SYLLABUS STATEMENT:

Life has existed on earth for approximately 3.5 billion years and has changed and diversified over time.

**What is Evolution?**

* Evolution is the process by which different kinds of living organism are believed to have developed from earlier forms during the history of the earth
* Evolution is also the process of gradual change in the gene pool of a population or organisms that results in new species, and this may be due to inbreeding, hybridization or mutation

* Earth and its life forms have changed enormously over 3.5 billion years
* Some changes are rapid
* Other changes are measured in epochs, periods, and eras, and eons.
* Measurements in geological time are expressed in mya

Evidence for continental drift:

* Fossil evidence
* Fossils are preserved remain and traces of organisms. The provide evidence of past life. These remains can be hard parts, such as teeth, bones and shells, or impressions in the rock where the organism's tissue has decayed.
* Fossils can also include footprints, burrows and even preserved waste products such as coprolites: fossiled faeces

* Geological evidence

Temperature, Sea levels and Climate:

* Earth's climate has oscillated between hot, humid periods and cold, dry periods.
* Evidence for this is found in ice cores drilled, some ice cores are several kilometres long containing a record of climate change dating back 100 000 years.
* Earth was much warmer than it is today and the temperature gradation from the equator to the poles wa no as wide. Evidence suggest that past fluctuations have been dramatic.

Oxygen levels:

* A critical environmental factor for life is the composition of the atmosphere it affects all living things worldwide including anaerobes
* The first atmosphere of earth most likely had very little oxygen. Evidence from sediment cores shows that the oxygen concentration began to increase about 3 billion years ago.
* This increase in atmospheric oxygen came from large number of 'blue green algae' in the oceans. These algae are able to use water as a resource in photosynthesis, converting carbo dioxide to organic compounds and producing oxygen as a water product

**Biochemical:**

**Comparative Biochemistry:**

* All organisms have certain biochemical molecules in common.
* Comparisons of the similarities in amino acids and other molecules across species reflect evolutionary patterns seen in comparative anatomy and in the fossil record
* Common ancestry can be seen in the complex metabolic molecules that many different organisms share
* Comparison of the DNA or RNA of different species produce biochemical evidence for evolution
* Differences indicate degree of relatedness
* Protein conservation
* Genetic comparison
* Comparative genomics (bioinformatics)

**DNA Hybridization**:

* DNA-DNA hybridization, hybridize the genetic information from two different organisms to determine similarities between them
* Scientists separate strands of DNA from both species using heat, which breaks the bonds between the base pairs that link the two sides of the double helix.
* They then chop up the genetic information into small parts, mix up the genetic information from both, and watch how they recombine
* Parts where base pairs link back up exhibit genetic similarity
* The more information that links up, the closer the species evolutionarily

**Gene Sequencing:**

* Scientists sequences genetic information (strands of DNA or RNA or proteins), and then compare them to one another looking for similarities and differences
* Theoretically, the closer the evolutionary relationship, the less these similar gene structures should have changed in the intervening time

**Mitochondrial DNA:**

* Mitochondrial DNA can be used to construct evolutionary among humans
* Mitochondria have their open DNA rather than taking their form from human genetic information
* Because mitochondrial DNA in a particular human is inherited exclusively from the mother, it exists in a unbroken chain down genetic lines
* Scientist can therefore examine this DNA among humans in different parts of the worlds to reconstruct a genetic history of where we came from
* However, this process is not perfect, as it has a high mutation rate and may not be accurate.

**Molecular Clock:**

* The molecular clock is technique that uses the mutation rate of biomolecules to deduce the time in prehistory when two or more life forms diverged
* The biomolecular data used are usually nucleotide sequences for DNA or amino acid sequences for proteins
* The bench marks for determining the mutation rate are often fossil or archaeological dates
* The molecular clock was first in 1962 on the haemoglobin protein variants of various animals, and issued to estimate times of speciation or radiation
* It is sometimes called a gene clocker or an evolutionary clock

**Fossils:**

* Fossils: are the mineralized remains or traves (tracks, imprints) of animals, plants or other organisms
* The fossil record: fossils found in rock strata that show a sequence or history of life on Earth
* The fossil record provides us with this evidence

**Law of Superpositions:**

* Fossils found in young layers of rock (closer to the surface) tend to be more similar to present day organisms
* Fossils appear in chronological order (oldest ancestors in deepest layers)
* Not all organisms appear in the fossil record at the same time- example fish are the oldest vertebrates then in a subsequent layers amphibians, reptiles, mammals and birds

**Transitional fossils:**

* Transitional fossils are fossils that show intermediary links between groups of organisms
* They can provide a link between the past and present

**The pace of evolution:**

* In many cases, we seem to
* 'bursts' of evolution in the fossil record. For example, imagine that in a lower rock layer, you see ancestor 1. in the nest rock layer, you see species 2 and 3. species 2 looks the same as ancestor1. species 3 is morphologically distinct, but is clearly also descended from ancestor 1. what happen?
* The fossils we have are only 'time slices' of actual history. Several hypotheses about what happened when are consistent with these fossil time slices. In order to determine which of the following hypotheses most accurately explains the pace of evolution, we'd need more evidence

**Gradualism:**

* Slow steady divergence of lineages:

The 'burst' of evolution is a geological illusion. It only looks like a burst because a lot of time passed between the times when the two rick layers were laid down. In this period of time, species 3 gradually diverged from ancestor 1 through a series of transitional forms, but these transitional forms were not preserved

* Punctuated equilibrium:

A large amount of change in a short time tied to a speciation event. Species 2 and 3 are only 100,000 years younger than, and all the evolutionary change connecting them too places in the short time. The 'burst' of evolution is really a burst. Transitional forms between ancestor 1 and species 3 did exist, but for such a short amount of time that they were not preserved in the fossil record

**Relative and absolute dating:**

**Carbon 14 dating:**

* Carbon decays at a constant, measurable rate



**Potassium-40:**

* Potassium-argon (K-Ar) dating, is a radiometric dating method
* It is based on measurement of the product of the radioactive decay of an isotope of potassium (K) in to argon (Ar)
* Potassium is a common element found in many materials
* In these materials, the argon 40 is able to escape when the rock is molten, but accumulates when the rock solidifies
* The technique is most applicable for dating minerals and rocks more than 100000 years old
* The half-life of potassium-40 is 1.25 billion years
* It is mainly used to determine the age of rocks and meteorites

**Stratigraphy:**

* Scientific discipline concerned with the description of rock successions and their interpretation in terms of a general time scale. It provides a basis of historical geology, and its principles and methods have found application in such fields as archaeology

Comparative anatomy:

* Comparative anatomy is the study of similarities and differences in the anatomy of different species. It is closely related to evolutionary biology and phylogeny

Homologous structures:

* Features of organisms that have the same general structure but different functions
* The best example is the pentadactyl limb
* Skeletons and muscles of humans and gorillas show a high degree of similarity between them- therefore further evidence of a common ancestor
* Pyramidalis muscles: 1/5 of the population don’t develop these muscles, present or not, no difference in muscular Proliance. Note the rectus muscles used to go from the pelvis to the lower jaw; now just to the rib cage
* Appendix: has masses of lymphatic tissue in its walls, used to provide local defence against infection from micro-organisms in the colon. Now just prone to infection itself, and can easily rupture, causing death

Embryology:

* Comparative embryology is the scientific study of the similarities in structure between the embryos of various species that suggest a possible link to a common ancestor
* It supports evolutionary theory, in the sense that all vertebrates develop similarly
* Structures in common- gill pouches and arches, well developed tail, absence of paired appendages, two chambered heart, similar brain development
* Many structures are not present in adults
* Common development pathway depend on closeness of relationship
* Common or similar features in the embryo stage is evidence that these animals shared a common ancestor in the past

Vestigial structures:

* These are structures that have no use in an organism at the present, but used to have a use in an ancestor
* An alternate definition is "a body part that has become small and lost its use because of evolutionary change"
* They are considered to be evidence of evolution
* Vestigial organs: structures of a reduced size and appear to have no function, humans are to have around 90 such organs
* Nictitating membrane (transparent third eyelid): found in cats, birds and frogs. In humans it is a pinkish membrane at the inner corner of each eye
* Muscles that move the external ears: in humans that are reduced so much that they don’t move the ears at all
* Wisdom teeth (third molars): in humans they erupt abnormally and can't be used in mastication, frequent removal necessary. 1/5 of the population don’t develop them at all

Geographical distribution:

* Natural geographical distribution of related species is further evidence of evolution
* Isolated land areas and islands have frequently evolved their own distinctive plant and animal populations
* Unique primate species; lemurs in Madagascar, new world monkeys in the Americas, old world monkeys in the Africa and Asia