

# Biology Key Words- Exam

## Organizing the Living World

**Adaptive radiation** - Diversification of a species or single ancestral type into several forms that are each adaptively specialized to a specific environmental niche. To radiate means to spread outward, it refers to one or a few species which diversify ("spread out") and generate multiple daughter species. The most common situations which result in adaptive radiation occur following mass extinctions, or when species move into new, unoccupied regions.

### **Darwin Finches**

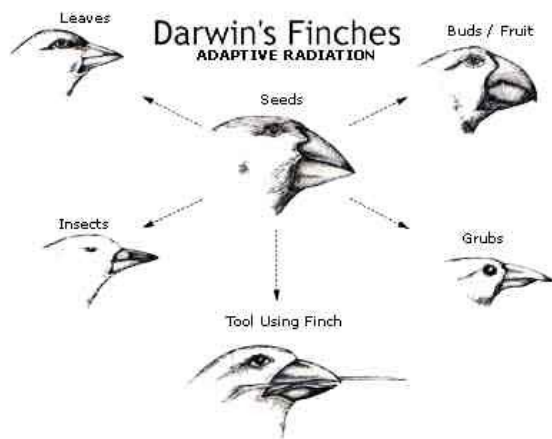
When [Charles Darwin](#) was in the Galapagos Islands, one of the first things he noticed is the variety of finches that existed on each of the islands. All in all, there were many different species of finch which differed in beak shape and overall size. This is adaptive radiation and natural selection at work.

These finches, better known as 'Darwin's Finches' illustrated adaptive radiation. This is where species all deriving from a common ancestor have over time successfully adapted to their environment via natural selection.

Previously, the finches occupied the South American mainland, but somehow managed to occupy the Galapagos islands, over 600 miles away. They occupied an ecological niche with little competition.

As the population began to flourish in these advantageous conditions, intraspecific competition became a factor, and resources on the islands were squeezed and could not sustain the population of the finches for long.

- Due to the mechanisms of natural selection, and changes in the gene pool, the finches became more adapted to the environment, illustrated by the diagram below.



As competition grew, the finches managed to find new ecological niches that would present less competition and allow them, and their genome to be continued.

As indicated by the diagram above, the finches adapted to take advantage of the various food sources available on the island, which were being used by other species. Over the long term, the original finch species may have disappeared, but by diversifying, would stand a better chance of survival.

All in all, the finches had adapted to their environment via natural selection, which in turn, has allowed the species to survive in the longer term, the prime directive of any species.

**Advanced characters** – similarities between organisms that were not in the last common ancestor of the taxa being considered but rather [evolved separately](#). (Similarity of function and superficial resemblance of structures that have different origins.)

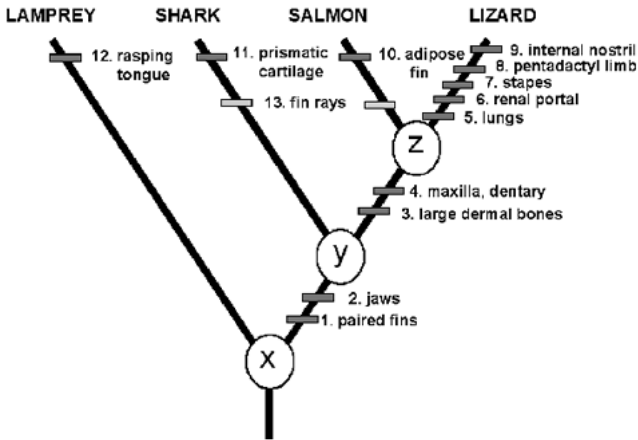
For example, the [wings](#) of a fly, a moth, and a bird are analogous because they developed independently as adaptations to a common function—flying. The presence of the analogous structure, in this case the wing, does not reflect evolutionary closeness among the organisms that possess it.

Another important example would be the development of a camera-type eye in both mollusks and vertebrates. This example of analogous structures is especially useful because one of most common claims made by religious creationists is that something as complex as an eye couldn't possibly have evolved naturally - they insist that the only viable explanation is a supernatural designer (which is always their god, though they rarely admit this outright).

The fact that eyes in different species are analogous structures proves not only that the eye could evolve naturally, but that it in fact evolved several times, independently, and in slightly different ways. The same is true of other analogous structures as well, and this is because certain functions (like being able to see) are just so useful that it's inevitable they will evolve eventually. No supernatural beings, whether gods or not, are necessary to explain or understand how eyes evolved multiple times.

### **Apomorphy –**

A [derived](#) characteristic of a [clade](#), or *derived state* is a characteristic believed to have evolved within the tree. For example, all tetrapods have four limbs; thus, having four limbs is an apomorphy for vertebrates but a plesiomorphy for tetrapods.



Jaws for example, would be an apomorphy described in the cladogram above.

### Autoapomorphy,

In [cladistics](#), an autapomorphy is a distinctive anatomical feature, known as a [derived](#) trait, that is unique to a given terminal group. That is, it is found only in one member of a [clade](#), but not found in any others or [outgroup taxa](#), not even those most closely related to the group (which may be a [species](#), [family](#) or in general any clade). It can therefore be considered an [apomorphy](#) in relation to a single taxon

### Binomen,

The [combination](#) of two [names](#), the [first being](#) a [generic name](#) and the [second](#) a [specific](#) name, that together constitute the [scientific](#) name of a [species](#). Example *Canis lupus wolf* Both names are typed in italics, but only the generic name is capitalised.

### Camera eye,

Described in advanced characters

### Character convergence,

process whereby two relatively evolved species interact so that one converges toward the other with respect to one or more traits.

### Character polarity,

Character polarity is the issue of the evolutionary history of a character: given two character states, which we call a and a' , we need to know whether a evolved from a' ' or the other way round. Discerning character polarity is a fundamental task of phylogeny.

### Character reversal,

The re-establishment of an ancestral [character state](#) through the loss of an [evolutionary novelty](#) ([apomorphy](#)). For example, winged insects (Pterygota) evolved from a wingless ancestor; however, some pterygote [lineages](#) have subsequently lost their wings, e.g., fleas, lice, some grasshoppers and beetles.

### Cladistics,

Cladistics emerged in the 1950s and 1960s when some researchers criticized the inherent lack of clarity in classifications based on two distinct phenomena, branching evolution and morphological divergence. After all, how can we tell why two groups are classified in the same higher taxon? Sometimes they have shared a recent common ancestor (e.g., lizards and snakes), but other times they have not (e.g., lizards and crocodilians).

To minimize such confusion, many systematists followed the philosophical and analytical lead of Willi Hennig, a German entomologist who wrote *Phylogenetic Systematics*, published in 1966. Hennig and his followers argued that classifications should be based solely on evolutionary relationships. [Cladistics](#) produces phylogenetic hypotheses and classifications that reflect only the branching pattern of evolution. Cladistics ignores morphological divergence.

Cladists group together species that share derived characters. Cladists argue that mammals form a monophyletic lineage, a [clade](#), because they have a unique set of derived characters, including hair, mammary glands, reduction of bones in the lower jaw, and a four-chambered heart. The ancestral characters found in mammals, such as an internal skeleton, a vertebral column, and four legs, do not distinguish them from other tetrapod vertebrates, so these traits are excluded from analysis.

Phylogenetic trees produced by cladists ([cladograms](#)) illustrate the hypothesized sequence of evolutionary branchings, with a hypothetical ancestor at each branching point (Figure 19.13b). Cladograms portray strictly monophyletic groups and are usually constructed using the principle of parsimony. Once a researcher identifies derived, homologous characters, constructing a cladogram is straightforward

### Cladogram, Clade,

A cladogram is a tree-like diagram showing [evolutionary](#) relationships. Any two branch tips sharing the same immediate node are most closely related. All taxa that can be traced directly to one node (that is they are "upstream of a node") are said to be members of a monophyletic group. A cladogram is a diagram much like a family tree showing the phylogenetic tree of different [species](#) and demonstrating where they evolved from common ancestors. Once [taxonomists](#) based cladograms on physical, easily-observed characteristics; today, they can use more reliable [information](#) like genetic and biochemical analysis to determine the relationships between different species. Each branch on a cladogram is referred to as a "clade" and can have two or more arms. Taxa sharing arms branching from the same clade are referred to as "sister groups" or "sister taxa." Synapomorphies are characteristics shared by the taxa branching from the same clade, but not shared by taxa on other branches – for instance, [vertebrates](#) share certain synapomorphies that are not shared by [invertebrates](#). The two basic principles behind assembly of a cladogram are that the process from ancestor to descendant should be shown as simply as possible in the tree; and

the taxonomic categories applied to the branches in a clade should be monophyletic, or cover an ancestor and all its descendants. Cladograms should not be seen as evolutionary fact, but only as a possible path for [speciation](#).

### Classical taxonomy,

The oldest form of taxonomy is what is now called classical taxonomy and it is concerned primarily with the description, naming, and classification of organisms based on their morphological characteristics. An adaptation of classical taxonomy is now taking into account molecular and biochemical (chemosystematics) data that is now available.

### Classification,

A [classification](#) is an arrangement of organisms into hierarchical groups that reflect their relatedness. Most systematists want classifications to mirror phylogenetic history and, thus, the adaptive radiation (evolutionary history) of the group of organisms in question.

### Common ancestor,

an ancestor that two or more [descendants](#) have [in common](#). Biological evolution also includes the idea that all of life is connected and can be traced back to one common ancestor.

### Convergent evolution, Henning,

Convergent [evolution](#) represents a phenomenon when two distinct [species](#) with differing ancestries evolve to display similar physical features. Environmental circumstances that require similar developmental or structural alterations for the purposes of [adaptation](#) can lead to convergent evolution even though the species differ in descent. These adaptation similarities that arise as a result of the same selective pressures can be misleading to scientists studying the natural [evolution](#) of a species. For example, the wings of all flying [animals](#) are very similar because the same laws of [aerodynamics](#) apply. These laws determine the specific criteria that govern the shape for a wing, the size of the wing, or the movements required for flight. All these characteristics are irrespective of the [animal](#) involved or the [physical](#) location. In various species of plants, which share the same pollinatio

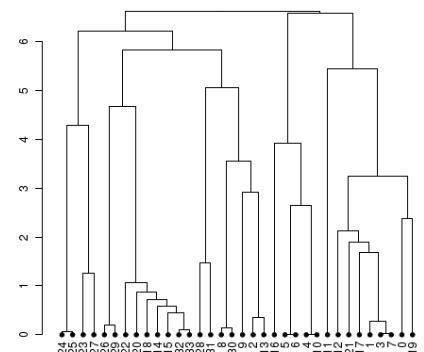
### Dendrogram,

is a [tree](#) diagram frequently used to illustrate the arrangement of the clusters produced by [hierarchical clustering](#). Dendrograms are often used in [computational biology](#) to illustrate the clustering of [genes](#) or samples.

For a clustering example, suppose this data is to be clustered using [Euclidean distance](#) as the [distance metric](#).

### Derived characters,

Among a given group of organisms, the shared derived



characters are generally the less common characters. The evolutionary interpretation is that these characters of organisms are more recently evolved. They are contrasted with *primitive characters*. Shared derived characters should have the same structure and function.

Derived characters are present members of 1 group of the line but not in the common ancestor. Fro Example: comparing fish & mammals. fish have scales and mammals have hair. so having hair is a derived character for mammals because only the mammals have ancestors with hair.

### Dichotomy,

A dichotomy is a split into two parts which are considered to be either contradictory or mutually exclusive. For example, the colors black and white represent a classic dichotomy: either something is black, or it is white, with no room for overlap or alternatives.

Dichotomies are used in a number of ways and in an assortment of fields, from [philosophy](#) to [biology](#), and learning to think about dichotomies can be important. It is also a good idea to learn to identify a false dichotomy; a dichotomy which is not, in other words, a true dichotomy

### Divergent evolution,

Divergent [evolution](#) occurs when a group from a specific population develops into a new [species](#). In order to adapt to various environmental conditions, the two groups develop into distinct species due to differences in the demands driven by the [environmental](#) circumstances. A good example of how divergent evolution occurs is in comparing how a human foot evolved to be very different from a [monkey's](#) foot, despite their common primate ancestry. It is speculated that a new species (humans) developed because there was no longer was a need for swinging from trees. Upright walking on the ground required alterations in the foot for better speed and balance. These differing traits soon became characteristics that evolved to permit movement on the ground. Although humans and [monkeys](#) are genetically similar, their natural [habitat](#) required different [physical](#) traits to evolve for survival.

### Evolutionary taxonomy,

Evolutionary taxonomy can be considered a mixture of phenetics and cladistics. It classifies organisms partly according to their evolutionary branching pattern and partly according to the overall morphological similarity. Evolutionary taxonomy is basically the method used by the early evolutionary taxonomists and is also called classical taxonomy.

### Folk taxonomy,

A folk taxonomy is a [vernacular naming system](#), and can be contrasted with [scientific taxonomy](#). Folk taxonomies are generated from [social knowledge](#) and are used in everyday speech. [Anthropologists](#) have observed that taxonomies are generally embedded in local cultural and social systems, and serve various social functions.

### Fungi,

Fungi are heterotrophic eukaryotes that obtain carbon by breaking down organic molecules synthesized by other organisms. Although all fungi are heterotrophs, fungi can be divided into two broad groups based on how they obtain carbon. If a fungus obtains carbon from

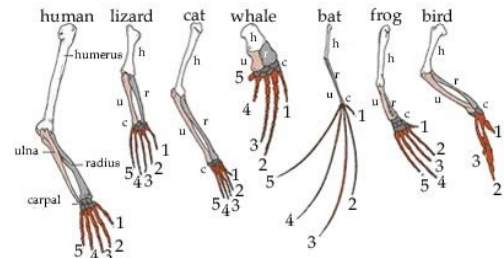
nonliving material, it is a [saprotroph](#) . Fungi that decompose dead plant and animal tissues, for example, are saprotrophs. If a fungus obtains carbon from living organisms, it is a [symbiont](#) . Symbiosis is the living together of two (or sometimes more) organisms for extended periods; symbiotic relationships range along a continuum from [parasitism](#) , in which one organism benefits at the expense of the other, to [mutualism](#) , in which both organisms benefit. Although we often think of fungi as decomposers, fully half of all identified fungi live as symbionts with another organism.

### Hierarchical,

Arranged in a hierarchy, in which the items are represented as being "above," "below," or "at the same level as" one another. Abstractly, a hierarchy is simply an ordered set or an acyclic graph.

### Homologous,

Having the same typical structure and position. In [Biology homologous](#) may refer to two [anatomical](#) structures or behavioral [traits](#) within different [organisms](#) which originated from a structure or [trait](#) of their common ancestral [organism](#). The structures or [traits](#) in their [current](#) forms may not necessarily perform the same functions in each [organism](#), nor perform the functions it did in the common [ancestor](#). An example: the wing of a bat, the fin of a whale and the arm of a man are [homologous](#) structures.



### Homology,

A homology is a character shared between species that was also present in their common ancestor.

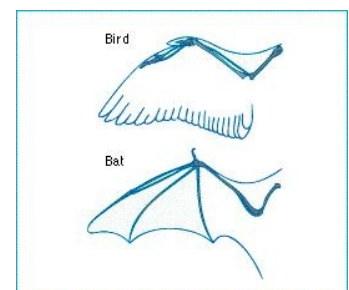
This can be contrasted with homoplasy, which is a convergent character shared between species but not present in their common ancestor.

Homologies are divided into derived homologies and ancestral homologies: a derived homology is one that is unique to a particular group of species (and their ancestor) and an ancestral homology is one that is found in the ancestor of a group of species and some, but not necessarily all, of its descendants.

The word homology has also been used in other senses. For example, before the theory of evolution was developed, homology referred to deep similarities of characters between species, as opposed to more superficial similarities called homoplasies.

### Homoplasy,

A homoplasy is a character shared by a set of species but not present in their common ancestor. A good example is the evolution of the eye which has originated independently in many different species. When



this happens it is sometimes called a convergence. Homoplasies can be compared with homologies, which are characters shared by a set of species and are present in their common ancestor.

Figure: the wings of birds and bats are homoplasies. They are structurally different: the bird wing is supported by digit number 2, the bat wing by digits 2-5.

### KISS principle,

KISS is an [acronym](#) for the design principle "Keep it simple, Stupid!". Other variations include "keep it short and simple" or "keep it simple and straightforward". The KISS principle states that [simplicity](#) should be a key goal in [design](#), and that unnecessary complexity should be avoided.

### Linnaeus,

The practice of naming and classifying organisms originated with the Swedish naturalist Carl von Linné (1707–1778), better known by his Latinized name, Carolus Linnaeus . A professor at the University of Uppsala, he developed the basic system of naming and classifying organisms still in use today. Linnaeus described and named thousands of species on the basis of their similarities and differences. Keeping track of so many species was no easy task, so he devised a [taxonomic hierarchy](#) for arranging organisms into ever more inclusive categories (Figure 19.8). A [family](#) is a group of genera that closely resemble one another. Similar families are grouped into [orders](#) , similar orders into classes, similar classes into phyla (singular, [phylum](#) ), and similar phyla into [kingdoms](#) . Finally, all life on Earth is classified into three [domains](#) (see Chapter 3). The organisms included within any category of the taxonomic hierarchy comprise a [taxon](#) (plural, taxa). Woodpeckers, for example, are a taxon (Picidae) at the family level, and pine trees are a taxon (Pinus) at the genus level.

### Mechanical taxonomy,

Key Term	Main Points
Monophyletic	-group organisms that includes single ancestral species and all descendants -taxon or group organisms -most common in creation of cladograms
Natural taxonomy	-uses evolutionary principles of similarities to classify things -used by Darwin to create his cladogram -also known as evolutionary taxonomy
Node	-place on phylogenetic tree where group organisms extend off -found between two branches -can have one or more organisms grouped together
Out group	-has all major characteristics -used as comparison point -found on separate branch than all other

	organisms
Paraphyletic	<ul style="list-style-type: none"> <li>-group organisms that includes ancestral species</li> <li>-includes some but not all descendants</li> <li>-don't want on phylogenetic tree</li> </ul>
Parsimony	<ul style="list-style-type: none"> <li>-also known as KISS principle</li> <li>-simplest way to organize organisms</li> <li>-in making phylogenetic tree, grouping that requires smallest number evolutionary changes</li> </ul>
Phenetic (numeric) taxonomy	<ul style="list-style-type: none"> <li>-uses numbers and measurements to show underlying genetics</li> <li>-no stability cause could use different numbers</li> <li>-usually used for plants</li> </ul>
Phylogenetic taxonomy	<ul style="list-style-type: none"> <li>-created by Hemming to get rid of bias</li> <li>-looks at changes in shared traits</li> <li>-use traits that are primitive and advanced</li> <li>-also known as cladistics</li> </ul>
Phylogenetic tree	<ul style="list-style-type: none"> <li>-branching diagram</li> <li>-depicts evolutionary relationships of groups of organisms</li> <li>-Hemming's attempt to get away from all problems</li> <li>-also known as cladogram</li> </ul>
Phylogeny	<ul style="list-style-type: none"> <li>-evolutionary history of groups of organisms</li> <li>-connections between all groups organisms as understood by ancestor/descendant relationships</li> <li>-relationships can be monophyletic, polyphyletic or paraphyletic</li> </ul>
Plesiomorphy	<ul style="list-style-type: none"> <li>-an ancestral or primitive character</li> <li>-features shared more widely than in a group of interest</li> <li>-character state present in both out group and ancestors</li> </ul>
Polyphyletic	<ul style="list-style-type: none"> <li>-group organisms belong to different evolutionary lineages and don't share recent common ancestor</li> <li>-2 organisms look similar so must be related but turns out they aren't</li> <li>-convergent evolution plays a role</li> </ul>
Polytomy	<ul style="list-style-type: none"> <li>-section of a phylogeny in which evolutionary relationships can't be fully resolved to dichotomies</li> <li>-in phylogenetic tree represented as node which has more than 2 immediate descending branches</li> <li>-means many temporal based branches</li> </ul>
Primitive characters	<ul style="list-style-type: none"> <li>-attributes of which all members of group possess</li> <li>-also known as plesiomorphies</li> <li>-when shared between groups called symplesiomorphies</li> </ul>
Sister group	<ul style="list-style-type: none"> <li>-also known as out group</li> </ul>

	<ul style="list-style-type: none"> <li>-has all major characteristics</li> <li>-used as comparison point</li> </ul>
Symplesiomorphy	<ul style="list-style-type: none"> <li>-shared primitive characters that are shared between groups</li> <li>-not evidence that groups are related</li> <li>-character inherited from ancestors older than last common ancestor</li> </ul>
Synapomorphy	<ul style="list-style-type: none"> <li>-derived characters shared between groups</li> <li>-derived character originated in groups last common ancestor</li> <li>-can be used as evidence that groups are related</li> </ul>
Systematics	<ul style="list-style-type: none"> <li>-a branch of biology</li> <li>-study of the diversity of life and its evolutionary relationships</li> <li>-rule used is evolutionary related</li> </ul>
Taxon	<ul style="list-style-type: none"> <li>-name designating a group of organisms included within category of Linnaean taxonomic hierarchy</li> <li>-usually a taxon is given a name and rank</li> <li>-a good taxon reflects evolutionary relationships</li> </ul>
Taxonomy	<ul style="list-style-type: none"> <li>-science of classification of organisms into ordered system that indicates natural relationships</li> <li>-when apply rules to collection in which organize things (eg. Linnaeus = morphology)</li> <li>-uses taxa (taxons)</li> </ul>

### Triassic, Jurassic and Cretaceous Periods

Key Term	Main points
Amniote animals	<ul style="list-style-type: none"> <li>-group of tetrapod vertebrates</li> <li>-have a terrestrially adapted egg</li> <li>-include mammals, reptiles and birds</li> </ul>
Anapsid	<ul style="list-style-type: none"> <li>-member of the group of amniote vertebrates</li> <li>-have no temporal arches and no spaces on sides of skull</li> <li>-includes turtles</li> </ul>
Angiosperm	<ul style="list-style-type: none"> <li>-seed producing plants</li> <li>-also are flowering plants which are the most diverse group of land plants</li> <li>-more highly evolved than algae, mosses, fungi and fern</li> </ul>
Anther	<ul style="list-style-type: none"> <li>-pollen-bearing part of stamen in flower</li> <li>-terminal part of stamen</li> <li>-place where the pollen grains are produced</li> </ul>
Bird hipped dinosaurs	<ul style="list-style-type: none"> <li>-type of dinosaur classified by pelvis bone</li> <li>-have hip structure similar to that of birds</li> <li>-did not lead to birds</li> </ul>
Carpel	<ul style="list-style-type: none"> <li>-reproductive organ of flower</li> <li>-houses an ovule and its associated</li> </ul>

	structures -leaflike seed-bearing structure
Cartilagenous fish	-skeleton made of cartilage rather than bone -includes sharks and rays -vertebrates -also known as Chondrichthyes
Cephalopods	-category of molluscs -includes octopus and squids -live in marine environment -have two well-developed eyes for hunting
Co-evolution	-can occur at multiple levels of biology -change of biological object triggered by change of related object -each thing involved exerts selective pressure on the other
Cretaceous	-period with relatively warm climate -ended with one of the largest mass extinctions -was after the Jurassic period -there were new groups of mammals, birds and flowering plants that appeared
Diapsids	-member of a group within amniote vertebrates -has skull with two temporal arches -includes lizards, snakes, crocodiles and birds
Double fertilization	-characteristic feature of sexual reproduction in flowering plants -process involves joining of one female gametophyte(embryo sac) with two male gametes(sperm) -complex fertilization mechanism that has evolved in flowering plants, angiosperms
End Triassic extinction	-4 <sup>th</sup> ranked in severity of the 5 mass extinctions -allowed dinosaurs to become dominant land animals -affected a lot of marine and land life

### Endosperm

- Tissues derived from that 3n cell. They nourish the embryo and, in monocots, the seedling, until its leaves form and photosynthesis has begun. Embryo-nourishing endosperm forms only in flowering plants, and its evolution coincided with a reduction in the size of the female gametophyte.
- Endosperm offers an advantage over female gametophyte tissue as a nutrient source for embryos because its development is tied to that of the embryo: if no embryo forms, the plant does not commit resources to endosperm.
- And if an angiosperm embryo is aborted, which can happen if environmental conditions become unfavourable for embryo development (e.g., in the case of drought), endosperm development also ceases, saving the plant energy and resources.

- Endosperm is the tissue produced inside the seeds of most flowering plants around the time of fertilization. It surrounds the embryo and provides nutrition in the form of starch, though it can also contain oils and protein.

### Extinct

- A species is said to be extinct when there are no living representatives known on Earth.
- Mass extinctions occurred at the end of the Ordovician and the beginning of the Devonian, at the end of the Devonian, at the end of the Permian, at the end of the Triassic, and at the end of the Cretaceous.
- The Permian extinction was the most severe, and more than 85% of the species alive at that time disappeared forever, including the trilobites, many amphibians, and the trees of the coal swamp forests.
- Causes → Asteroid impact, Marine anoxia, Sea level changes, Elevated Carbon dioxide (Flood Basalts, Volcanoes, Gas hydrates)

### Extant

- refers to taxa, such as species, genera, and families that is quite ancient but still in existence

### Fruit

- Fruits have two functions: they protect seeds, and they aid seed dispersal in specific environments.
- Fruits begin to develop after ovules are fertilized. The fruit wall, called the pericarp, develops from the ovary wall and can have several layers. Hormones in pollen grains provide the initial stimulus that turns on the genetic machinery leading to fruit development; additional signals come from hormones produced by the developing seeds.
- A major defining feature is the nature of the pericarp, which may be fleshy (peaches) or dry (hazelnut). A fruit also is classified according to the number of ovaries or flowers from which it develops. Simple fruits, such as peaches and tomatoes develop from a single ovary, and in many of them, at least one layer of the pericarp is fleshy and juicy.

### Jurassic

- formed in the second period of the Mesozoic era, between the Triassic and Cretaceous periods, lasting for 55 million years during which dinosaurs and ammonites flourished
- The supercontinent begins to rotate, but the different components of the huge mass rotated at different rates and then in different directions, forming rift valleys. This was North America drifting westward, opening the Gulf of Mexico, and forming the central Atlantic.

Jurassic period (206 - 144 Ma)

200 Ma - Pangaea starts to break apart

150 Ma - Birds

K/T (K/P) boundary,

- Geologists' shorthand for the boundary between the rocks of the Cretaceous and the Tertiary periods 65 million years ago. It coincides with the end of the extinction of the dinosaurs and in many places is marked by a layer of clay or rock enriched in the element iridium. Extinction of the dinosaurs at the K-T boundary and deposition of

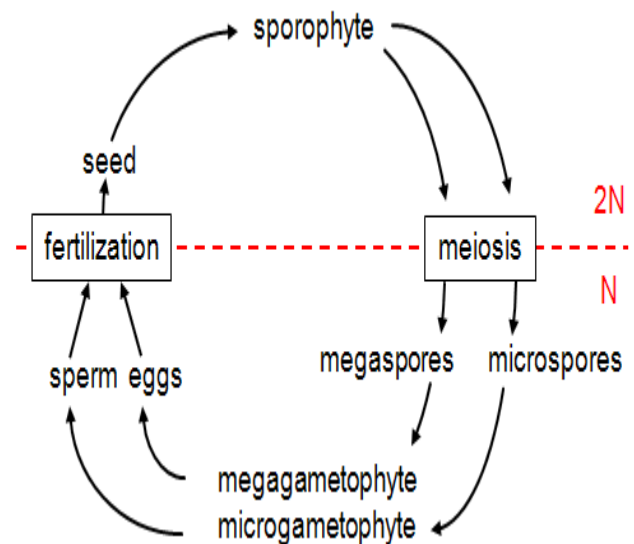
the iridium layer are thought to be the result of either impact of an asteroid or comet that crashed into the Yucatán Peninsula, perhaps combined with a period of intense volcanism on the continent of India.

### Keratin

- Ectoderm cells synthesize mainly keratin, a different protein.
- Keratin is a component of surface structures such as skin, hair, feathers, scales, and horns.
- In response to induction by the optic vesicle, genes of ectoderm cells coding for crystalline are activated, but genes coding for keratin are not.
- Some epithelial cells, particularly in the epidermis of vertebrates, contain a network of fibres of keratin, a family of tough proteins. Keratin monomers assemble into bundles to form intermediate filaments, which are tough and insoluble and form strong unmineralized tissues
- Keratin forms the scales of fish and reptiles (including the shells of turtles), the feathers of birds, and the hair, claws, hooves, horns, and fingernails of mammals.
- First, waterproof skin: keratin and lipids in the cells make skin relatively impermeable to water.

### Megasporangium,

- Produces megaspores
- Are the comparable "female" structures on these plants, associated with the flower carpel and the megasporangial cone.
- megasporangium is surrounded by extra layers of sporophyte tissue, which would add additional protection for gametes and embryos,
- Surrounded by layers of sporophyte tissue called the integument. The integument and structures within (megasporangium, megaspore) are the ovule.



### Megaspore

- One of the two types of haploid spores produced by a heterosporous plant
- A plant spore that develops into a female gametophyte; usually larger than a microspore.
- Inside the cell mass, a diploid megasporocyte (also called a megaspore mother cell) divides by meiosis, forming four haploid megaspores. In most plants, three of these megaspores disintegrate. The remaining megaspore enlarges and develops into the female gametophyte

### Mesozoic

- The Mesozoic Era is a period from about 250 million years ago to about 67 million years ago.
- Era featured the dramatic rifting of the supercontinent Pangaea. Pangaea gradually split into a northern continent, Laurasia, and a southern continent, Gondwana. This created the passive continental margin that characterizes most of the Atlantic coastline.
- The Mesozoic was a time of tectonic, climatic and evolutionary activity. The continents gradually shifted from a state of connectedness into their present configuration; the drifting provided for speciation and other important evolutionary developments.
- The climate was exceptionally warm throughout the period, also playing an important role in the evolution and diversification of new animal species.

#### Changing earth highlights

Triassic period (248 - 206 Ma)

220 Ma - Mammals, dinosaurs, crocodiles

215 Ma - Flying reptiles

206 Ma - Late Triassic extinction

Jurassic period (206 - 144 Ma)

200 Ma - Pangaea starts to break apart

150 Ma - Birds

Cretaceous period (144 - 65 Ma)

130 Ma - Flowering plants

65 Ma - Tropical climate extends to Polar Regions, end Cretaceous extinction

#### Microsporangium

- Microsporangia are the structures on the stamens of flowers called anthers, and the pollen-producing structures on the microsporophyll's of male conifer cones or cycad cones.
- Microspores of gymnosperms (and other seed plants) are not dispersed. Instead, they are retained inside microsporangia and are enveloped in additional layers of sporophyte tissue.
- As in other heterosporous plants, each microspore produces a male gametophyte, which develops inside the microspore wall.

#### Microspore

- A plant spore from which a male gametophyte develops; usually smaller than a megaspore.
- In seed plants the microspore gives rise to the pollen grains, and the megaspores are formed within the developing seed
- The spores that give rise to male gametophytes are produced in anthers. The pollen sacs inside each anther hold diploid microsporocytes (microspore mother cells); each microsporocyte produces four small haploid microspores by meiosis. Inside the spore wall, each microspore divides again, this time by mitosis. The result is an immature, haploid male gametophyte—a pollen grain.

#### Mollusc,

- The mollusc is a soft-bodied, usually shelled INVERTEBRATE belonging to one of the largest animal phyla (Mollusca) with some 100 000 living and about 35 000 FOSSIL species.
- Molluscs are found on land and in salt and fresh water, and include SNAILS, ABALONE, CLAMS, MUSSELS, octopuses and squid.

- The group is characterized by a muscular foot on which the animals creep; a calcareous shell secreted by the underlying fleshy mantle; and a feeding structure, the radula, consisting of a membrane, bearing sharp cusps, thrusting out from the mouth (found in all major groups except Bivalvia).

### Nectar,

- A sweet liquid secreted by flowers of various plants, consumed by pollinators, such as hummingbirds and insects, and gathered by bees for making honey.
- Produced either by the flowers, in which it attracts pollinating animals, or by extrafloral nectarines, which provide a nutrient source to animal mutualists providing anti-herbivore protection.
- It is produced in glands called nectarines. Common nectar-consuming pollinators include bees, butterflies and moths, hummingbirds and bats.

### Ornithischia

- The largely herbivorous ornithischian dinosaurs had large, chunky bodies. This lineage included armoured or plated dinosaurs (Ankylosaurus and Stegosaurus), duck-billed dinosaurs (Hadrosaurus), horned dinosaurs (Styracosaurus), and some with remarkably thick skulls (Pachycephalosaurus).
- The ornithischian pubis bone points downward and toward the tail (backwards), parallel with the ischium, with a forward-pointing process to support the abdomen. This makes a four-pronged pelvic structure. In contrast to this, the saurischian pubis points downward and toward the head (forwards), as in ancestral lizard types
- They were more numerous than the saurischians. They were prey animals for the theropods and were smaller than the sauropods.



### Oviparous

- Amniotes that reproduce by laying an enclosed egg on land
- The animals lay eggs, whereas viviparous and ovoviviparous animals bear live young. The eggs of oviparous animals contain all of the nutrients necessary for development of the embryo outside the mother's body.
- This is the reproductive method of most fish, amphibians, reptiles, all birds, the monotremes, and most insects and arachnids. Birds and most invertebrates including snails are oviparous

### Ovule

- The lower part of a carpel is the ovary, where inside it contains one or more ovules, in which an egg develops and fertilization takes place.
- A seed is a mature ovule. In many flowers that have more than one carpel, the carpels fuse into a single, common ovary containing multiple ovules.
- Meanwhile, in the ovary of a flower, one or more dome-shaped masses form on the inner wall. Each mass becomes an ovule, which will develop into a seed after fertilization, if all goes well.
- Only one ovule forms in the carpel of some flowers, such as the cherry. A numerous amount form in the carpels of other flowers. At one end, the ovule has a small opening, called the micropyle.

## Pangea,

- About 250 million years ago, Earth's landmasses coalesced into a single supercontinent that existed during the Paleozoic and Mesozoic eras.
- Later continental drift separated Pangea into a northern continent, Laurasia, and a southern continent, Gondwana. Laurasia and Gondwana subsequently broke into the continents we know today
- The rifting that took place between North America and Africa produced multiple failed rifts. One rift resulted in a new ocean, the North Atlantic Ocean.

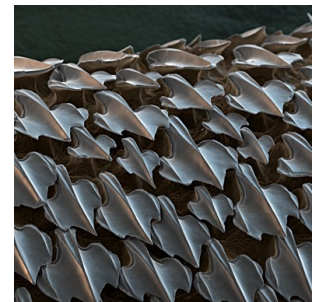


The Atlantic Ocean did not open uniformly; rifting began in the north-central Atlantic. The South Atlantic did not open until the Cretaceous. Laurasia started to rotate clockwise and moved northward with North America to the north, and Eurasia to the south. The clockwise motion of Laurasia also led to the closing of the Tethys Ocean. Meanwhile, on the other side of Africa, new rifts were also forming along the adjacent margins of east Africa, Antarctica and Madagascar that would lead to the formation of the south-western Indian Ocean that would also open up in the Cretaceous.

The second major phase in the break-up of Pangea began in the Early Cretaceous (150–140 Ma), when the minor supercontinent of Gondwana separated into multiple continents (Africa, South America, India, Antarctica, and Australia).

## Placoid scale,

- Tough scales that cover the skin of elasmobranchs (sharks and rays).
- Like our teeth, placoid scales have an inner core of pulp (made up of connective tissues, blood vessels, and nerves), which is covered by a layer of dentine (hard calcareous material). This dentine is covered by enamel-like vitrodentine.
- Even though placoid scales are similar to the scales of bony fish, they are really modified teeth and are covered with hard enamel.
- Placoid scales are packed tightly together and grow with their tips facing backwards. This gives the fish's skin a rough feel. The function of these scales is for protection against predators, although in some sharks, they may also have a hydrodynamic function.
- Scales in bony fish grow as the fish gets larger, but placoid scales stop growing after they reach a certain size, and then more scales are added as the fish grows.



## Plesiosaurs

- Group of marine reptiles that were Mesozoic diapsid reptiles that lived in the ocean, but breathed air.



- Plesiosaurs appeared at the start of the Jurassic Period and thrived until the K-T extinction, at the end of the Cretaceous Period. The animal was less fish-like in form than the ichthyosaurs, but was still adapted for life in the oceans.
- Cruised slowly below the surface of the water, using their long flexible neck to move their head into position to snap up unwary fish or cephalopods.
- Their four-flippered swimming adaptation may have given them exceptional manoeuvrability, so that they could swiftly rotate their bodies as an aid to catching prey.

There were two kinds of plesiosaurs:

- Plesiosaurids, which had long snake-like necks with tiny heads and a large physical frame.
- Pliosauroids, which had large heads with strong jaws. They had short necks and consumed larger sea creatures.

### Pollen.

- The male gametophyte of a seed plant.
- Pollen grains have a hard coat that protects the sperm cells during the process of their movement between the stamens to the pistil of flowering plants or from the male cone to the female cone of coniferous plants.
- When pollen lands on a compatible pistil of flowering plants, it germinates and produces a pollen tube that transfers the sperm to the ovule of a receptive ovary.

### Pollen tube.

- This male gametophyte consists of three cells—two sperm cells plus a third cell that will form a pollen tube. When pollen lands on a stigma, this tube grows through the tissues of a carpel and carries the sperm cells to the ovary.
- A mature male gametophyte consists of the pollen tube and sperm cells—the male gametes.
- The walls of pollen grains are tough enough to protect the male gametophyte during the somewhat precarious journey from anther to stigma.
- These walls are so distinctive that the family to which a plant belongs usually can be identified from pollen alone—based on the size and wall sculpturing of the grains, as well as the number of pores in the wall.
- Because they withstand decay, pollen grains fossilize well and can provide revealing clues about the evolution of seed plants, as well as help biologists reconstruct ancient plant communities and determine how climates have changed over time.

### Pollination.

- The transfer of pollen to a flower's reproductive parts by air currents or on the bodies of animal pollinators.
- The process by which plants produce seeds—which have the potential to give rise to new individuals—begins with pollination, when pollen grains make contact with the stigma of a flower.
- Pollination and fertilization can take place only if the pollen and stigma are compatible. For example, if pollen from one species lands on a stigma from another, chemical incompatibilities usually prevent pollen tubes from developing.

### Pterosaurs.

- Pterosaurs , now extinct, were flying predators of the Jurassic and Cretaceous and included the largest vertebrate ever known to fly
- Pterosaur wings were covered by a leathery membrane. This thin but tough membrane stretched between its body, the top of its legs and its elongated fourth fingers, forming the structure of the wing.
- Claws protruded from the other fingers.
- The appearance of flight in pterosaurs was separate from the evolution of flight in birds and bats; pterosaurs are not closely related to either birds or bats, and thus provide a classic example of convergent evolution.
- Fibers in the wing membrane added structural support and stiffness. At least some pterosaurs may have had some sort of hair-like body covering, which could very well mean that they were endothermic.
- Pterosaurs had hollow bones, large brains with well-developed optic lobes, and several crests on their bones to which flight muscles attached. All of this is consistent with powered flapping flight.



### Ray-finned fishes

- Bony fishes first appeared in the Silurian and rapidly diversified into two lineages→ Actinopterygii and Sarcopterygii.
- The ray -finned have fins supported by thin and flexible bony rays, whereas the fleshy-finned fishes have fins supported by muscles and an internal bony skeleton.
- Ray -finned fishes are more diverse as measured by numbers of species and today vastly outnumber fleshy-finned fishes. The 30 000 living species of bony fishes occupy nearly every aquatic habitat and represent more than 95% of living fish species.
- The crushing teeth of ray -finned fishes often occur on the bones of the pharynx.
- In many modern ray -finned fishes, a gas-filled swim bladder serves as a hydrostatic organ that increases buoyancy. The swim bladder is derived from an ancestral air-breathing lung that allowed early actinopterygians to gulp air, supplementing gill respiration in aquatic habitats, where dissolved oxygen concentration is low.

### Saurischia.

- Saurischians included bipedal carnivores and quadrupedal herbivores.
- Some carnivorous saurischians were swift runners, and some had short forelimbs (e.g., Tyrannosaurus rex) By the Cretaceous, some herbivorous sauris-chians were gigantic, and many had long, flexible necks.
- One group of saurischians, the deinonychsaur, is ancestral to birds
- The saurischian, or "lizard-hipped" dinosaurs, like all other tetrapods, had pelvis (hips) composed of three elements→ the ilium, ischium, and pubis.
- What distinguishes saurischians (among other major characteristics; including a grasping hand, asymmetrical fingers, and a long, mobile neck) is the pubis that points downward and forward at an angle to the ischium.

### Sauropods.

- Sauropods (meaning "Lizard-Footed") were an infraorder of large, four-legged, herbivorous dinosaurs.
- They had very long necks, small heads with blunt teeth, a small brain, and long tails for counterbalancing their necks. They had large guts, which were necessary for digesting huge amounts of plant material.
- They walked relatively slowly on four short, thick, five-toed legs. Their nostrils were located on the upper parts of their skulls, sometimes very close to the eyes. A few of the later Sauropods had some body armor (e.g., Titanosauridae).
- The Sauropoda were large herbivores such as Apatosaurus and Diplodocus.
- Sauropods, such as Diplodocus shown here, appeared in the Late Triassic and began to diversify in the Middle Jurassic, about 180 million years ago.

### Stamen,

- A "male" reproductive organ in flowers, consisting of an anther (pollen producer) and a slender filament.
- Inside the petals are the stamens, in which male gametophytes form.
- In almost all living flowering plant species, a stamen consists of a slender filament (stalk) capped by a bilobed anther.
- Each anther contains four pollen sacs, in which pollen develops.

### Synapsids,

- A group of small predators were the first offshoot from ancestral amniotes.
- Synapsids had one temporal arch on each side of the head and emerged late in the Permian, and mammals are their living descendants.
- Synapsids evolved in the late Permian Period and were characterized by carrying their limbs under their body and developing front teeth that were different from their back teeth.



### Temporal fenestra

- The temporal fenestrae are anatomical features of the skulls of several types of amniotes, characterised by bilaterally symmetrical holes (fenestrae) in the temporal bone.
- Depending on the lineage of a given animal, two, one, or no pairs of temporal fenestrae may be present, above or below the postorbital and squamosal bones.
- The upper temporal fenestrae are also known as the supratemporal fenestrae, and the lower temporal fenestrae are also known as the infratemporal fenestrae.
- The presence and morphology of the temporal fenestra is critical for taxonomic classification of the synapsids, of which mammals are part.  
Ex. The Synapsids (mammal-like reptiles) and the Diapsids (most reptiles and later birds).

### Theropods,

- They include the largest terrestrial carnivores ever to have made the earth tremble.
- Dinosaurs belonging to the suborder theropoda were primarily carnivorous, although a number of theropod groups evolved herbivory, omnivory, and insectivory.
- Theropods first appeared during the Carnian age of the late Triassic period about 230 million years ago (Ma) and included the sole large terrestrial carnivores from the Early Jurassic until at least the close of the Cretaceous, about 65 Ma.
- In the Jurassic, birds evolved from small specialized coelurosaurian theropods, and are today represented by 9,900 living species. Among the features linking theropod

dinosaurs to birds are the three-toed foot, a furcula (wishbone), air-filled bones and (in some cases) feathers and brooding of the eggs.

### Vertebrate

- Vertebrate skeletal muscles connect to the bones of the skeleton. The cells forming skeletal muscles are typically long and cylindrical and contain many nuclei (see Chapter 32).
- Skeletal muscle is controlled by the somatic nervous system (see Chapter 33). In addition, the internal skeleton and attached muscles allow most vertebrates to move rapidly.
- Vertebrates are the only animals that have bone, a connective tissue in which cells secrete the mineralized matrix that surrounds them (see Chapter 36). One vertebrate lineage, cartilaginous fishes (class Chondrichthyes), may have lost its bone over evolutionary time.
- We suspect that vertebrates arose from a cephalochordate-like ancestor through duplication of genes that regulate development.
- Vertebrates appear to be more closely related to cephalochordates than to urochordates. The change from cephalochordate-like creature to vertebrate was marked by the emergence of neural crest, bone, and other vertebrate traits.

### Paleogene and Neogene periods

#### **Amniote Animals**

- Amniotes are a group of tetrapod vertebrates that lay eggs that are specially adapted to survive in a terrestrial environment -these eggs are referred to as amniotic eggs
- Amniotes include all present day reptiles, birds, and mammals - they arose from a group of lizard-like amphibians called the amphibian reptiliomorphs
- Amniotes evolved about 340 million years ago during the Carboniferous Period

\*The amniote embryo is protected by a set of membranes that shelter it from the harsh conditions of a **terrestrial environment**. These membranes ensure the following four things:

- Ensure that the embryos do not dry-out
- Enable gas exchange between the embryo and its environment as it develops
- Allow waste materials to be disposed of while the embryo develops - this prevents waste products from building up to toxic levels within the egg
- Enable the embryo to receive the nutrition it needs to develop

\*\*\*Additional information: The development of the amniotic egg is a significant milestone in the evolutionary history of the vertebrates because it freed them from the necessity to lay their eggs in water. Although amphibians are both vertebrates and tetrapods, they are not amniotes. As a result, they do not lay amniotic eggs and are, to this day, bound to aquatic habitats for reproduction. Their eggs dry out and die if they are not laid in moist environments. Amniotic eggs enabled the vertebrates that possessed them to become the most dominant land vertebrates alive today.

## Anthropoids

- Resembling or characteristic of an ape; apelike

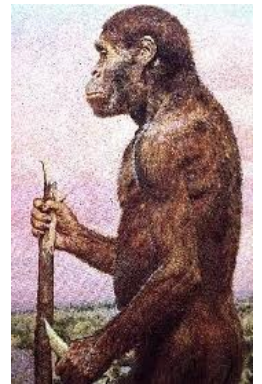
General anthropoid characteristics:

- Fully binocular vision;
- Larger brains;
- Substantial reduction in olfactory organs and nasal area;
- Improved manual dexterity.

\*The Anthropoid ("man-like") Apes are those Old World Monkey descendants in which the tail is absent

## Australopithecus

- Group of [extinct hominids](#) that are closely related to modern [humans](#)
- They were widespread in eastern and southern [Africa](#) from about 4 million years ago to 2 million years ago, appearing during the [Pliocene](#) epoch
- Fossil record reveals that Australopithecus remained essentially unchanged throughout their long history
  
- Australopithecus is considered to have provided the foundation for modern humans



## Bipedal

- Form of [terrestrial locomotion](#) where an organism [moves](#) by means of its two rear [limbs](#), or [legs](#)
- biped meaning "two feet" (from the [Latin](#) *bi* for "two" and *ped* for "foot")
- Types of bipedal movement include [walking](#), [running](#), or [hopping](#), on two [appendages](#) (typically [legs](#))
- Within [mammals](#), habitual bipedalism has evolved four times, with the [macropods](#), [kangaroo mice](#), [springhare](#) and [homininan](#) apes

\*Basically anything that [moves](#) with two [legs](#)

\*View page 657 in textbook

## Cro-magnons

- The first [early modern humans](#) (early *Homo sapiens sapiens*) of the [European Upper Paleolithic](#) in [Europe](#)
- The earliest known remains of Cro-Magnon-like humans are [radio metrically dated](#) to 35,000 years before present
- Ice age
- Cro-Magnons hunted mammoth, reindeer, red deer, bison and wild horses.



- Invented the spear thrower, which allowed them to hurl spears much further than before - used bows and arrows - also fished using harpoons tipped with bone points
- Highly skilled at making efficient tools from stone, bone, wood and antler
- Physically they were exactly the same as modern humans - they looked just like us
- The Cro-Magnons made warm clothes such as trousers, coats and boots from animal skins using bone needles

## Endothermy

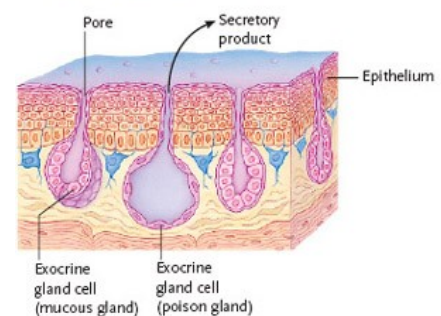
- Warm-blooded
- An animal keeps its body warm by producing heat within its body - internally heated
- The heat is made by the chemical reactions which digest food and some is also made when muscles contract during movement
- Modern endotherms include mammals and birds
- Most endotherms are also homeotherms (they are able to control their temperature to within 4 degrees centigrade of a given value)
- For example, if we get too hot we start to sweat, which cools us down and if we get too cold we start to shiver which makes our muscles contract and heats us up.

## Glandular skin

- Relating to glands, the main secretory organs of organisms; glandular skin has many glands, whereas aglandular skin has few or none
- Example: amphibians

\*See Ch. 32.2 (Animal tissues) for toxic secretion

\*Same in image in textbook →



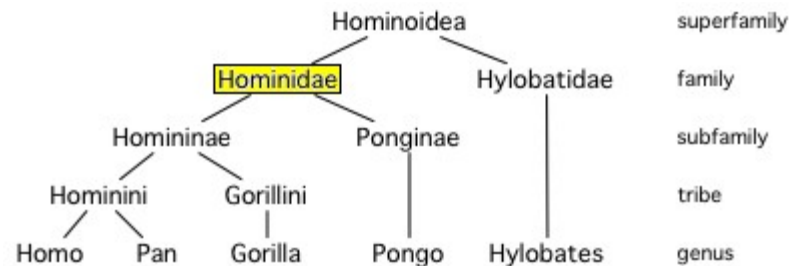
a. Examples of exocrine glands: The mucus- and poison-secreting glands in the skin of a blue poison frog

## Great apes

- The great apes belong to the taxonomic family Homindae (includes chimpanzees, bonobos, orangutans, gorillas and humans)
- All members of this family share possibly more than 97% of their DNA
- The great apes have all been documented using tools, and communicating with amazing complexity
- Found primarily in Central Africa with the exception of orangutans, which are native to the islands of Borneo and Sumatra in Asia
- All of the great apes face serious threats and are all endangered, some critically endangered
- Habitat loss, climate change, infectious disease and illegal hunting for both meat and the live pet trade have combined to push these species to the brink of extinction

## Hominids

- Refers to members of the family of humans, Hominidae, which consists of all species on our side of the last common ancestor of humans and living apes
- Hominids are included in the superfamily of all apes, the Hominoidea, the members of which are called hominoids
- Upright posture and bipedal locomotion are adaptations that distinguish **hominids** from apes.
- Evolutionary refinements in grasping ability allow **hominids** to hold objects tightly with a *power grip* or manipulate them precisely with a *precision grip*  
\* View 27.15: The Evolution of Humans in textbook



## Hominins

- The term hominin is used to describe members of the human family, distinguishing us and our ancestors from the non-human primates
- In the past, researchers used the term hominid in this way, but recent research has changed the way scientist use this terminology- Hominin is the preferred term in current research
- Today, humans are the only living hominins
- Over the past 7 million years, there have been dozens of species of humans, some of which are our own ancestors and others which were evolutionary dead-ends that went extinct

## Mammary gland

- An organ in mammals that produces milk for the sustenance of young offspring
- It is an exocrine gland that is an enlarged and modified sweat gland, and gives mammals their name
- Mammary glands are derived from a modification of [sweat glands](#)- They first appear in [embryonic](#) life as clumps of cells proliferating from a longitudinal ridge of ectoderm (the outermost of the three [germ layers](#) of the embryo) along the so-called milk line, from the buds, or beginnings, of the lower limbs to those of the [upper limbs](#).

## Neanderthal

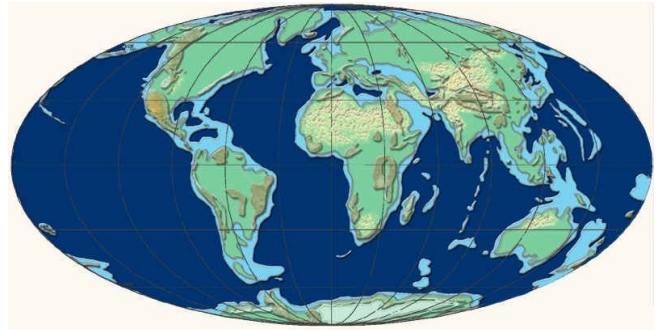
- An extinct member of the [Homo](#) genus that is known from [Pleistocene specimens](#) found in Europe and parts of western and [central Asia](#)
- Neanderthals are either classified as a [subspecies](#) (or [race](#)) of modern [humans](#) (Homo sapiens neanderthalensis) or as a separate human [species](#) (Homo neanderthalensis)
- Neanderthal [cranial capacity](#) is thought to have been as large as that of [Homo sapiens](#), perhaps larger
- On average, the height of Neanderthals was comparable to contemporaneous Homo sapiens- Neanderthal males stood about 165–168 cm (65–66 in), and were heavily built with robust bone structure. They were much stronger than Homo sapiens,

having particularly strong arms and hands- Females stood about 152–156 cm (60–61 in)

- They were almost exclusively [carnivorous](#) and [apex \(highest rank\) predators](#)

## Neogene

- Age of Grass
- (24 Ma - present)
- The continents began the Neogene by crashing into each other - created parts of the Rocky, Sierra Nevada, and Cascade Mountains in North America (The high mountains altered air circulation and weather patterns, contributing to the drier and cooler climate)
- The Arctic ice cap grew and thickened. Snow and ice fell on the high mountains, locking up water far from the oceans. Sea levels plummeted, exposing land bridges between Africa and Eurasia and between Eurasia and North America. Eventually, South America moved north and merged with North America, forming the Isthmus of Panama



The continental connections gave animals that had evolved in isolation access to new lands:

Miocene (24 - 5.3 Ma)

20 Ma - Inland seas dry out, great mountain building, kelp forests

18 Ma - Grazing horses

- 16 Ma - Orangutan line separates from African Ape/Hominid
- 9 Ma - Miocene extinction
- 6 Ma - Chimpanzee and Hominid line separate
- Pliocene (5.3 - 1.8 Ma)
- 5.2Ma - Hominids
- 2 Ma - Global ice ages begin
- Pleistocene (1.8 - 0.01 Ma)
- 0.6Ma - Early Humans
- 0.1Ma - Modern Humans
- 0.01Ma - Late Pleistocene extinction
- Holocene (0.01 Ma - present)

## Out-of-Africa hypothesis

- Argues that every living human being is descended from a small group in Africa
- Migrated into Eurasia and replaced all populations which had descended from *Homo erectus*
- after *Homo erectus* migrated out of Africa the different populations became reproductively isolated, evolving independently, and in some cases like the Neanderthals, into separate species

- *Homo sapiens* arose in one place, probably Africa (geographically this includes the Middle East)
  - *Homo sapiens* ultimately migrated out of Africa and replaced all other human populations, without interbreeding
  - modern human variation is a relatively recent phenomenon
  - The replacement hypothesis suggests that the genes in fully modern humans all came out of Africa
- 
- As these peoples migrated they replaced all other human populations with little or no interbreeding

## Oviparous

- Animals that lay [eggs](#), with little or no other [embryonic](#) development within the mother
- This is the [reproductive method](#) of most [fish](#), [amphibians](#), [reptiles](#), all [birds](#), the [monotremes](#), and most [insects](#) and [arachnids](#)
- Land-dwelling animals that lay eggs, often protected by a shell, such as reptiles and insects, do so after having completed the process of internal [fertilization](#)
- Water-dwelling animals, such as fish and amphibians, lay their eggs before fertilization, and the male lays its sperm on top of the newly laid eggs in a process called [external fertilization](#)
- Almost all non-oviparous fish, amphibians and reptiles are [ovoviviparous](#), i.e. the eggs are hatched inside the mother's body (or, in case of the [sea horse](#) inside the father's). The true opposite of oviparity is [placental viviparity](#), employed by almost all mammals (the exceptions being [marsupials](#) and [monotremes](#))

\*There are only five known species of oviparous mammals: four species of [Echidna](#) and the [Platypus](#).

## Paleogene

- 65 -24 Ma
- Comprises the first part of the [Cenozoic](#) Era
- Lasting 42 million years
- Time in which [mammals evolved](#) from relatively small, simple forms into a large group of diverse [animals](#) in the wake of the [Cretaceous–Tertiary extinction event](#) that ended the preceding [Cretaceous](#) Period
- Some of these mammals would evolve into large forms that would dominate the land, while others would become capable of living in [marine](#), specialized terrestrial and even airborne environments
- [Birds](#) also evolved considerably during this period, changing into roughly-modern forms. Most other branches of [life](#) on [earth](#) remained relatively unchanged in comparison to birds and mammals during this period
- Some [continental motion](#) took place
- [Climates](#) cooled somewhat over the duration of the Paleogene and inland seas retreated from North America early in the period.
- This period consists of the [Paleocene](#), [Eocene](#), and [Oligocene](#) Epochs

## Highlights

- 60 Ma - Primates
- 57 Ma - Rodents
- 55 Ma - Bats
- Eocene (54 - 33 Ma)
- 50 Ma - Whales
- 40 Ma - Continents near present day conditions, drying and cooling trend begins
- 33 Ma - Late Eocene extinction
- Oligocene (33 - 24 Ma)
- 25 Ma - Ape/Human line evolves, grasses
- 24 Ma - Short term warming and drying

## Paranthropus

- Distinguishable from the gracile by their large molars and premolars. The possession of such in powerful chewing to help digest tough plant materials
- There are believed to be three species of *Paranthropus*. They are named

*robustus*, *boisei*, and *aethiopicus*

- These forms are thought to have lived from about 2.4 million years ago to about 1.8 or even 1 million years ago

## Parental care

- Uhhh parental strategies for protecting and nurturing their offspring?

## Placenta

- An organ that connects the developing fetus to the uterine wall to allow nutrient uptake, waste elimination, and gas exchange via the mother's blood supply
- Placentas are a defining characteristic of eutherian or "placental" mammals, but are also found in some snakes and lizards with varying levels of development up to mammalian levels
- Protherial (egg-laying) and metatherial (marsupial) mammals produce a choriovitelline placenta that, while connected to the uterine wall, provides nutrients mainly derived from the egg sac
- The placenta develops from the same sperm and egg cells that form the fetus, and functions as a fetomaternal organ with two components, the fetal part and the maternal part

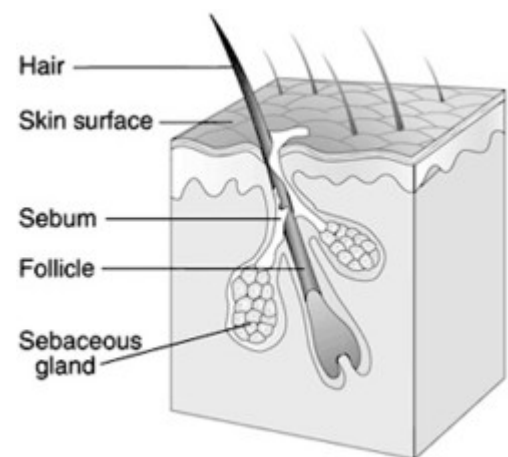
## Primates

- Include the most familiar of the placental mammals, because they include us, *Homo sapiens*
- Primates also include familiar animals, such as the chimpanzees, gorillas, and monkeys

- With the exception of [humans](#), who inhabit every continent on Earth, most primates live in tropical or subtropical regions of the Americas, Africa and Asia.
- According to fossil evidence, the primitive ancestors of primates may have existed in the late [Cretaceous](#) period around 65 million years ago, and the oldest known primate is the Late [Paleocene Plesiadapis](#), c. 55–58 million years ago.
- Primates are characterized by their large brains, relative to other mammals, as well as an increased reliance on [stereoscopic](#) vision at the expense of smell, the dominant sensory system in most mammals
- Most also have [opposable thumbs](#) and some have [prehensile](#) tails
- Many species are [sexually dimorphic](#), which means males and females have different physical traits, including body mass, canine tooth size, and coloration
- Have slower rates of development than other similarly sized mammals, and reach maturity later but have longer lifespans

### Sebaceous gland

- Microscopic glands in the skin that secrete an oily/waxy matter, called sebum, to lubricate the skin and hair of mammals
- In humans, they are found in greatest abundance on the face and scalp, though they are distributed throughout all skin sites except the palms and soles.
- In the eyelids, meibomian sebaceous glands secrete a special type of sebum into tears.



### Sternal keel

- The breastbone has a deep keel which increases the area for the attachment of the large flight muscles (Birds)- A keel in bird anatomy is an extension of the sternum
- Human- a long flat bone (The sternum is composed of three fused bones.) shaped like a capital 'T' located in the center of the thorax (chest)
- It connects to the rib bones via cartilage, forming the anterior section of the rib cage with them, and thus helps to protect the lungs, heart and major blood vessels from physical trauma

### Sweat gland

- [Are](#) endocrine glands found under the [skin](#) in most [mammal](#) species which are used for [body temperature regulation](#) (thermoregulation)
- In humans, [apocrine](#) and [merocrine sweat glands](#) form the primary method of [cooling](#), though many other mammals, such as cats, dogs and pigs, rely on [panting or other means](#) as a primary source of cooling. Sweat also serves to increase friction on the palms of hands or the pads of paws
- Both apocrine and merocrine sweat glands contain [myoepithelial cells](#) (from Greek *myo-*, "muscle"), specialized epithelial cells located between the gland cells and the underlying basal lamina.
- Myoepithelial cell contractions squeeze the gland and discharge the accumulated secretions.

- The secretory activities of the gland cells and the contractions of myoepithelial cells are controlled by both the autonomic nervous system and by the circulating hormones.
- Additionally, [ceruminous glands](#), which produce ear wax, and [mammary glands](#), which produce milk, are frequently considered to be modified sweat glands.

### **Viviparous**

- Has two different meanings: In animals, it means development of the embryo inside the body of the mother, eventually leading to live birth (as opposed to laying eggs)- In plants, it means reproduction via embryos, such as spores or buds, that develop from the outset without interruption (as opposed to germinating externally from a seed).
- Viviparous offspring live independently and require an external food supply from birth - contrasting with some egg laying animals, such as fish the recently hatched young of which bear yolk sacs
- Viviparous plants produce seeds that germinate before they detach from the parent- In many [mangroves](#), for instance, the seedling germinates and grows under its own energy while still attached to its parent before dropping into the water in order to transport away

## [Silurian and Devonian periods](#)

### **Agnatha** \*focus mainly on lampreys and the hagfish

- A [superclass](#) of jawless fish in the [phylum Chordata](#), subphylum [Vertebrata](#)
- The group excludes all vertebrates with jaws, known as [gnathostomes](#).
- The oldest fossil agnathans appeared in the [Cambrian](#), and two groups still survive today: the [lampreys and the hagfish](#), with about 100 [species](#) in total
- In addition to the absence of jaws, modern agnathans are characterised by absence of paired [fins](#); the presence of a [notochord](#) both in larvae and adults; and seven or more paired [gill](#) pouches
- All living and most extinct Agnatha do not have an identifiable [stomach](#) or any [appendages](#)
- Fertilization and development are both external. There is no parental care in the Agnatha class. The Agnatha are [ectothermic](#) or cold blooded, with a [cartilaginous skeleton](#), and the [heart](#) contains 2 chambers

### **Alternation of generations**

- Describes the life cycle of plants, fungi and protists
- A multicellular diploid phase alternates with a multicellular haploid phase.
- A more understandable name would be "alternation of phases of a single generation" because we usually consider a generation of a species to encompass one complete life cycle

- The life cycle of organisms with "alternation of generations" is characterized by each phase consisting of one of two distinct organisms: a gametophyte (thallus (tissue) or plant), which is genetically haploid, and a sporophyte (thallus or plant), which is genetically diploid
- A haploid plant of the gametophyte generation produces gametes by mitosis
- Two gametes (originating from different organisms of the same species or from the same organism) combine to produce a zygote, which develops into a diploid plant of the sporophyte generation. T
- his sporophyte produces spores by meiosis, which germinate and develop into a gametophyte of the next generation.
- This cycle, from gametophyte to gametophyte, is the way in which all land plants and many algae undergo sexual reproduction.

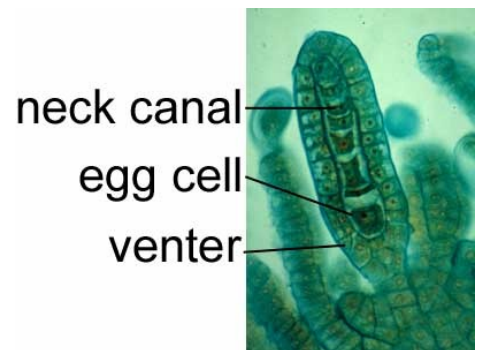
### Antheridia

- A [haploid](#) structure or organ producing and containing male [gametes](#) (called *antherozoids* or *sperm*)
- It is present in the [gametophyte](#) phase of [lower plants](#) like [mosses](#) and [ferns](#), and also in the primitive vascular [psilotophytes](#).
- Many [algae](#) and some [fungi](#), for example [ascomycetes](#) and [water moulds](#), also have antheridia during their [reproductive](#) stages.
- An antheridium typically consists of sterile [cells](#) and spermatogenous [tissue](#)
- The sterile cells may form a central support structure or surround the spermatogenous tissue as a protective jacket.
- The spermatogenous cells give rise to [spermatids](#) via mitotic [cell division](#).
- The female counterpart to the antheridium is the [archegonium](#) (producing and containing the [ovum](#) or female [gamete](#))



### Archegonia

- Multicellular structure or organ of the [gametophyte](#) phase of certain [plants](#), producing and containing the [ovum](#) or female [gamete](#)
- Has a long neck and a swollen base
- Typically located on the surface of the plant [thallus](#), although in the [hornworts](#) they are embedded
- In the [moss \*Physcomitrella patens\*](#), archegonia are not embedded but are located on top of the leafy [gametophore](#)
- Example: [Gymnosperms](#) have their archegonium formed after [pollination](#) inside female [pine cones](#) (megastrobili)



## Arthropoda

- An [invertebrate animal](#) having an [exoskeleton](#) (external [skeleton](#)), a segmented body, and jointed [appendages](#)
- Members of the [phylum](#) Arthropoda (from [Greek](#) [ἄρθρον](#) *arthron*, "[joint](#)", and [πόδος](#) *podos* "[foot](#)", which together mean "jointed feet")
- Include the [insects](#), [arachnids](#), [crustaceans](#), and others
- Arthropods are characterized by their jointed limbs and [cuticles](#), which are mainly made of [α-chitin](#); the cuticles of crustaceans are also [bio mineralized](#) with [calcium carbonate](#)
- arthropods replace it periodically by [molting](#).
- The arthropod [body plan](#) consists of repeated [segments](#), each with a pair of [appendages](#)- so versatile that they have been compared to [Swiss Army knives](#)
- have over a million described species, making up more than 80% of all described living animal species
- Have [open circulatory systems](#)
- Internal organs of arthropods are generally built of repeated segments
- Their [nervous system](#) is "ladder-like", with paired [ventral nerve cords](#) running through all segments and forming paired [ganglia](#) in each segment
- Their heads are formed by fusion of varying numbers of segments, and their [brains](#) are formed by fusion of the ganglia of these segments and encircle the [esophagus](#).
- The versatility of the arthropod modular body plan has made it difficult for [zoologists](#) and [paleontologists](#) to classify them and work out their evolutionary ancestry, which dates back to the [Cambrian](#) period. From the late 1950s to late 1970s, it was thought that arthropods were [polyphyletic](#), that is, there was no single arthropod ancestor.
- Although arthropods contribute to human food supply both directly as food and more importantly as [pollinators](#) of crops, they also spread some of the most severe diseases and do considerable damage to [livestock](#) and crops



\*Overwhelming info... read textbook for more condensed information)

## Bony fish

- The bony fish (*Osteon* = "bone"; "*ichthys*" = "fish") are the most diverse and numerous of all vertebrates
- Bony fish (Class Osteichthyes) are first seen in fossils from the Devonian (about 395 million years before present)

- Differ from most of the cartilaginous fishes in having a terminal mouth and a flap (operculum) covering the gills.
- In addition, most have a swim bladder, which is ordinarily used to adjust their buoyancy, although among the air-breathing fishes it is attached to the pharynx and serves as a simple lung
- The skin has many mucus glands and is usually adorned with dermal scales
- Their jaws are well developed, articulated with the skull, and armed with teeth
- Although the skeleton of most is bone, that of sturgeons and a few others is largely made of cartilage. They have a two-chambered heart built on the same plan as the Chondrichthyes (two-chambered with a conus arteriosus and a sinus venosus)
  - The sexes are separate, most are oviparous, and fertilization is usually external

\*Example: Atlantic Herring

### **Cartilaginous fish**

- Cartilaginous fish such as sharks, skates, and rays are vertebrates whose internal skeleton is made entirely of cartilage and contains no ossified bone
- Cartilaginous fish are also known as Chondrichthyes and have one or two dorsal fins, a caudal fin, an anal fin, and ventral fins which are supported by girdles of the internal skeleton
- Cartilaginous fish are divided into two subclasses on the basis of gill slits and other characteristics
- The first is the Elasmobranchs, which have at least five gill slits and gills on each side, one spiracle behind each eye, dermal teeth on the upper body surface, a tooth jaw, and an upper jaw not firmly attached to the skull (Selachii), rays, and skates (Rajiformes) belong to this group II
- Sharks

- Cartilaginous fish do not have swim [bladders](#), so a swimming motion must be maintained continuously, even when sleeping, or they will sink to the bottom. The caudal fin of the shark provides the propellant force in swimming, the dorsal fin provides balance, and the pectoral fins are used for upward force and depth rudders.
- The flattened body and the rear spine of the rays make their swimming motion unique and completely different than that of sharks. The large flattened body of the rays has become fused with the pectoral fins, which produces vertical waves from front to rear, similar to that of a bird in flight.
- The chimeras utilize their pectoral fins when swimming, beating these fins simultaneously for propulsion, or alternately, to change direction. This method is highly effective for this group of cartilaginous fish, but is seen most often in bony fish.
- The pectoral fins in the male cartilaginous fish are also used for mating. The rear part of the pectoral fin is modified as a copulatory organ. All cartilaginous fish have internal fertilization. Some species are oviparous, or egglayers, and some are ovoviviparous, hatching the eggs within the female and giving birth to live young.
- Cartilaginous fish are predatory, meaning that they feed on other animals, from zoo plankton to shellfish to [whales](#)
- Cartilaginous fish themselves are sought after by humans as a food source

### Chondrichthyes

- Sharks, skates, rays, and even stranger fish make up the Chondrichthyes, or "cartilaginous fish."
- First appearing on Earth almost 450 million years ago
- Members of the Chondrichthyes all lack [true bone](#) and have a skeleton made of cartilage (the flexible material you can feel in your nose and ears)
- Only their teeth, and sometimes their vertebrae, are calcified; this calcified cartilage has a different structure from that of true bone

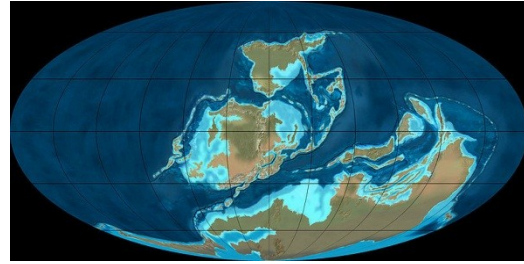
### Crustacean

- form a very large group of [arthropods](#), which includes such familiar animals as [crabs](#), [lobsters](#), [crayfish](#), [shrimp](#), [krill](#) and [barnacles](#).
- Like other [arthropods](#), crustaceans have an [exoskeleton](#), which they [moult](#) to grow
- They are distinguished from other groups of arthropods, such as [insects](#), [myriapods](#) and [chelicerates](#) by the possession of [biramous](#) (two-parted) limbs, and by the [nauplius](#) form of the [larvae](#)
- Most crustaceans are free-living [aquatic animals](#), but some are [terrestrial](#) (e.g. [woodlice](#)), some are [parasitic](#) (e.g. [fish lice](#), [tongue worms](#)) and some are [sessile](#) (e.g. [barnacles](#))
- The group has an extensive [fossil record](#), reaching back to the [Cambrian](#), and includes [living fossils](#) such as [Triops cancriformis](#), which has existed apparently unchanged since the [Triassic](#) period.
- More than 10 million tons of crustaceans are produced by fishery or farming for human consumption, the majority of it being [shrimps](#) and [prawns](#).
- [Krill](#) and [copepods](#) are not as widely fished, but are the animals with the greatest [biomass](#) on the planet, and form a vital part of the food chain

### Devonian period

417 - 354 Ma

- A geologic period and system of the Paleozoic Era spanning from 416 to 359.2 million years ago
- Pectoral and pelvic fins of [lobe-finned fish](#) evolved into [legs<sup>\[6\]</sup>](#) as they started to walk on [land](#) as [tetrapods](#) around 397 [Ma](#).<sup>[7]</sup> Various terrestrial [arthropods](#) also became well-established.
- The first [seed-bearing plants](#) spread across dry land, forming huge [forests](#)
- In the [oceans](#), primitive [sharks](#) became more numerous than in the [Silurian](#) and the [late Ordovician](#), and the first [ray finned](#) and [lobe-finned bony fish](#) evolved.
- The first [ammonite mollusks](#) appeared, and [trilobites](#), the mollusc-like [brachiopods](#), as well as great [coral reefs](#) were still common.
- The [Late Devonian extinction](#) severely affected marine life.
- The [paleogeography](#) was dominated by the [supercontinent](#) of [Gondwana](#) to the south, the [continent](#) of [Siberia](#) to the north, and the early formation of the small supercontinent of [Euramerica](#) in between.



Some highlights

- 400 Ma - Oxygen nears present day levels
- 375 Ma - Land vertebrates
- 364 Ma - Late Devonian extinction
- 360 Ma - Seed plants

### External fertilization

- Form of [fertilization](#) in which a [sperm cell](#) is united with an [egg cell](#) external to the bodies of the reproducing individuals
- In [sexual reproduction](#), there must be some way of getting the sperm to the egg. Since sperm are designed to be mobile in a watery environment (they have tails and are streamlined), aquatic animals can make use of the water in which they live.
- Many plants make use of external fertilization, especially ones without bright flowers or other means of attracting animals.
- In many fish species, including [salmon](#), the female will deposit unfertilized eggs in the substrate and the male will swim by and fertilize them.
- External fertilization uses or needs thousands of sperm cells

Gametangia:

- A cell or organ in which gametes are produced
- Found in most multicellular protists, fungi, algae and the gametophytes of plants.
- A haploid structure in which the formation of gametes does not involve gametes
- Female gametangia are most often called archegonia and produce the egg
- Male gametangia are called antheridia and produce sperm cells

Gametophyte:

- An individual of the haploid generation produced when a spore germinates and grows directly by mitotic divisions in organisms that undergo alternation of generations
- The phase in the plant life cycle that bears gametes
- Each of its cells contains one set of chromosomes
- The fusion of male and female gametophytes results in the formation of zygote which produces a sporophyte

#### Gastropod:

- A member of the largest class of phylum mollusca
- Characteristics are; a foot which the body sits on, a well developed head, a one piece shell and body torsion
- Examples are snails, sea slugs

#### Gemma and gemma cups:

- Small cell masses that forms in cuplike growths on a thallus
- Develops into a new organism (a leaf bud)
- A means of asexual propagation in plants
- Commonly found in fungi and mosses
- Gemmae are dispersed from gemma cups during rainfall.

#### Gill arches:

- One of the series of curved supporting features between the slits in the pharynx of a chordate
- These arches support the gills on fish
- Each arch has a cartilaginous stick, a muscle component an artery and a cranial nerve

#### Gill slits:

- One of the openings in the pharynx of a chordate through which water passes out of the pharynx
- Characteristic of cartilaginous fish (sharks, rays)
- Anterior edge is motile, letting water out and closing to prevent reverse flow

#### Gnathostomes:

- Group of vertebrates with movable jaws
- Have an advantage of catching prey more easily
- Broken into 3 groupings (Chondrichthyes: cartilaginous fish, Placodermi:an extinct armoured fish, Teleostomi: mammals, bony fish, birds, reptiles, amphibians)
- Believed the jaw evolved from anterior gill arches

### Jaw:

- An opposable articulated structure at the entrance of the mouth
- Derived from the embryonic pharyngeal (and in some case gill) arches.
- Evolved as a means of catching prey and holding on to it

### Lignin:

- A tough inert polymer that strengthens the secondary walls of various plant cells, comprised most of the first plants
- Protected plants against degradation by microorganisms
- Played a crucial role in developing the plant vascular system

### Mesozoic:

- One of three geologic eras in the Phanerozoic eon
- The time in which reptiles prevailed in vast number and size
- The period of time where the continents rifted into basically their present states
- Contained the KT extinction, one of the major extinctions, where the dinosaurs and other large reptiles became extinct

### Neutral buoyancy:

- A condition in which a physical body's mass equals the mass it displaces in a surrounding medium
- Fish obtain natural buoyancy using a swim bladder, by controlling the amount of water and air in the swim bladder
- This is achieved by having a average density that is lower then the surrounding water, with the density of the fish being counteracted by the density of the air in the bladder

### Opercular gill:

- A lid or flap of bone serving as the gill cover in some fishes
- Found in bony fish
- Vital in obtaining oxygen; as the fishes mouth closes they open, water then flows through the gills allowing some oxygen to be absorbed

### Ostracoderm:

- One of an assortment of extinct jawless fishes that were covered in bony armour
- Found in the ordivician and Devonian periods
- Have separate pharyngeal gill arches that were always open with no opercular gill

- Used their muscular pharynx to create a suction and pull small prey into their mouth

#### Pectoral fin:

- Located on each side of the fish behind the opercular gill
- Homologous to the forelimbs of tetrapods
- In many fish the fins aiding in walking (ex mudskipper)
- It is also highly developed in some fish (sharks) as a dynamic lifting force in maintaining depth

#### Pectoral girdle:

- A bony or cartilaginous structure in vertebrates that supports and is attached to the forelimbs
- Many similarities with the pelvic girdle
- In humans it consists of the clavicle and scapula

#### Pelvic fin:

- Located ventrally below the pectoral fins
- Homologous to the hindlimbs of tetrapods
- Assists the fish in going up or down through the water, turning sharply or stopping

#### Pelvic girdle:

- A bony or cartilaginous structure in vertebrates that supports and is attached to the hindlimbs
- First developed in amphibians, so that the legs faced outwards from the body
- Later perfected so that a bodies weight would be directly over the legs

#### Placoderm:

- A class of extinct, armoured prehistoric fish which lived from the late Silurian into the Devonian period
- Head and thorax were covered by armoured plates, with the rest of the body naked or scaled
- One of the first jawed fish

#### Placoid scale:

- Scales found on cartilaginous fish
- Also called denticles
- Similar in structure to a tooth

#### Primary plant cell wall:

- The initial cell wall laid down by a plant cell
- A thin, flexible and extensible layer formed when the cell is growing
- Composed of cellulose and pectin

Rhizoids:

- A modify hypha that anchors a fungus to its substrate and absorbs moisture
- A noncellular thread like extension of some plants which have evolved for absorption and conservation of water during the evolution of plants to land habitats
- Characteristic feature of bryophytes

Secondary plant cell wall:

- A layer added to the cell wall of plants that is more rigid and may become many layers thicker than the primary cell wall
- Strengthens and waterproofs the wall
- Composed mostly of lignin

Silurian period:

- A geological period which extends from the end of the Ordovician to the beginning of the Devonian
- Set at a major extinction event in which 60% of marine life was wiped out
- Continents represented in one land mass (Gwandana) during this time
- Relatively stable and warm temperatures
- First bony fish appear
- First fossil records of vascular plants

Sporangia:

- A single celled or multicellular structure in plants and fungi in which spores are produced
- Ex sporophyte ferns
- Consists of microsporangia (male structures) and megasporangia (female structures)

Spores:

- A haploid reproductive structure (usually a single cell and haploid) that can develop into a new individual without fusing with another cell
- Found in plants, fungi and certain protists
- Adapted for dispersal and survive long periods of time
- Unit of asexual reproduction

Sporophyte:

- An individual of the diploid generation produced through fertilization in organisms that undergo alternation of generations
- Produces haploid spores through meiosis
- The fusion of male and female gametes results in a diploid zygote, which develops into a new sporophyte

#### Stomata:

- A tiny pore in a plant leaf surrounded by a pair of guard cells that regulate its opening and closure and serves as a point for gas exchange
- Present in the sporophyte generation of all land plants
- Water vapour exits the plant through the stomata

#### Swim bladder:

- A gas filled internal organ that helps fish maintain buoyancy
- Also a stabilizing agent as it balances out the fishes body
- Originated in the same way as lungs

#### Tetrapod:

- A monophyletic lineage of vertebrates that includes animals with four feet, legs or leglike appendages
- Includes amphibians, reptiles, birds, mammals, and even snakes and other limbless reptiles by descent
- Earliest tetrapods evolved from lobe finned fishes in the Devonian

#### Thallus:

- A plant body not differentiated into stems, roots or leaves
- Ex the gametophytes of liverworts
- Have analogous structures that resemble those of vascular plants (ex thallus of a fungus is called a mycelium)

#### Tracheids:

- A conducting cell of xylem, usually elongated and tapered
- Functions primarily in the conduction of water and mineral salts collected by the roots to other parts of the plants.
- Also provides structural support to plants