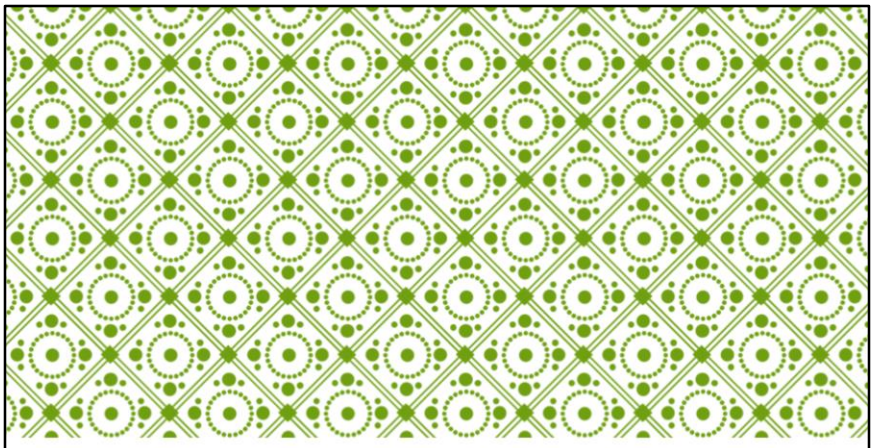
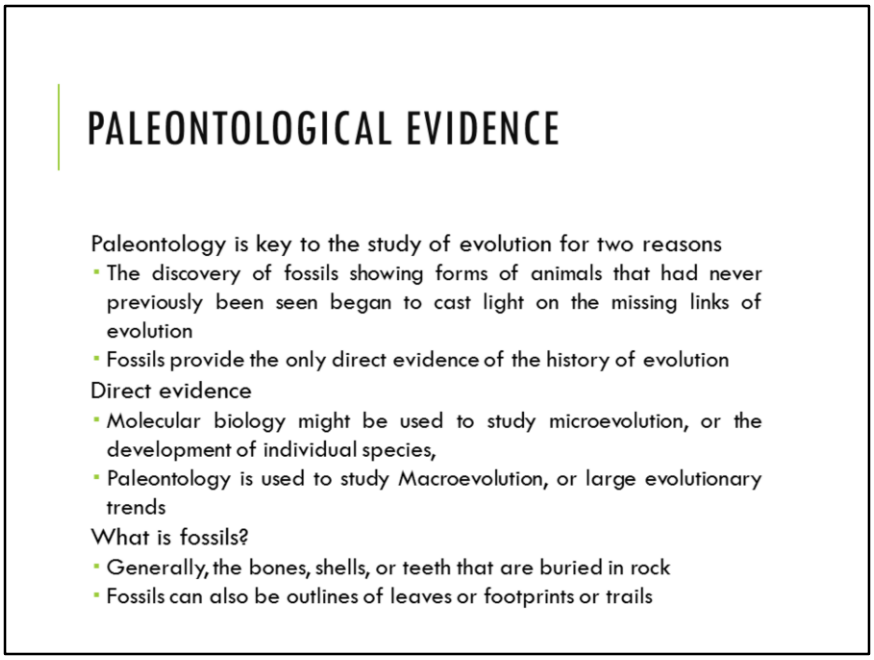


LECTURE 4: EVIDENCES FROM PALEONTOLOGY

Geological time scale
Fossilization
Fossils and Evolution



Fossil: The remains or impression of a prehistoric organism preserved in petrified form or as a mold or cast in rock. Fossils are formed when sediment covers some material, such as a piece of bone. Very gradually, the bone becomes impregnated with chemicals from the surrounding rock. Eventually all that remains is essentially a piece of rock in the shape of the original bone, or material.

FOSSIL RECORDS

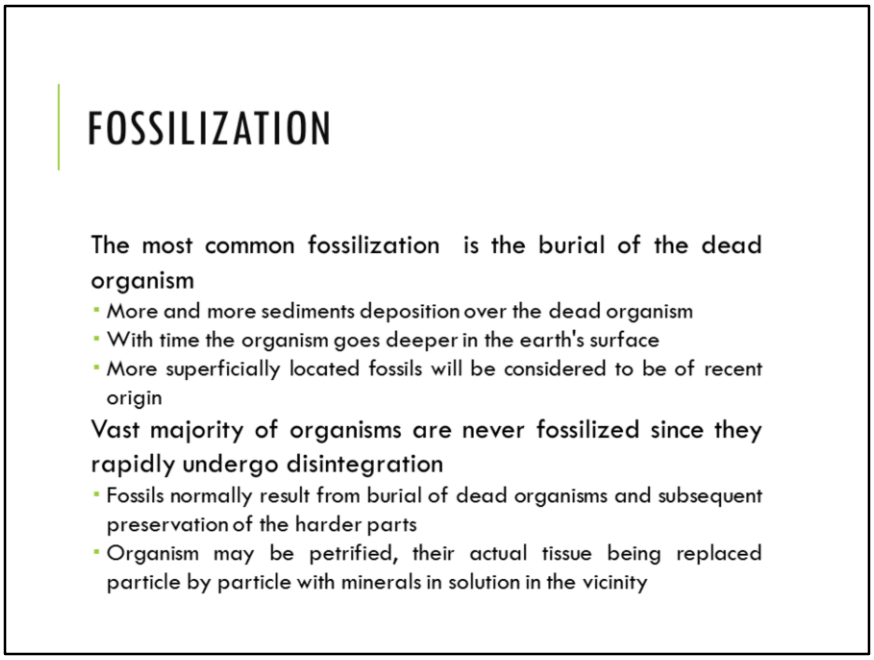
- Strata of rock in which fossils are found give us clues about their relative ages
- New technologies such as radioactive carbon dating help determine the absolute ages of fossils
- Rock strata can also give clues about the environments in which an animal or plant lived
- Chemical make-up of the strata can tell us the balance of gases in ancient atmospheres
- Major cataclysmic events such as eruptions and meteor strikes can also be know from the fossil record

Fossils can be used to construct a fossil record, which is a timeline of fossils reaching back through history.

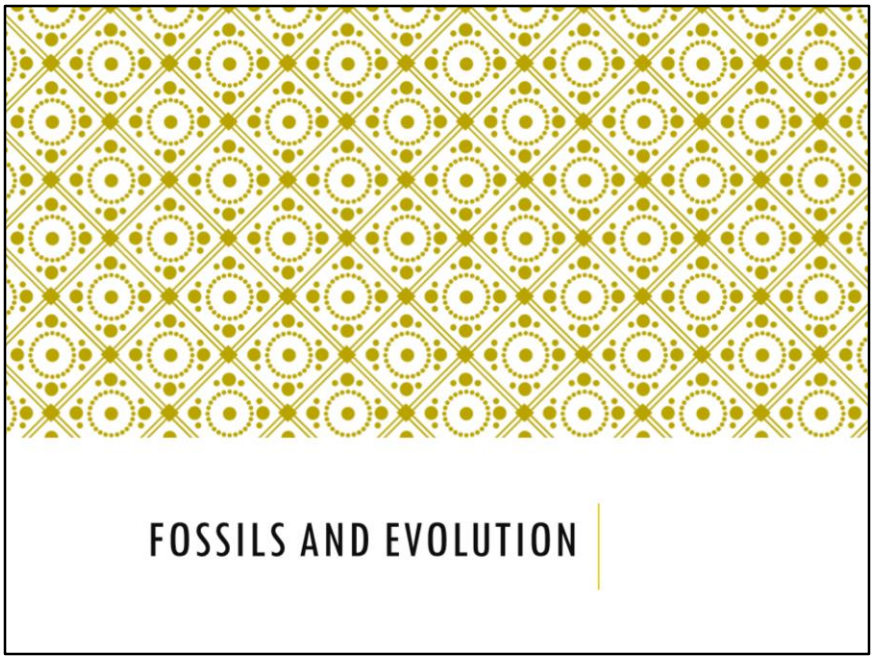
GEOLOGICAL TIME SCALE

Geological time scale and evolution of different life forms (time is given in millions of years, duration given in perentheses).

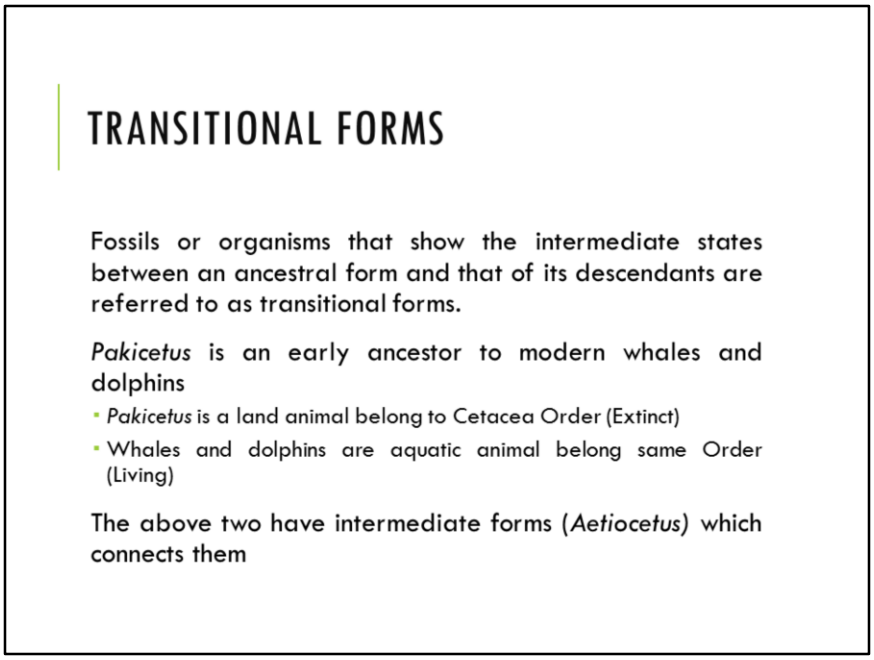
Eras	Periods*	Epochs	Time (age & duration)	Advances in Life	Dominant life and fossil record	
1. Coenozoic or Tertiary	Quaternary	Recent Pleistocene	0–1 (1)	Rise of World Civilization : era of mental life	(Fossils of man)	Age of man
				Glaciation; extinction of great mammals		
	Tertiary	Pliocene	10 (9)	Origin of man		
		Miocene	25 (15)	Culmination of mammals	Age of mammals	
		Oligocene	35 (10)	Rise of higher mammals		
		Eocene	55 (20)	Vanishing of archaic mammals		
		Palaeocene	65 (10)	Rise of archaic mammlas		
2. Mesozoic or Secondary	Cretaceous		135 (70)	Extinction of great reptiles; rise of flowering plants		
	Jurassic		180 (45)	Rise of birds and flying reptiles	First bird fossils	Age of reptiles
	Triassic		230 (50)	Rise of dinosaurs	First mammals fossils	
3. Palaeozoic or Primary Carboniferous	Perman		280 (50)	Rise of land vertebrates, modern insects and ammonites	First reptile fossils	Age of amphibians & lycopods
	Pennsylvanian		310 (30)	Rise of primitive reptiles and insects		
	Mississippian		345 (35)	Rise of ancient sharks; rise of echinoderms		
	Devonian		405 (60)	Rise of amphibians and lung fishes	First amphibian fossils	Age of fishes
	Silurian		425 (20)	Rise of scorpions; increase of fishes		
	Ordovician		500 (75)	Rise of corals, armoured fishes and nautilids	First vertebrate fossil	Age of higher invertebrates, (shelled)
	Cambrian		600 (100)	Rise of shelled animals; dominance of trilobites		
4. Proterozoic	Precambrian		74000 (3500)	Evolution of primitive marine invertebrates		
5. Archaeozoic				Evolution of unicellular animals and plants		



It should be realized that the vast majority of organisms are never fossilized since they rapidly undergo disintegration before being preserved. The fossils normally result from burial of dead organisms and subsequent preservation of the harder parts. In other cases, the organism may be petrified, their actual tissue being replaced particle by particle by minerals in solution in the vicinity. Iron pyrites, silica, calcium carbonate and other carbonates are the common minerals involved. Petrified forests of the South Western United States is a classical example of this kind of fossilization.

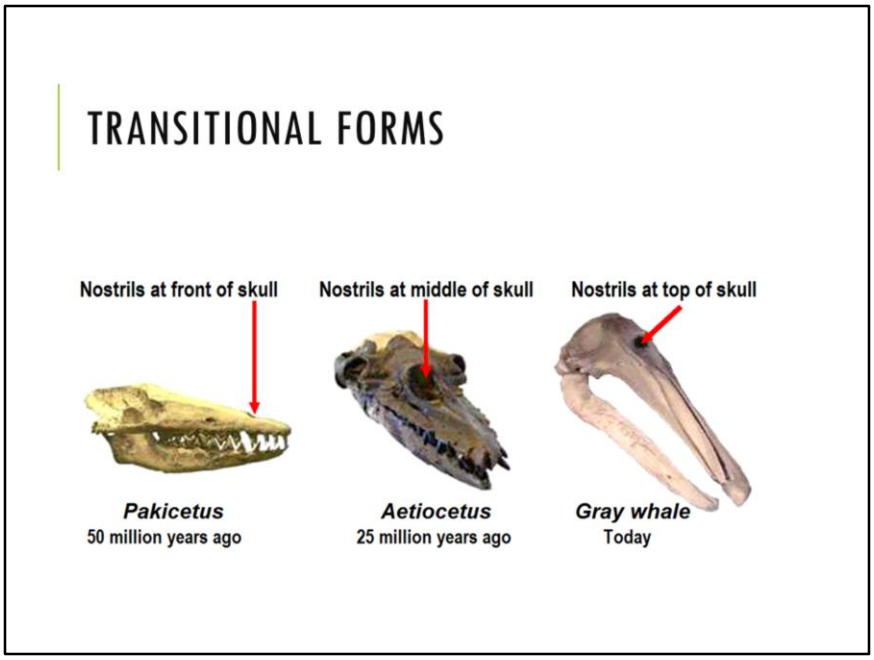


The fossil record provides snapshots of the past that, when assembled, illustrate a panorama of evolutionary change over the past four billion years. The picture may be smudged in places and may have bits missing, but fossil evidence clearly shows that life is old and has changed over time.



Fossils or organisms that show the intermediate states between an ancestral form and that of its descendants are referred to as transitional forms. There are numerous examples of transitional forms in the fossil record, providing an abundance of evidence for change over time.

Pakicetus, is described as an early ancestor to modern whales. Pakicetus is an extinct genus of amphibious cetacean of the family Pakicetidae, which was endemic to modern Pakistan during the Eocene.



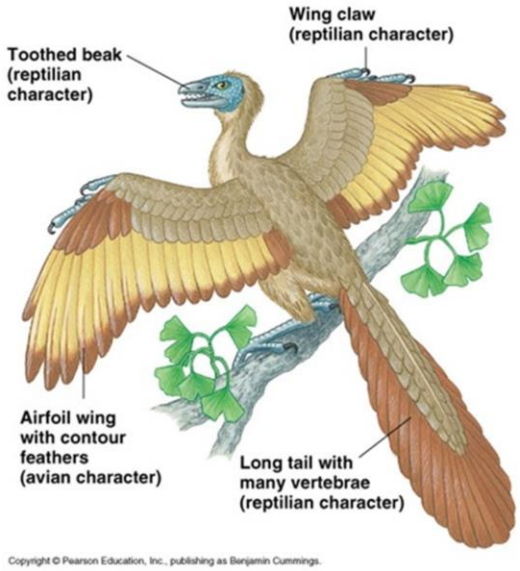
Although pakicetids were land mammals, it is clear that they are related to whales and dolphins based on a number of specializations of the ear, relating to hearing. The skull shown here displays nostrils at the front of the skull.

A skull of the gray whale that roams the seas today has its nostrils placed at the top of its skull. It would appear from these two specimens that the position of the nostril has changed over time and thus we would expect to see intermediate forms.

Note that the nostril placement in *Aetiocetus* is intermediate between the ancestral form *Pakicetus* and the modern gray whale — an excellent example of a transitional form in the fossil record!

CONNECTING LINKS

Animals exhibiting characters of two adjacent taxonomic groups are called connecting links



CONNECTING LINKS

CONNECTING LINKS

Ichthyostega

It is a primitive fossil amphibia included in the group Stegocephalia. It is lived during the late Devonian and Carboniferous periods. In addition to the amphibian characters . it was provided with many piscine characters, So it forms a connecting link between pisces and amphibians. The piscine characters of *Ichthyostega* are autostylic jaw suspension, presence of internal ears. lateral line canals, labrynthodont dentition, fin rays in the caudal region and well developed limbs, pectoral and pelvic girdles.

Seymouria

Seymouria (extinct)is a missing link between amphibia and reptiles.

It was lizard like animal lived about 250 million years ago. It combines amphibian and reptilian characters. Its amphibian characters include short limbs, labrinthine teeth and lateral line canals. The reptilian characters include two sacral vertebrae, an interclavicle and cleidoic eggs. *Seymouria* clearly a transitional stage in the evolution of amphibians into reptiles.

CONNECTING LINKS

Protopterus (Lung fish) is a connecting link between fishes and amphibians.Like other fish, they have paired fins, dermal scales, gills, segmented trunk, tail muscles, and ear represented by internal ear only. They resemble amphibians in having internal nostrils, a lung and the heart with imperfectly divided auricle.

Chimaera is a connecting link between cartilaginous and bony fishes.

It resembles cartilaginous fishes in the following characters: cartilaginous skeleton, ventral mouth, two dorsal fins, clapers, placoid scales in the young.

It resembles bony fishes in the following characters: small mouth with fleshy lips, tooth plates joined to the jaws, four pairs of gills, absence of cloaca, separate anus and urinogenital aperture.

CONNECTING LINKS

Peripatus is a living connecting link between arthropods and annelids. Its arthropods characters are claws, jaws, haemocoel, tracheae and dorsal tubular heart. The annelidan characters are continuous muscle layers in the body wall, unjoined legs and nephridia.

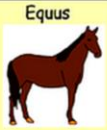
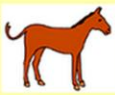
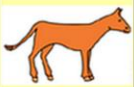
Neopilina is a connecting link between annelids and molluscans. It is the only segmented mollusc. It has a cup shaped shell like that of limpet. Its visceral mass is divided into five segments, each with a pair of shell muscles, gills, auricles, and nephidia.

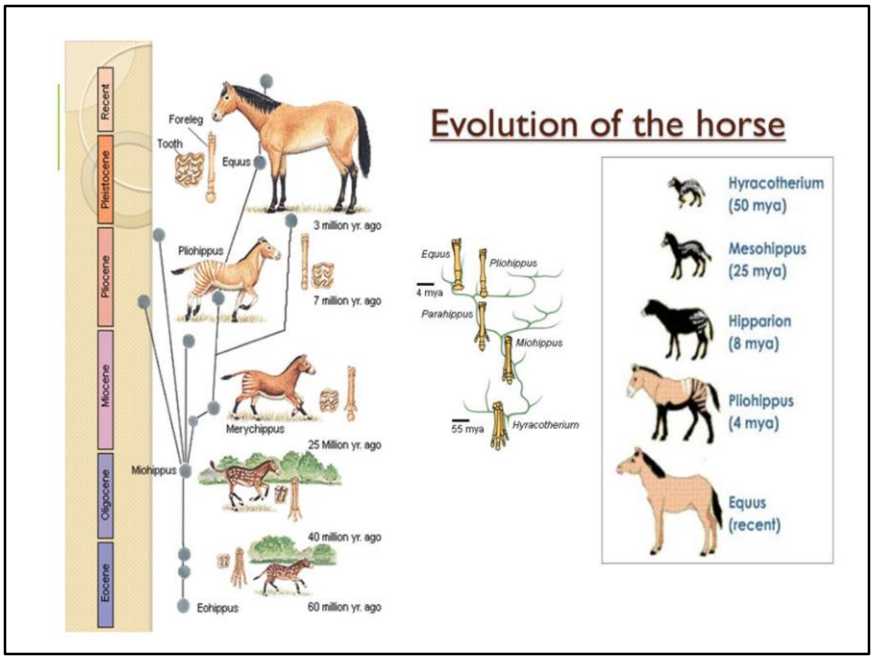
CONNECTING LINKS

Balanoglossus is a connecting link between invertebrates and chordates. It is a protochordate.
It is a chordate because it contains a notochord, tubular nerve cord and gill slits. The invertebrates characters include the phosphogens and the larva.

Egg laying Mammals are the connecting link between reptiles and mammals. They are definitely mammals because they have mammalian characters like mammary glands, hair, diaphragm, single aortic arch etc. They resemble reptiles in having a large coracoid in the pectoral girdle and in laying eggs with yolk and shell. Eg: Duck-billed platypus or Ornithorhynchus.

EVOLUTION OF HORSES

Equus	Pliohippus	Merychippus	Mesohippus	Hyracotherium
				
1 million years ago	10 million years ago	30 million years ago	40 million years ago	60 million years ago
1.6m	1.0m	1.0m	0.6m	0.4m
 Single hoof, runs quickly over hard ground	 Other toes lost as only middle hoof used	 Middle toe developed into a hoof, to run faster	 Toe lost for moving faster over dry ground	 4 toed hoof, well spread for walking on soft ground
				


Evolution of the horse
Recent
Pleistocene
Pliocene
Miocene
Oligocene
Eocene
Foreleg
Tooth
Equus
3 million yr. ago
Pliohippus
7 million yr. ago
Merychippus
25 Million yr. ago
Miohippus
40 million yr. ago
Eohippus
60 million yr. ago
Equus
Pliohippus
4 mya
Parahippus
Miohippus
55 mya
Hyracotherium
Hyracotherium (50 mya)
Mesohippus (25 mya)
Hipparion (8 mya)
Pliohippus (4 mya)
Equus (recent)

NEXT CLASS
21/06/2016

Evidences from Physiology and Biochemistry