Animals

Animal knowledge

Animals' reproduction

Most of animals, even the simplest ones, have a sexed reproduction, which allows to increase the genetic variability of individuals and organisms' diversity. Their internal organs, which are different in males and females, are called gonads and specifically produce **gametes** (sexed cells: sperms and egg-cells). They are bound to join and form a single cell called **zygote** or fertilized egg, from which the embryo, that is the new organism, will develop.
Some animals, even invertebrates, are **hermaphrodites**, as they are able to produce both sperms and egg-cells. The chance to be able to behave as male and female individuals is an advantage for animals like earthworms, snails and slugs, very slow animals that in this way double their possibility to meet a mate. In this case both individuals will be able to produce new offspring. **Where does fertilization occur?**
Animals that live in a **water habitat** release a high number of gametes into the water, where they will meet to form the zygote. This is called **external fecundation.** Those organisms that live on the land had to solve a serious problem: providing gametes with a liquid environment that allows their survival and fertilization. Some amphibians have adopted a simple solution: male and female exchange particular signs and go back into the water to release the gametes at the same time. Almost all **terrestrial animals** have adopted another solution: the male introduces the sperms into the female body, where the fertilization occurs (**internal fecundation**). This solution is advantageous as it protects the offspring during the first growth stages. The male individuals of insects, vertebrates and many animals that have a specialized organ (sexual organ) to insert the sperms inside the female organ and in particular into a hollow organ (vagina or cloaca). Other organisms have found particular solutions. For example some male arthropoda like mites and scorpions or some male amphibians like tritons build "bags" of sperms (spermatophore) and it's the females who insert them into their own bodies. As for some spiders and squid, the male collects the bag he has formed and, by helping himself with his forelegs and tentacles, he inserts them into the female body. **Embryo protection/ The care for the new individual during his growth**
From the zygote, the cell that forms after the insemination, the embryo develops, that is the new organism that at the beginning needs to be protected. In particular the embryo will have to be fed, oxygen will be needed for its breathing, and carbon dioxide will have to be kept away. Animals have solved this problem in two ways:
• Insects, reptiles, birds and mammals monotremata like echidna (**oviparous animals**) lay the eggs in the same environment as they live. The embryo grows inside the egg that contains all the nutritional substances it needs. The eggshell protect it from dehydration, but allows oxygen to enter and prevents carbon dioxide from disperse outside. Some parents, however, take care of the eggs by building a nest and hatching them. Once the new organism has developed and gets free from the egg protection, he will need more care.
• Mammals are **viviparous animals** since the females keep the embryo inside their body until a determined stage in its development. Marsupialia (kangaroo and opossum) deliver the babies when they have not completely developed yet. Then they are kept inside a special pouch until the growth has been completed. Mammals other than marsupialia and monotremata are called **placentalia**, as they can count on a structure (placenta) that allows the embryo to grow completely inside the female body, guaranteeing an efficient supply of nutrients.

Classifying animals

In view of the close relationship between man and nature, since the antiquity people have been trying to know more about the living creatures and to class them. In the IV century b.C., Aristotle, the great Greek philosopher and scientist, began to class the known animals according to their physical features. Obviously, at that time very little was known on the internal anatomy of animals and such classification was therefore mainly based on the observation of their external

features and was therefore rather approximate. The modern classification was developed by the Swedish scientist Linnaeus, who in the XVIII century introduced the concept of SPECIES (“group of individuals having the same characteristics and that, by mating, give birth to a fertile offspring, i.e. that can reproduce in its turn”). In addition, Linnaeus gave to each species two Latin names, the first indicating the genus, written with a capital initial, the second one indicating the species, written instead with a small initial, both in italic.
Very similar species are grouped into GENERA and likewise similar genera are grouped into the wider set of the FAMILY; families in their turn are grouped into ORDERS, orders into CLASSES, classes into TYPES or Phyla and finally types into KNGDOMS. There are five kingdoms: ANIMAL, VEGETAL, FUNGI, PROTISTA, MONERA.

Let’s classify the dog

To be clearer, let’s make an example: let’s take the dog and let’s class it like this. It belongs to the Animal kingdom and, since it owns a spine, it belongs to the type Chordata and subtype Vertebrates. Vertebrates in their turn are divided into five classes: Mammals, Birds, Reptiles, Amphibia and Fish. Dog is a Mammal, since its female breast-feeds its offspring; it belongs to the order Carnivores (the other orders being: Insectivores, Rodents, Cetaceans, Marsupials, etc.) and to the family Canidae. Some Canidae look very much like "man's best friend": for instance, the wolf, the fox and the jackal. All these are grouped into the genus *Canis* and distinguish themselves by the name of their species; in the case of the domestic dog, the name of the species is *Canis familiaris*.

How many animals?

The animal kingdom is characterized by the exceptional range of organisms that belong to it. In fact, there are at least 30 million species. You can have an idea of this variety of species by having a look at the different Phyla animals are grouped in.
Among the animals that live in water habitats there are: **Porifera**, that is sponges, **Cnidaria** like jellyfish, corals, sea anemones, and hydra. In particular, polyps are able to build limestone support structures that form coral reefs.
Platyhelminthes are flat worms, often hermaphrodites and parasites of the intestine such as the taenia, characterized by a structure of hooks and suckers that hang on the intestine walls in the host organism. Cylinder-shape worms are called **nematoda**; anellida are earthworms and leeches (important decomposers and parasites).
Molluscs are animals with a soft body because they do not have an internal skeleton, but they simply have an external calcareous skeleton. Some of them are covered in a shell, others in two shells, like clams and mussels. Gastropoda are the most numerous molluscs. They can be aquatic (limpets) or terrestrial (snails and slugs). Cattlefish and octopuses are cephalopoda (sea organisms without shell).
The group of **Arthropoda** is the most numerous: more than a million terrestrial, aquatic and aerial species belong to it. They are characterized by an external skeleton made up of chitin and proteins, and a body that is subdivided into: head, thorax, abdomen, appendixes similar to “legs”. Moreover their respiratory and nervous systems are well developed.
Some examples are: myriapoda like millipede and centipede (terrestrial animals that eat insects by killing them with the poisonous pliers they have on their head); crustacea like crayfish, lobsters and crabs; arachnida like spiders, scorpions, ticks and mites; insects such as bees, butterflies, ants, etc.
Sea organisms like sea urchin, starfish, and holothurians (or sea cucumbers) all belong to **Echinodermata** phylum.
Finally there are the **Chordata**, the ones without spine and those with spine (vertebrates like fish, amphibians, reptiles, birds and mammals).

Arthropoda

The group of Arthopoda are the most numerous animals on Earth: until today more than a million species of insects and other arthropoda have been classified, while the number of living insects today can reach a billion of billions. Arthropoda can be found in all habitats, and it was calculated that in a mild region there can be 20 million arthropoda distributed in the biosphere.

Insects

The word "insect" comes from the Latin insectum, which means "cut"; the body of these invertebrates is actually divided

into segments that are neatly separated from each other. The class Insects is composed of approximately 1,000,000 species, divided into 28 orders, including: Lepidoptera (for instance the butterfly and the moth; Coleoptera (such as the ladybird), Diptera (such as the fly), Hymenoptera (such as the bee, the asp and the ant), Orthoptera (such as the grasshopper). They are also called "Hexapoda" which in Greek means "six feet", since all Insects have six limbs.
They have an external skeleton called "exoskeleton": as it grows, the insect peels off its old external coating while a new one is ready underneath. Generally, the males and females of one species are very different from each other in both size and shape (sexual dimorphism). Fertilisation is internal and the females produce eggs from which larvae will be borne. For some species, there is the metamorphosis: the larva pupates inside the cocoon, which it will leave when completely mature.

Animals with spine

The numerous invertebrates' phyla are characterized by a wide range of shapes and way of living. All the vertebrates (Vertebrata), instead, have a similar body. Despite their limited differences and the modifications in time, the vertebrates have conquered on just emerged lands, but also the sky. Vertebrates include some of the biggest organisms that have ever lived on Earth and our species also belongs to them
The vertebrates are characterized by a **spine**, or backbone, consisting of vertebra that surround the nerve cord. Between the vertebra are the cartilage disks, that make the spine a flexible bone structure. Connected to the vertebra are the muscles that allow the movement of the different parts of the spine. These animals have a bone internal skeleton, mainly made up of living material that grows with the animal until it reaches its definitive dimensions.

Fish

Fish have been the first vertebrates to have appeared on the Earth. Their appearances can be the most diverse, depending on how they have adapted to the environments in which they live. A typical organ of most, but not all, fish is the air bladder, which is filled with gas and allows therefore the fish to change its specific gravity (i.e. the body weight/volume ratio) to swim up and down without moving its fins. Fish produce a huge number of eggs, since they have to go through many dangers and few can survive: cods lay up to six million eggs at a time. Fertilization is mostly external: the female lays its eggs and the male fertilizes them by coating them with its sperms. In this case, the fish are called "oviparous", which means the embryo develops inside the egg after having been laid by the female. If instead the eggs are held inside the female's body until the hatching, the fish are called "ovoviviparous".

Amphibians

The word "amphibian" comes from the Greek and means "double life", since these animals live partly in water and partly on land. Before becoming adults, they undergo changes that completely transform their appearance. From the eggs wriggle out the young animals, called tadpoles and looking like small fish: later on, the tadpole from a larva becomes a fully formed adult. During the metamorphosis, the tadpole begins to grow legs and its gills become smaller and smaller until they disappear: they are replaced by lungs, that are necessary to breath air. Finally, the tail is completely swallowed up into the body.

Reptiles

The word "reptile" comes from the Latin *reptilis*, which means "creeping". Actually, the animals that best represent the entire class are snakes, but Reptiles also include such quadrupeds as tortoises and crocodiles. Reptiles look quite like Amphibians, but have something more: they can also live in dry areas, far from water. They have lungs to breathe and are commonly called "cold-blood vertebrates"; in fact the temperature of their blood depends on that of the environment, and is slightly higher than that, so it would be more correct to call them heterothermal animals, i.e. "whose body temperature varies". Their body is coated in scales and they reproduce by laying eggs. Reptile reproduction is sexed, with internal fertilization; their eggs, protected by a waterproof shell, are always laid on land (sometimes the eggs develop inside the oviduct).

Birds

Birds are perfectly formed for flying; their skeleton is actually very light because their bones are pneumatized, i.e. contain

air. The upper limbs of Birds are wings, while their lower limbs are retractile; their body is coated in feathers and plumage, that offer excellent protection with minimum weight. They also have an exceptional prehensile organ: the beak, whose proper name is "rhamphotheca" and consists of two corneal cases. The class Birds is composed of approximately 9,000 species that are very different from each other in both their physical appearance and living habits: some live in water, where they find plenty of food, while others, instead of using their wings, climb trees with their claws and beak, others can no longer fly. Obviously, each species has all it needs to live in its surroundings: webbed feet to swim, strong feet to run and scratch about, claws to grasp their preys. Fertilization is external and the female lays its eggs on the ground, coated in a protective shell.

Mammals

Mammals are homoeothermic animals, i.e. they maintain a body temperature of around 37°C. The name "mammal" (which literally means "that bears mammary glands") refers to one of their distinguishing features, i.e. for some time they feed their offspring with the milk secreted by their mammary glands. Their body is covered in hair, which are reduced or missing in those species that have adapted to living in water (Cetaceans, such as dolphins and whales) or that have scales (such as armadillos and pangolins). Apart from Cetaceans (such as dolphins and whales), Sirenians (such as dugongs) and Pinnipedia (such as seals and sea lions;), whose limbs have turned into flippers, all Mammals have four limbs and are therefore called quadrupeds. Quadruped Mammals are divided into Plantigrades (such as bears), Digitigrades (for instance dogs and cats) and Unguligrades (such as horses), depending if they walk by resting all the sole, fingers only, or the last phalanxes on the ground. Mammals can be divided into three groups depending on their offspring: Monotremata, Marsupials and Placentalia. Monotremata are oviparous, their females lay eggs and their offspring develop inside them, such as the platypus and the echidna. Marsupials are viviparous, which means their offspring are incomplete at birth and complete their growth inside their mother's marsupium, a pouch located in the abdomen, where the new-born animals move (for instance the kangaroo and the opossum). The offspring of the Placentalia develop, instead, inside their mother's uterus and are very well developed at birth.

Natural selection and evolution

The Earth has a long history and all organisms, man included, originated during history and came after other forms of life. As a consequence, all species derive from other species, and all living beings have a common ancestor in the past. This was all possible because in time a series of changes occurred having an influence on species: this is **evolution**.

Lamarck and Darwin

Jean-Baptiste Lamarck, a French scientist (1744-1829) thought that the environment is the cause of evolution as it forces animals to use some parts of their body instead of others. With time passing, those parts of the body that are not used tend to disappear, while the most used ones develop more.

The English naturalist Charles Darwin (1809-1882) defined the natural selection process by stating that the interaction between individuals and the environment generate two different situations: some animals do not manage to survive while others survive and reproce themselves, transmitting to their offspring the variations that allow them to survive in that specific environment. This variability of individuals can be inherited and is expressed genetically.

Genetical variability is the basis for evolutionary changes, and almost all species show to change genetically, if they are assessed in time in the same place, but also if different placet are compared.

To understand it better

According to Lamarck, giraffes gradually stretch their neck to eat the leaves from the trees and transmit this modification from one generation to another. According to Darwin, inside a group of giraffes with a short neck one was born with a long neck. This long-neck giraffe was facilitated in reaching the leaves and therefore could eat better. As a consequence, that giraffe became stronger and more robust than the others. That different giraffe had been subject to a mutation of the gene that determines the neck characteristics. Since it was an advantageous characteristic, in time it spread to the whole species. This was possible because the children inherit the characteristics of their parents.

Animals' behaviour

All organisms provide themselves with food and water, often they manage to avoid being eaten by other organisms, they reproduce themselves (they follow courtship and mating rituals) and finally they take care of their offspring. All these activities are very important for animals' survival and for species success.
Behaviour characteristics are subject to evolution: normally the behaviour varies among single individuals, and behaviours are more advantageous than others. Some variations are determined by genes, and the most successful ones will be predominant.

A well-organized society for bees

Bees live in societies made up of thousands of individuals who have a "queen", the only bee capable of laying eggs (up to 50,000 in one year). The queen can live for up to five years, while the other "worker" bees live for only a bit more than a month. When the community becomes too numerous, the queen bee and some worker bees leave their beehive and build a new one. The abandoned beehive keeps functioning with the bees that have remained in there and a new queen. The worker bees have the task to transport honey and pollen from the reserve cells to the larva, produce wax to build the beehive and look for nectar and pollen.

Mole rats' society

Mole rats are the only vertebrates with a social system that is similar to the insects'. They live in Kenya, Ethiopia and Somalia. In each colony only one dominant female (queen rat) and one or few males reproduce. The others deal with food collection and tunnel maintenance.

Power hierarchies among wolves

Within wolf packs there is a power hierarchy that is valid both for males and females. Subordinate wolves pay their respect to the dominant individuals (the only ones that reproduce) through some typical behaviours. The rest of the pack takes care of the babies, of the lair and provide with the food.

Defence of the territory

Many invertebrates keep close to their birthplace and occupy a well-defined area, of varying shape and size. Male antelope stays in the middle of his territory, which is a circle of 15 metres of diameter and is surrounded by similar territories, defended by other males. The females expresses her preference for a male by entering inside his territory. The fiddler crab has a big chela by which he makes particular sounds that attract females and keeps other males away. Howler monkeys define their territory by screaming. Also fish living between rocks are used to defending their territory.

The distribution of animals

Scientists are convinced that life came from the sea and from there the living organisms conquered, through the necessary evolutionary stages, both the Earth and the internal freshwaters. These steps, moving from the sea to the other environments, occurred in very ancient times, when the living forms were poorly developed and poorly specialised. Later on, the living beings, even though spreading all around, found impassable boundaries that confined them to certain regions. These boundaries were mountain ridges, deserts, seas, rivers, temperatures, available water, the presence of oxygen in the water, geological events (continental drift, rising of the sea).
Animals can be divided on the basis of an ecological criterion (i.e. in relation to the environments in which they live) into marine, freshwater and terrestrial organisms. In between the first two there should be the organisms that live in brackish waters, waters of passage between salty waters and freshwaters. A separate category of terrestrial animals are those that live in tunnels, caves and in the cracks of the ground, animals that altogether compose the "hypogean fauna".

Fauna in the marine environment

Temperatures at sea are less variable than those on land. The daily and seasonal temperature ranges (differences between the minimum and maximum temperatures reached) are actually shorter there. Salinity, even if very different in different seas, does not normally change too much in one sea. This is why marine organisms, especially those of deeper

and offshore waters, did not have to adapt to sudden changes in temperature and salinity, and generally do not tolerate dramatic changes in these two factors. Animals that live in the sea can be divided into:

- **benthos**: organisms that live on the bottom, can be stationary (such as corals and sponges) or move (such as worms, some types of fish, many molluscs, etc.);
- **plankton**: it is an extremely important water biocenosis. Biocenosis is the whole of the populations of animal and vegetal species that live together in space and time, in a mutual relationship. Plankton is composed of animals (zooplankton) and plants (phytoplankton) that live suspended in the mass of water and are carried by the sea currents.
  These organisms are small in size, some of them are part of the plankton only when they are larvae (for instance larvae of molluscs, Anellida, etc.), then, when adult, they live on the bottom and become part of the benthos. Plankton is eaten by some organisms that are at the higher levels of the ecological pyramid, such as fish. Plankton is however an extremely delicate biocenosis, which is directly related to the chemical and physical conditions of the water: small changes in these conditions can therefore affect its development, by dramatically disrupting the balance of the entire food chain.
- **nekton**: this biocenosis includes all the animals that can move smoothly enough to overcome currents and actively swim in water (nekton actually means "to swim"). The most common animals that belong to it are, among vertebrates, many types of fish, reptiles (tortoises and water snakes), sea mammals (whales, dolphins, sperm whales, etc.). They are generally predators, i.e. consumers placed at the end of the food chain, at the top of the ecological pyramid.

Fauna in the brackish environment

The areas where river waters flow into the sea are the environment of passage from freshwater to salty water, an environment that, due to sudden daily and seasonal changes in salinity and temperature, can only be inhabited by organisms that are specialised enough to tolerate such peculiar conditions. Because of such a difficult environment, the fauna and flora of brackish waters include quite few species. These few species are however plentiful because of the huge amount of nutrients coming from the rivers. In addition, such migrant species as eels and salmon can easily penetrate through the river mouths.

Hypogean fauna

Caves and tunnels are inhabited by very specialised organisms that, over the centuries, have developed characters that make them particularly suitable for this environment. Most of these animals are invertebrate: anellida, molluscs, insects, crustaceans and arachnida, sometimes also amphibians, reptiles and some species of blind fish. These creatures have no eyes or breathing apparatuses. They breathe straight through the pores that compose the tissue that coats their body. To "observe" the surrounding word, they have very sensitive relation organs all over their bodies. The hypogean environment is saturated with humidity and has a constant temperature. The animals that live there are used to consuming as little energy as possible. This is why their reproductive cycle is much slower than that of the other animals: for instance, they lay few, but very large, eggs.

In the fresh water environment

Freshwaters offer an infinite range of chemical and physical conditions (temperature, depth, pH, etc.). In addition, the biocenoses that live in stagnant waters (swamps, ponds, lakes) are completely different from those of running waters (rivers, torrents). Stagnant waters have, like the sea, a benthos, a plankton and a nekton, but with fewer species. Running waters, due to changes in temperature and water movement, do not have a plankton.

In the terrestrial environment

The environment with the most daily and seasonal changes in the factors that affect animal life is the terrestrial one. These factors depend, among other things, on latitude (from the poles to the Equator) and altitude (from the sea level to mountaintops). Temperature is therefore an important limiting factor for life on Earth. The other limiting factor for terrestrial organisms is the availability of atmospheric water, i.e. humidity in the air and soil due to rains. The harder the temperature and water conditions, the fewer the animal species. Terrestrial animals have developed, however, a number of mechanisms to resist sudden changes in temperature, such as hibernation, migration, production of feathers or hairs, fat and many others. The groups of animals that have evolved the most and that have therefore adapted to all the environments of the Earth are Reptiles, Birds and Mammals and Insects. To divide animals by the terrestrial environment in which they live, it is useful to follow the distribution of biomes. A biome is the typical community of one climatic region and is generally classed on the basis of its vegetation. Terrestrial biomes are the tundra, the boreal conifer forest, the temperate forests, the Tropical rainforest, the prairie, the Mediterranean scrub and the desert.

Short history on life on Earth

Life on Earth must have started approximately 4 billion years ago and the oldest fossil remains are those of organisms that lived 1 billion years ago: clearly, then, many years of the history of life on Earth are shrouded in the dark of the past and we only know the most recent part of this history.
This part, whose remains have been preserved and accidentally found in the geological strata, testifies of organisms that were already very complicated and divisible into Phyla. So, an essential part of the history of living beings, the one that concerns their origins and first evolutionary stages, can only be based on assumptions, which are corroborated through experiments. Some scientists have assumed that, when the Earth's crust cooled over 4 billion years ago, some inorganic substances must have synthesised into complex organic molecules. Then, the passage from these complex molecules to the first veritable living beings was slow and difficult. This passage can be assumed to have been as follows:

1) formation of a number of organic molecules organised into colloidal systems (the so-called “coacervates”);
2) some protein complexes might have become able to preserve themselves, multiply, transform themselves and use other organic substances existing in the surrounding environment, getting to form, in the end, the first living beings. These must have been the first primary heterotrophic organisms since they metabolised already organic substances;
3) through accidental chemical changes (mutations), some of these heterotrophic organisms might have become able to perform a rudimental photosynthesis. These organisms must have been autotrophic (able to feed on inorganic substances by themselves), i.e. the direct ancestors of the vegetal organisms that later on would enrich the atmosphere in oxygen;
4) the autotrophic organisms might have evolved into secondary heterotrophic organisms, the ancestors of animals. Or part of the primary heterotrophic organisms might have evolved into animals. Whatever may have happened, the living beings differentiated into vegetal and animal beings, i.e. into producers and consumers of organic substances. Fungi, that are heterotrophic, and degrading organisms (such as bacteria), able to turn dead organic substances into inorganic substances available for other living beings, must also have evolved at some time
5) the development and spreading of vegetal species caused oxygen to build up in the atmosphere; this gas changed the breathing of the primitive organisms. Part of the oxygen collected in the upper atmosphere as ozone. Ultraviolet sunrays were thus filtered out, allowing for the development of some special and delicate organisms which could not otherwise have formed and survived in the presence of large amounts of harmful ultraviolet rays. Then, life would find and go the evolutionary way that let it spread all over the Earth, preserve itself until now and diversify into an indefinite number of animal and vegetal species