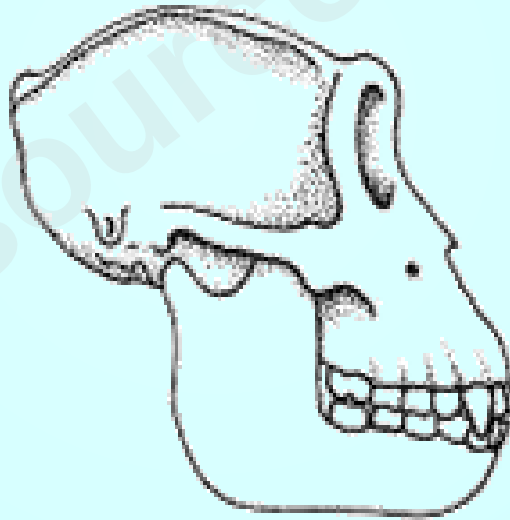


Sequence of Evolution

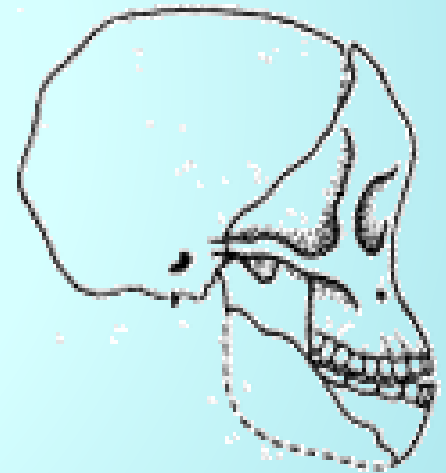
- ▶ Based on the observable characteristics and the trends in evolution, what is the sequence in which the following organisms most likely appeared:



A

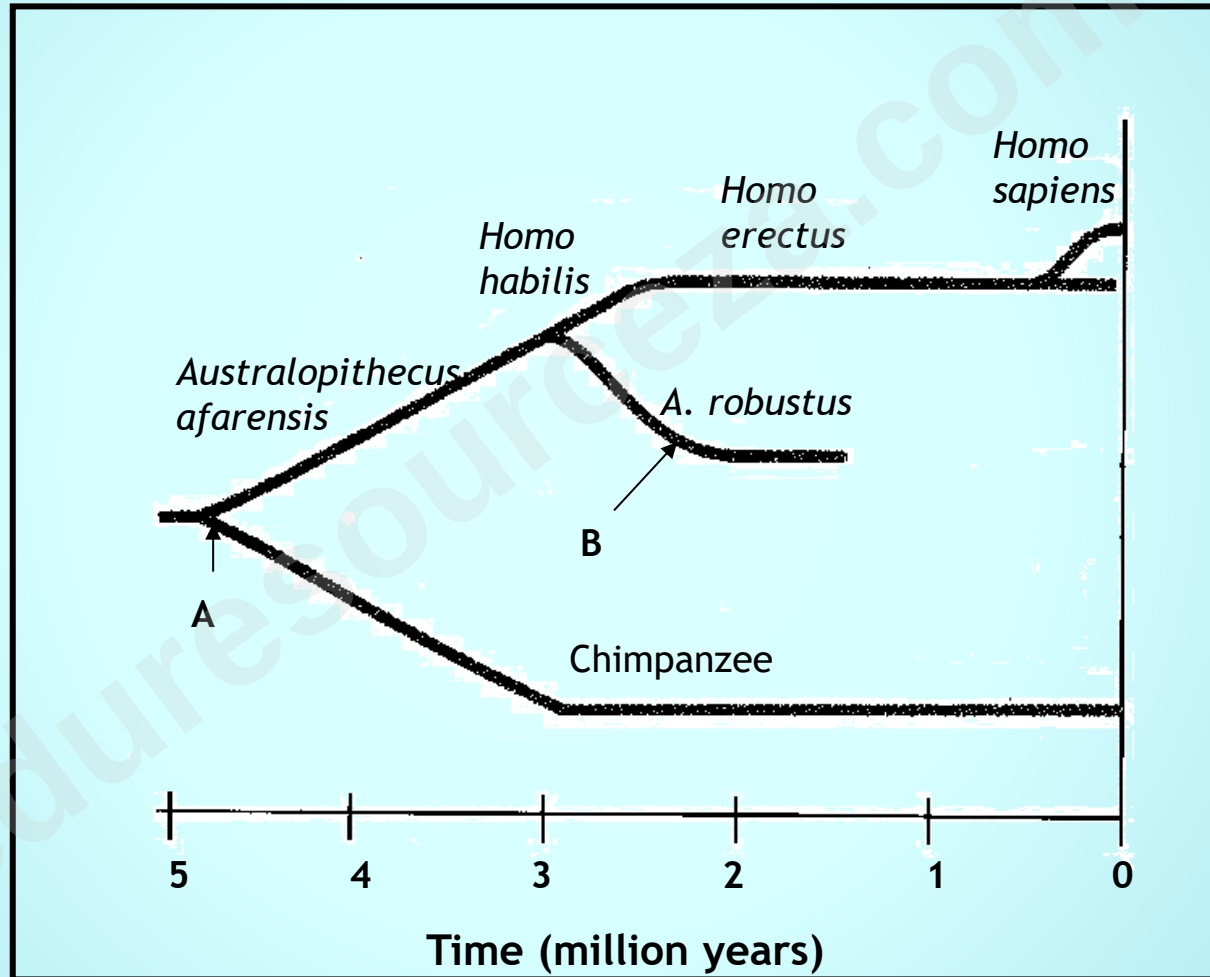


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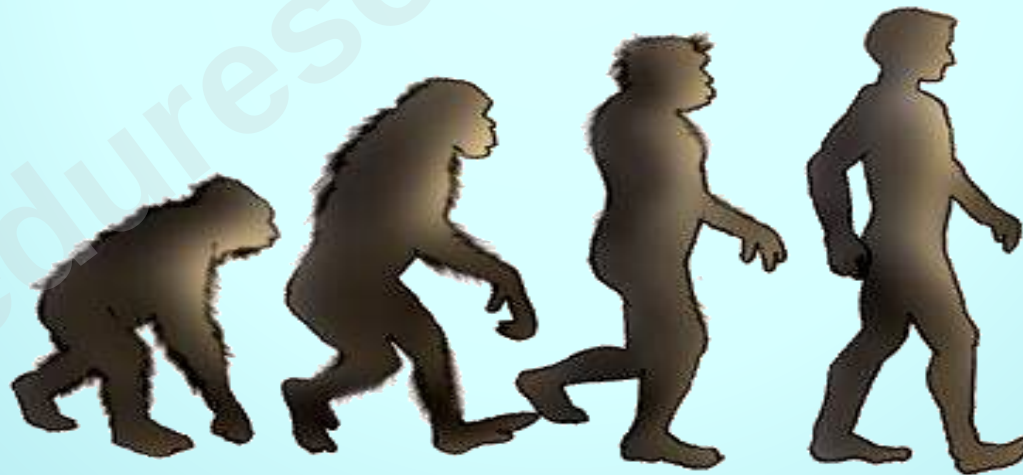
C

History of Hominids

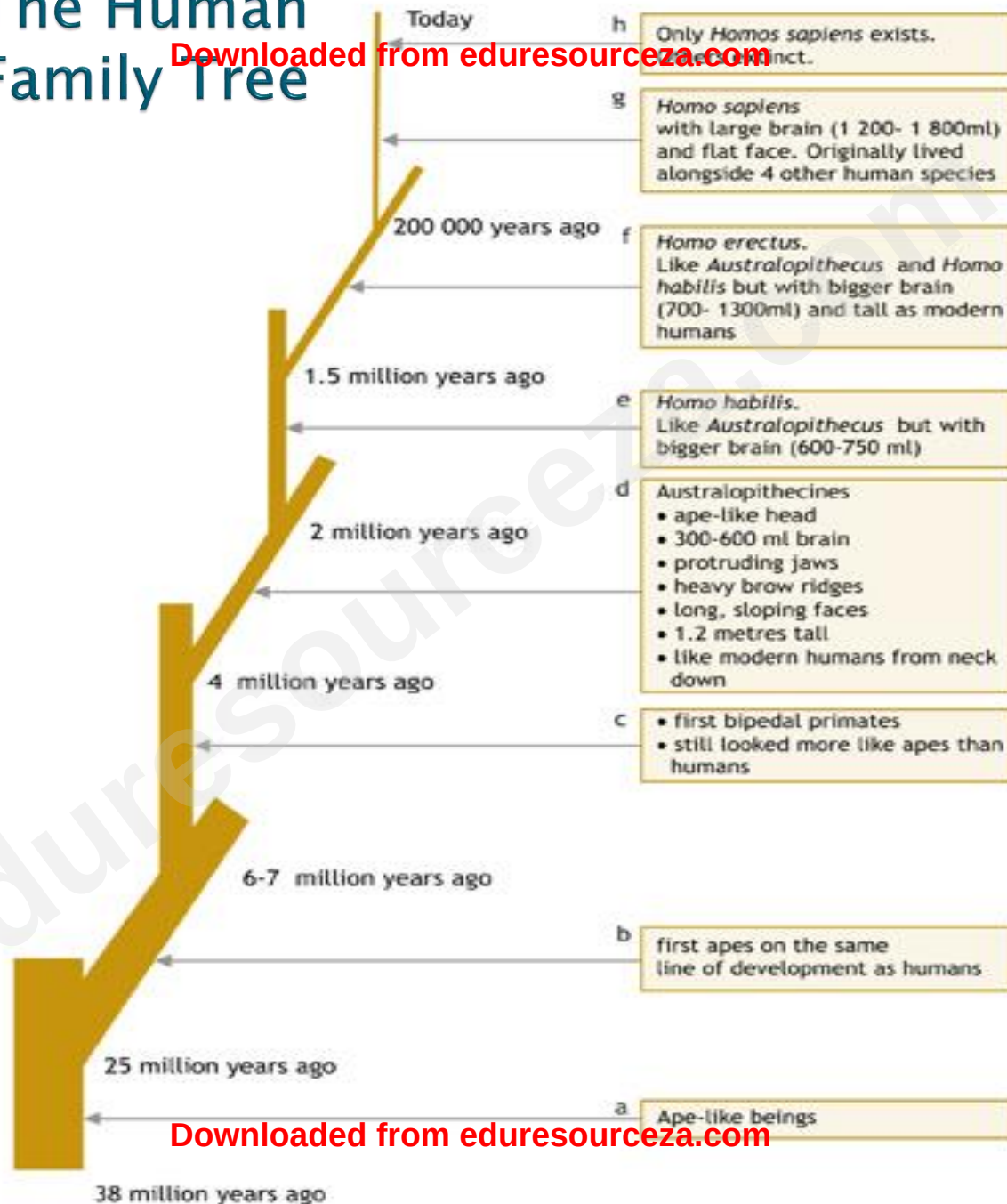


The Broad Pattern of Human Development

- ▶ Scientists generally agree on the following pattern of human development:
- ▶ Apes → ape men → early humans → modern humans



The Human Family Tree



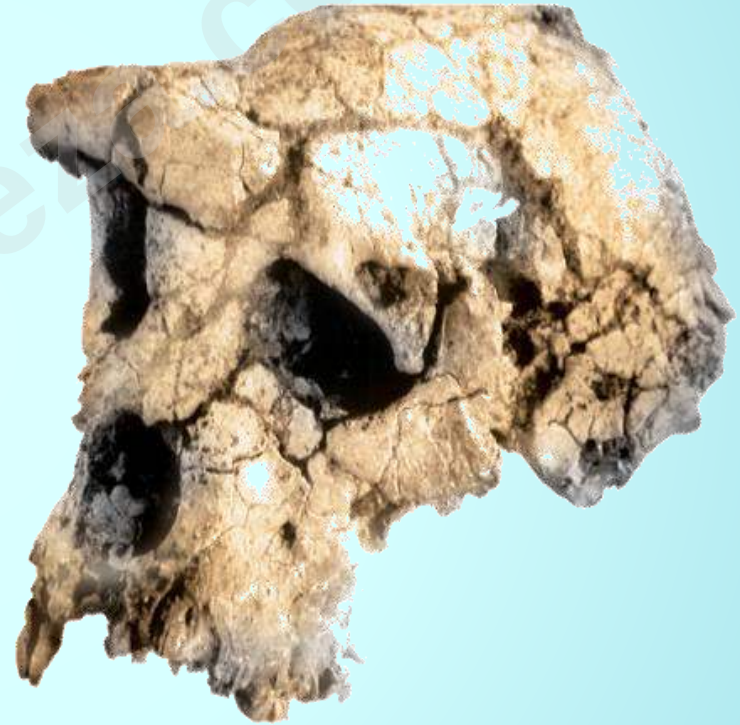
Activity

- ▶ Human Evolution
- ▶ QB – Page 33–35
- ▶ Focus: Q 3.1.2 (Page 35)

The Fossil Evidence : Toumai

Sahelanthropus tchadensis

- ▶ 6–7 Million years old
- ▶ Forward position of foramen magnum suggests bipedalism
- ▶ Possibly earliest hominid ancestor of modern humans
- ▶ Found in Chad in 2001 by Michael Brunet and team mates (France + Chad)



The Fossil Evidence : Ardi

Ardipithecus ramidus

- ▶ 4.4 my old
- ▶ Discovered in Ethiopia in 1992–1993 by Tim White
- ▶ A small brain, measuring between 300 and 350 cm³. Smaller than the brain of australopithecines like Lucy (400 to 550 cm³) and roughly 20% the size of the modern Homo sapiens brain.
- ▶ More prognathic than modern humans
- ▶ Grasping big toe for swinging on trees.
- ▶ Adapted for bipedalism on the ground as well.



The Fossil Evidence : Little Foot (Stw 573)

- ▶ In 1994, Ron Clarke, field officer at the Sterkfontein Caves, found a number of small bones in a small bag.
- ▶ Bones belonged to a hominid which was comfortable walking on the ground as well as on trees i.e. showed ape and human characteristics.



The Fossil Evidence : Little Foot (Stw 573) contd

- ▶ Named Stw 573 or Little Foot
- ▶ In 1997 Clarke found bones at Wits including the tibia which connected with Little Foot
- ▶ On 3rd July 1997, Stephen Motsumi and Nkwane Molefe matched the tibia of Little Foot with a circle of bone in one of the caves at Sterkfontein

The Fossil Evidence : Little Foot (Stw 573) contd

- ▶ In September 1998 they found part of the arm bones and skull
- ▶ Careful chiselling away showed the entire skeleton of an early hominid
- ▶ The skeleton was brought to the surface in Oct 2006
- ▶ Thought to be that of an australopithecine 3.9–4.2 million years old

The Fossil Evidence: The Laetoli Footprints

- ▶ In 1978, Mary Leakey discovered a set of footprints in Laetoli in Tanzania
- ▶ Made about 3.6 million years ago
- ▶ Made by a bipedal animal as it walked over volcanic ash in a shallow stream
- ▶ Made by hominds, most probably australopithecines which spent a lot of time on all fours on trees



The Fossil Evidence : Lucy

Australopithecus afarensis
(southern ape from afar)

- ▶ 3.2 million years old
- ▶ Forward position of foramen magnum – bipedal
- ▶ 30–45kg; 1 m in height
- ▶ Discovered in 1974 by Donald Johanson, Yves Coppan and Tim White in Ethiopia



The Fossil Evidence : Taung Baby

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Australopithecus africanus

(southern ape from Africa)

- ▶ 2.6 – 2.8 million years old
- ▶ Forward position of foramen magnum– bipedal
- ▶ Ape-like head; dentition of a human baby
- ▶ Discovered by Raymond Dart in 1924 in the village of Taung (N. Cape)



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The Fossil Evidence : Mrs Ples

Australopithecus africanus

- ▶ Adult form of Taung baby
- ▶ About 2.6 million years old
- ▶ Discovered by Robert Broom in 1947 in the Sterkfontein caves
- ▶ Originally called *Plesianthropus* (Mrs Ples for short)
- ▶ In 2002, Francis Thackeray concluded that it was actually male



The Fossil Evidence : Handy man

Homo habilis

- ▶ About 2.5 million years old
- ▶ Discovered by Mary and Louis Leaky in 1968 at the Olduvai Gorge in Tanzania
- ▶ Earliest species of the genus *Homo*
- ▶ Less pronounced brow-ridges, more human-like teeth, flatter face, more rounded head and a brain size of 650 to 800 ml.



The Fossil Evidence : Karabou

Australopithecus sediba

- ▶ On 15 August 2008 by Mathew and Lee Berger found the lower jaw and clavicle at the Malapa site in the Cradle of Humankind.
- ▶ Karabou had a brain size between 420 and 450 ml, a height of 1.27 metres and estimated to be 1.78 to 1.98 million years old.
- ▶ Probably transitional between *Australopithecus africanus* and *Homo habilis* or *Homo erectus* because it is more similar to *Homo* than any other australopithecine, and therefore a possible ancestor of *Homo*.
- ▶ *A. sediba* was bipedal with long arms suitable for climbing, but had a number of humanlike traits in the skull, teeth and pelvis.



The Fossil Evidence : Homo erectus

Homo erectus

- ▶ Around 1.5 million years ago *Homo habilis* probably gave rise to *Homo erectus*.
- ▶ Like *Australopithecus* and *Homo habilis*, *Homo erectus* had a head that looked like an ape but looked like modern humans from the neck down. However, it was different from the australopithecines and *Homo habilis* in that it was as tall as modern humans and had a brain size of 700 ml to 1 300 ml.
- ▶ *Homo habilis* and all the australopithecines are found only in Africa, but *erectus* was wide-ranging, and has been found in Africa, Asia, and Europe. There is evidence that *erectus* probably used fire, and their stone tools are more sophisticated than those of *habilis*.
- ▶ Scientists believe that about 150 000 to 200 000 thousand years ago *Homo erectus* gradually gave rise to *Homo sapiens* with our distinctive features such as a larger brain (1 200 ml to 1 800 ml) and a flat face.



The Fossil Evidence : Nutcracker Man

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Paranthropus boisei

- ▶ About 1.2 – 2.2 mil. years old
- ▶ Discovered by Mary and Louis Leaky at Olduvai Gorge in Tanzania
- ▶ Given the name “Nutcracker Man” by Philip Tobias because of huge teeth and massive jaws
- ▶ Scientists think that this is not a direct human ancestor but an evolutionary side branch



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The Fossil Evidence : Kromdraai (Robust Ape man)

Paranthropus robustus

- ▶ About 1–2 million years old
- ▶ Discovered by Robert Broom in 1938 in Kromdraai
- ▶ Closely related to *Australopithecus*
- ▶ Discovery of the Kromdraai skull made the world take seriously the fossils coming out of South Africa.



The Piltdown man fraud

- ▶ In Dec 1912 Charles Dawson “discovered” a skull with some crude tools in southern England.
- ▶ It was considered to be the missing link between apes and humans
- ▶ In 1949 it was later found to be a combination of the bones of an orangutan and a modern man; the bones had been stained and the teeth filed
- ▶ Dawson died in 1916 before the fraud was discovered.

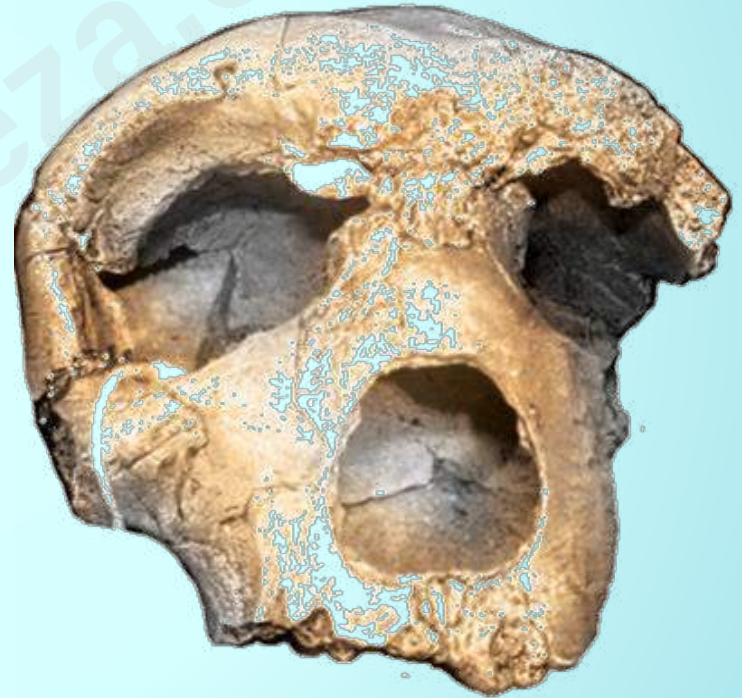


The Fossil Evidence . Florisbad Man

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Homo sapiens

- ▶ About 250 000 yrs old
- ▶ Larger brain (1 200 ml to 1 800 ml) and a flat face.
- ▶ Discovered in Florisbad in the Free State in 1932
- ▶ Considered to be that of an earlier form of *Homo sapiens*.

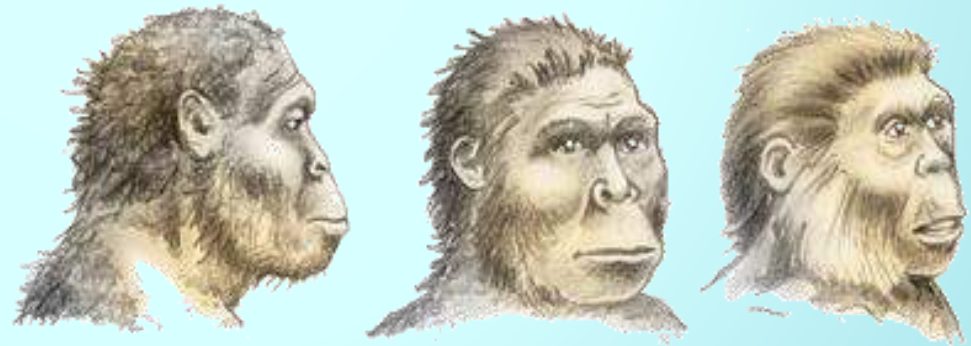


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Trends in Human Development

- ▶ Shift of foramen magnum to a more forward position
- ▶ A more rounded skull and Increased cranium size
- ▶ A flatter face due to:
 - ❑ Less sloping forehead
 - ❑ Less protruding jaws (decreased prognathous)
 - ❑ A more developed chin
- A more rounded jaw
- Increased size of skeleton
- Change in dentition

Are these our ancestors ?



*Australopithecus
africanus*

*Homo
habilis*

*Homo
erectus*

The Nature of Science

- Some aspects of our scientific knowledge are incomplete and tentative with a doubt component
- Scientific knowledge is developmental
- Both males and females played important roles in the development of scientific knowledge
- Scientists from many races contributed to the development of knowledge
- People from many countries often work in a co-operative spirit in the development of scientific knowledge
- While most scientists work within a strong code of ethics some are cheats

Activity 6

- ▶ Human Evolution – Fossil Evidence and Phylogenetic Trees
- ▶ QB – Page 36
- ▶ Activity Manual – Page 16

Out of Africa Hypothesis

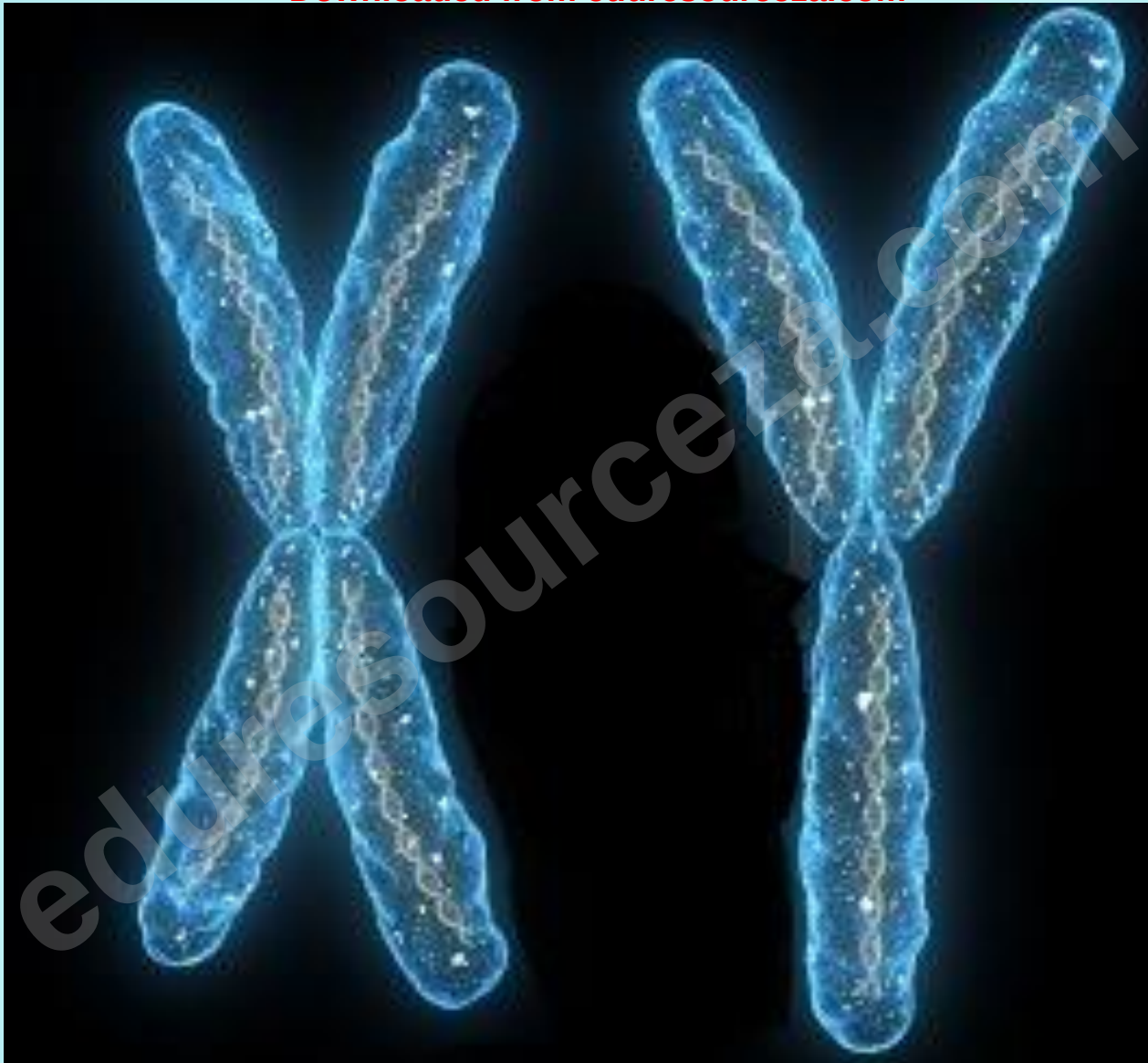
- ▶ According to the 'Out of Africa' hypothesis, humans originated in Africa and then migrated out of Africa to all parts of the world.
- ▶ The 'Out of Africa' hypothesis is based on fossil evidence as well as on genetic evidence.

Fossil Evidence for the 'Out of Africa Hypothesis'

- ▶ The richest collections of fossils of human ancestors come from Africa
- ▶ *Ardipithecus, Australopithecus, Homo habilis and Homo erectus*

Genetic Evidence for the 'Out of Africa Hypothesis'

- ▶ When DNA is analysed for the purpose of tracing ancestry, a search is made for mutations
- ▶ Individuals which have the same mutation must share the same common ancestor
- ▶ Mutations can therefore be used to trace our ancestors



DNA from the Y-chromosome

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- ▶ The major part of the **Y-chromosome** of males does not undergo crossing over with its mis-matched X chromosome
- ▶ Most of the DNA on the Y-chromosome is passed on from **father to son** without being mixed with DNA from the mother
- ▶ Mutant DNA can be traced back from son to father to grandfather to great grandfather and so on.
- ▶ By following mutations in the Y-chromosome, we are able to trace our **male line of descent**

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Mitochondrial DNA

- ▶ Mitochondria also contain DNA, referred to as **mitochondrial DNA (mt DNA)**
- ▶ During fertilisation, only the nucleus of the sperm cell enters the egg cell to fuse with its nucleus.
- ▶ The original egg cell then becomes the cell of the zygote after fertilisation. The mitochondria of the egg cell continue as the mitochondria of the zygote.
- ▶ In this way mitochondrial DNA is handed down from **mother to child**.
- ▶ By following mutations in mitochondrial DNA, we are able to trace our **female line of descent**

What can be Concluded?

- ▶ Mutant nucleotides from Y chromosomes traces every man alive to a common ancestor in east Africa about 60 000 yrs ago
- ▶ Analysis of mtDNA leads to an ancestral female in east Africa about 150 000 years ago
- ▶ Scientists believe that other species of humans such as *H. erectus*, *H. neanderthalensis*, *H. heidelbergensis* and *H. florensiensis* also lived at this time
- ▶ However, these other species all became extinct and our species (*Homo sapiens*) was the only one which survived

Activity

- ▶ Out of Africa Hypothesis
- ▶ QB – Page 35