# Animals

## Introduction

When we hear someone talking about animals, we immediately think of the animals we know best and that are evolutively nearer to us, like birds and mammals. Actually the larger part of the animal kingdom is made up of invertebrates, animals without a skeleton, that account for 95% of the living species. Jellyfish, corals, worms, arachnids, crustaceans, molluscs, echinoderms and, among the most numerous species, insects, are all very different from one another and they populate all the environments on land and in the seas. These are mainly small sized animals, with the exception of the giant squid that is the largest living invertebrate, whose tentacles grow up to twenty meters long.
Reptiles exist since millions of years, and their ancestors were amphibian, and lived both on land and in the water. Their size, and their structure varies greatly: tortoises, crocodiles, alligators, lizards and snakes are reptiles. From 230 to 65 million years ago, the Earth was dominated by dinosaurs that became extinct at the end of the period. 150 million years ago, birds evolved from the reptiles and they were characterized by their capacity to fly, that enabled them to spread rapidly to all the environments of the planet. Mammals can survive in almost all the environments and can adapt to various climates: to life in the jungle, in the desert, in the polar regions, in the air, in the oceans, underground, on trees, and they move from one environment to another.
In order to live in each environment, mammals have developed different bodies: most of the domestic animals, humans, bats, whales, elephants and beavers, kangaroos, koalas, the duck-billed platypus and bears are mammals!

# 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 place 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

# Man and animals

## Popular culture

As early as 20,000 years ago, some Primitive men portrayed on rocks, in caves and in the open air the main events of hunting, mostly by drawing animals (caves of Altamira, Pesche-Merle, etc.). Many of these drawings have now become important documents on the fauna that lived on Earth at some historical times and therefore on the climate and flora as well. All peoples in all continents have produced animal figures, either painted or sculpted, giving them a fantastic or divine dimension.
The first important civilisations to have settled along rivers (Nile, Tigris, Euphrates) have distinguished themselves for their strong culture based on deities with animal traits. For the Egyptians, Bastet (the Goddess of joy and sunshine and the protector of the pharaoh) was portrayed as a woman with the head of a cat or as a feline, Anubis (protector of mummification and lord of necropolises) was portrayed with the body of a man and the head of a jackal, he accompanied the dead in their journey to the afterlife and headed the tribunal of the afterlife.
Later on, animals have kept going hand in hand with man along the centuries, becoming part of folk cultures in the most bizarre ways. The protagonists of legends, fairy tales and myths are often drakes, talking animals or naughty monsters that have always been talking to man in the simplest and most straightforward way through funny, frightening or educational stories.
Some stories derive from well-founded fears, such as that of the wolf, that was really a serious danger, especially in the Middle Ages, when Europe was still mostly covered in forests and in the winter packs of hungry wolves moved closer to villages or even got inside towns. Man feared these animals, not only because of their potentially deadly attacks, but also

because of rabies, a disease that was transmitted by their bites and that could not be treated at that time. This historical background is also the source of the werewolf, a man who turns into a wolf during full moon nights. In fact lycanthropy refers to a rare genetic disease, porphyria, which causes hypersensitivity to sunrays, the growth of down on the face and limbs, and finally a red-brown colour of the teeth.

## Use or exploitation?

For human beings, fauna has always been an important vital resource. Hunting and fishing were the only means that primitive men had at their disposal to eat and clothe themselves. Then, when men left their nomadic lives to settle permanently in a given area, they began to tame animals. Cattle breeding increased the availability of food, such as meat, milk, eggs, honey; in addition, animals also supplied such raw materials as wool and hides. It should not be forgotten, then, that before the internal combustion engine was discovered the most important source of energy and power were just animals. Animals were used in farming as well as to carry goods and people. With the coming of mechanisation in the late nineteenth century, the old cattle breeding practices used in the country essentially disappeared. The increasing demand for food from a strongly increasing population across the world and the increase and spreading of welfare caused today's farms to become more and more like "factories" in order to increase production and meet the demand. Lately, though, this trend seems to have reversed, since consumers are giving more and more priority to quality over quantity. In many cases, therefore cattle breeding is gong back to more "traditional" methods, more respectful of the animals' needs.

## Experiments on animals

Man uses animals not just to satisfy his primary needs of food and clothing. Many drugs, cosmetics and detergents are usually tested on animals. On the one hand some scientists are sure that they could eliminate most of animal testing without hindering medical progress or the discovery of new treatments against human diseases; on the other hand many researchers think that part of animal testing is vital for biomedical progress.

## Animals out in the space

Scientific research was also greatly improved by the use of animals in astronautics. The very first living beings having been launched into space were mice and midges (fruit flies). These insects were chosen for they reproduce very quickly, and this allowed scientists to see very quickly if the cosmic rays could affect the hereditary characters. Laika, a Russian dog, was the first animal to have been sent into space, in particular into orbit around the Earth, in 1957. The environmental conditions of the Earth had been recreated in the space shuttle in which the dog lived; Laika had learnt how to feed herself from an automatic food dispenser. This proved that a living being could live in space for a long time.

## Animals as a resource

For humans, animals are a productive resource. First of all, they supply a wide variety of foods that man needs to survive: milk, cheese, eggs, butter, salami and cold meat, etc. Some animal species, such as corals and oysters, are used by man to produce jewels and handicrafts. The hide of some animals is used instead to produce clothes. In many places across the world, animals are still one of the main means of transport. For instance, camels are particularly used in such desert areas as the Sahara desert, while in Northern areas sleighs are drawn by huskies, dogs that are very resistant to cold and fatigue .
Every day, animals join man and help him in the most diverse activities. For their innate sensory superiority and their great adaptability to the external climatic conditions, they can carry out tasks that man cannot.

# Protection of biodiversity

## The disappearance of species

An animal species is seriously threatened with extinction when its population is broken up. Extinction is a natural process that may be caused by natural selection, shortage of food or natural calamities. It has been calculated that 9 species out of 10 of those that have appeared on Earth over the centuries have disappeared. Man's action on nature has also caused entire animal species to disappear over the years. Hunting, deforestation, pollution, the conversion of uncultivated areas into pastures, the illicit trade of wild animals as well as climatic changes have made life difficult for many animals. The areas that have been hit hardest by the rise in the Earth's temperature are the Arctic and the oceans. In these places, animals suffer because they have lost their habitat and find it hard to find food to eat. This results in a decrease of births and therefore in the slow disappearance of some species. In the oceans, the reduction of plankton caused many types of fish to migrate and many invertebrate organisms to disappear.

## How animals can be safeguarded

Nevertheless, over the last few years, man has realised that the loss of some animal species can cause extremely serious damages to the natural course of the food chain, so he tried to help the species most at risk. Many animals, such as, for instance, the chamois and the ibex in Italy, have been brought back to their habitat through a "re-colonisation" operation. For instance, green areas have been extended to protect butterflies.
Disappearing animals cannot be hunted or traded. Scientists have thought of meeting the animals' needs by building up some communicating "corridors" within the forests and broken-up natural areas. When a natural area is divided up, corridors are dug out to let the animals move within the last pieces of habitat left. And some animal populations have been found to really move along these corridors and also use them to mate.
Nevertheless, even if some animals have got back on their feet, the survival of many species is still at risk. The attempt to protect species at risk within parks and wildlife sanctuaries is certainly positive.

## Biodiversity

The word "biodiversity" was coined in 1988 by Edward O. Wilson, entomologist, and has become common parlance since the 1992 Earth Summit. Biodiversity means the wealth composed of the whole of the genetic information of the living organisms that live in different climatic regions and habitats. Biodiversity originates from the evolutionary process that generated, through natural selection and over the centuries, all the living animal and vegetal species. Due to the fast and indiscriminate exploitation of natural resources, many living species (both animal and vegetal) have disappeared, while many others are at risk. More and more species are disappearing all over the world, much faster than it takes new species to appear. According to the 1995 Global Biodiversity Assessment (GBA) presented by the United Nations Environment Programme (UNEP), 112 species of mammals disappeared between 1810 and 1995, three times as much as those disappeared between 1600 and 1810. As regards the disappearance of invertebrates, fish and plants, we are talking thousands of species.

# Breeding and environment

## How to breed animals

Have you ever wondered how is produced meat you can find well-packaged and neatly filed on shelves at the supermarket? If we retrace the production process we can discover lots of interesting information on how animals are raised and on the environmental damages resulting from the production of meat, eggs, milk and cheese that we eat every day. In the last decades, a method of breeding which is very far from traditional techniques employed in the past by

mankind has got a foothold at a global scale. It's industrial breeding, an intensive method of production allowing to lower production costs and at the same time increase the quantity of produced meat: basically, this method allows to produce more economically and faster! This allows to sell meat, which has always been a luxury good that few people could afford to eat, at lower prices. We shouldn't be misled, though, the cost of meat, in fact, is low only for consumers but it isn't low for the environment nor for animals that pay a very high price: in breeding farms often the well-being of animals isn't respected and polluting substances for the environment are produced.

## Feeding animals

Feeding animals to feed men is an expensive way to produce food. In the world about ¼ of arable lands are employed to produce fodder, soy and cereals and ¼ of these cereals are employed in industrial breeding farms to feed livestock: it's an expensive energy cost which adds to the economic cost, all the more so since the same lands could be used to produce food that the world's undernourished population needs. It's been estimated, in fact, that if all cereals produced every year were shared among the world population, each person would receive much more food than is necessary for survival: reality, though, is very different, in fact, on one side food consumption in developed countries is sometimes excessive, and on the other side, 2 billion people suffer chronic denutrition and 18 million people die for famine-related diseases. We feed and raise animals to eat them (mainly cattle, sheep, goats, pigs and poultry) as a balanced diet requires a certain amount of proteins and meat is one of its main sources together with other livestock products as milk, cheese and eggs. In developed countries is consumed a lot of meat both because population incomes have increased and allow to buy meat in great quantities and because meat costs less: as it's produced partially or totally with an industrial system this type of food has become a good available for many and isn't anymore a luxury good. In recent years, meat consumption is on the rise also in developing countries: in China, for example, more and more people start to earn enough to buy meat. This means that over time, as consumption increases, more and more lands and water will be required to enhance animal production.

## Producing food

An intensive system of production capable of producing a lot of meat in small time has thus got hold to face growing consumers' demand of meat. Farmers turn a raw material as cereals, available in great amounts at a low price, in meat which we eat. It's an absolutely inefficient system as it uses much to produce little, in fact, about 7 k of cereals and about 15 thousand litres of water are required to produce 1 k of beef meat! Apart from the consequences related to the overexploitation of resources, breeding farms have a substantial impact on the environment also with regards to the waste substances introduced in soil, water and atmosphere. Knowing the mechanisms of the meat production chain is important to discover what lies behind a beef steak, a ham slice or a chicken breast.

## Man and breeding

Today in the world almost two billion people depend on livestock to satisfy their basic daily needs. The connection between man and breeding is longstanding and has always represented a balanced relationship between man, environment and culture: in the past, in fact, cattle, apart from being employed for meat production, played and still plays a series of fundamental functions. Cattle, in fact, satisfies 30% of man's needs in terms of its nutrition – production of meat, milk and derivatives – as well as support to agricultural production as workforce. In the Mediterranean area, for example, donkey is used in agriculture for its work capacity under the typical climate conditions of this area and is still present in countries as Greece, Italy, Spain and Portugal, together with mule to farm the most steep and sloping lands. In the Tropics, instead, bovines contribute to the ploughing of about 60% of crops. Breeding farms, moreover, supply with

their manure useful substances for soil fertilizing and in some countries manure is also used as domestic combustible. We shouldn't forget even the economic relevance of cattle production that is a source of income both for rural and urban populations.

## Ancient balances

The relation between production and consumption of products of animal origin has changed over time. Historically, transport and communication were limited in comparison to the current globalization context and commercialization of fresh products, which thus perish quickly as meat, milk, and eggs was very difficult. For this reason the demand for this type of food was satisfied locally and cattle breeding, above all, depended on local availability of resources as fodder, pastures and water. The connection between agriculture and animal production, in fact, has always been very strong: bovines and ovines munched on fields which were turned into pastures during crop rotation, eating fodder and their natural manure was employed to fertilize lands. In recent years, instead, the intensity of animal production is no longer determined by local ecological limits but can theoretically grow permanently or at least until the environment is able to balance to some extent the damages caused by human activities.
In particular, in countries were intensive breeding has gained the upper hand, several consequences are taking place:

- fields which were left as "pastures" have been largely substituted by corn and soy crops: unlike fodder, this type of food makes animals grow much faster;
- cattle used as workforce in fields has been substituted by modern machinery that employs fuels and produces polluting substances;
- cattle has been gathered in enormous fenced areas in intensive breeding farms;
- the great amount of zootechnical manures that is accumulated in industrial breeding plants, must be disposed as waste: partly because today fields are fertilized with chemical fertilizers and also because manures are produced in such great quantities that all fields surrounding industrial breeding farms wouldn't be sufficient to absorb the amount of manure produced!
- the broken balance between agriculture and breeding has led, ultimately, to a greater use of resources and production of waste superior to the capacity of the environment to absorb it.

## Environment and breeding

Cattle breeding products – eggs, meat, milk and derivatives – supply a third of global human protein intake. As consumption of this type of food isn't distributed evenly in the countries of the world, at the same time, it causes obesity in western countries (where consumption of this type of food is excessive) and is a potential undernourishment remedy in developing countries (DCs). But the cattle breeding is also one of the main accountable sectors for the many environmental changes registered in the last decades on a local and global scale. Demand for cattle breeding products is on the rise due to population growth and changes in food preferences: predictions, in fact, estimate meat and milk production will double between 2000 and 2050. This poses a risk for the health status of the environment as it implies a deterioration of the process of environmental degradation that is currently taking place. For a full-scale assessment of the impacts of cattle breeding on the environment, it's necessary to take into account both direct environmental aspects, which are closely related to the typical activities of animal production and indirect aspects, related for example to agriculture activities required to feed cattle. Polluting processes connected to animal production are complex and difficult to control because, on the one hand, industrial cattle breeding presents forms of "acute" pollution having point sources

and easily identifiable, on the other hand, various activities related to animal production (agricultural production, chemical industry, waste production and disposal) are to some extent widespread sources of pollution causing a “chronic” impact that are thus identifiable on the long run. Substantial environmental impacts related to animal production concern soil degradation, climate change and atmospheric pollution, use of water resources and the process of their contamination and, more generally, loss of biodiversity. Let’s have a closer look to the current situation and environmental impacts that should be reduced.

## The transformation of the zootechnical sector

Growing demand of animal source foods has determined the need to have highly efficient breeding systems that are thus capable of producing much in little time and space. A tendency is infact underway leading to intensive breeding and industrial cattle production although extensive pastures still cover wide areas of the planet. In this process, insufficient availability of lands has played a crucial role and has generated the need of developing zootechnical systems requiring less areas in comparison to animal production. This is why industrial breeding “without land” is instead increasing whereas extensive breeding of bovines, ovines, caprines and buffalos is decreasing. As pastures become less, even the sources of nutrition destined for cattle breeding change: about 80% of global cereal production, today, is employed as fodder in breeding farms. Cereals, in fact, allow animals to grow faster. Industrialized agriculture, responsible for the production of these cereals, has transformed lands altering the frail balance regulating different environmental compartments (soil, atmosphere, water, etc.). In this context of rapid increase of animal production, environmental impacts are amplified as the enhanced inputs within the zootechnical system generate a corresponding increase of waste, pollutant emissions in the atmosphere and exploitation of resources, causing numerous highly intensive sources of pollution.

## Breeding and soil

The zootechnical sector is the main sector accountable for the use of soil and its progressive drying. Animal production occupies 30% of all lands existing on the planet plus pastures which cover 26% of lands. In particular, 33% of arable lands are destined for crops that produce food for breeding farms. Intensive breeding, for example, destroys soil because cereal cultivation to produce fodder requires many arable lands. Agriculture can contribute to desertification both, directly, through harmful agricultural practices as intensive farming and unrestrained water use and, indirectly, when land is deforested to create new farming areas to feed cattle. Land-use change, in fact, is another crucial element that alters ecosystems: deforestation has transformed most of the Amazon forest of Latin America (an area twice the size of Portugal) in pastures and farmed fields to feed livestock. Between 1997 and 2003, the amount of bovine exportation from Brazil increased more than fivefold; 80% of this increase in production took place precisely in the Amazon forest. After a few years of intensive exploitation of pastures and newly created fields, deforested areas face an irreversible desertification process in which dried land doesn’t produce as before. It’s thus necessary to cut down a new portion of forest in a continuous cycle that degrades more and more the environment. Today, about 20% of all pastures existing on the planet register to some extent an impoverishment, especially, due to over-pasturing: this phenomenon consists in the compression and erosion of soil due to the trampling of hoofs of too many animals and activities of cattle herds. This takes place especially in pasture areas characterised by water scarcity which are equivalent to 73% of global pastures.

## Climate and atmosphere

The greenhouse effect, the phenomenon that entails the overheating of the planet, is caused by the presence in the atmosphere of different substances, which are normally existing in nature in low concentrations but that are now

produced in high quantities by human activities, especially in the last decades (combustion of fuels to move from one place to another, to make machinery work, fuels to produce electric energy, etc.). Among these substances, some have a stronger impact as methane ($CH_4$) and nitrous oxide ($N_2O$), others, as carbon dioxide ($CO_2$), affect less the greenhouse effect but are produced in great amount by humans. $CO_2$ is employed as benchmark to measure the extent of the impact of other molecules on global overheating (Global Warming Potential, GWP): it's like a bargaining counter where the effect of $CO_2$ on climate change counts as 1 and the effects of methane and nitrous oxide are its multiples. Animal production plays a crucial role in terms of climate change as it's accountable for 18% of global atmospheric GHG (Green House Gases) emissions produced on the whole by human activity. This share is even superior to GHG emissions generated by means of transport in the whole world!! In particular, cattle breeding produces 9% of global carbon dioxide emissions, especially as a consequence of land-use change as deforestation caused by the extension of pastures and farmed lands. The zootechnical sector, though, is accountable also for 37% of methane produced on the whole by human activities: this share is emitted mostly by ruminants and fermentation of cellulose that takes place in their stomach. We should take into account that methane is 23 times more powerful than carbon dioxide with regards to the overheating of Earth. Moreover, animal production contributes for 65% of nitrous oxide introduced on the whole by humans in the atmosphere ($N_2O$ has a potential of overheating that is 296 times stronger than $CO_2$!) The greatest part of nitrous emitted by breeding farms comes from zootechnical waste, which is manure and slurry produced by livestock and fertilizers applied on farmed lands to feed raised animals: we could in fact state that zootechnology is accountable for 75-80% of agricultural emissions of $N_2O$. Breeding eventually produces about two thirds of anthropogenic ammonia ($NH_3$) existing in gaseous form in the atmosphere. The agricultural sector is accountable for 94% of ammonia emissions related to anthropic activities that cause acid rain and acidification of ecosystems. In zootechnology, the passing of ammonia in the atmosphere is especially caused by the application of manure on farmed fields.

## Water employed for breeding

By 2025 more than 60% of the world population will live in water-stressed conditions. The zootechnical sector substantially contributes to water consumption and its pollution both directly and indirectly: 8% of world hydric consumption concerns the zootechnical sector that employs water mainly to irrigate farmed fields to produce fodder. Just think that 15 thousand litres of water are required to produce 1 k of beef! To produce 1 k of chicken we need 3,500 litres of water whereas the production of cereals requires less water, that is 3,400 litres for rice, 2 thousand for soy, 1,400 for wheat, 900 for corn and 500 for potatoes. Animal production represents, moreover, one of the major sources of pollution of waters that entails: eutrophication that alters the balance of acquatic ecosystems; pollution of aquifers by nitrogen and phosphorus, organic and antibiotic micro-polluting agents with consequent risks for human and environmental health. Eutrophication is generated by zootechnical waste, chemical pollution of aquifers is caused by excessive use of fertilizers and pesticides in crops that produce fodder for livestock. Liquid and semi-liquid shedding of cattle contain levels of phosphorus and nitrogen above the average because animals can absorb only a small part of the amount of these substances contained in their fodder, the rest is released through their faeces. When animal manure filters in water flows, nitrogen and phosphorus contained in it in excess alter water quality and damage acquatic ecosystems in damp areas. Just think that up to 70-80% of nitrogen provided to bovines, pigs and laying hens through nutrition and 60% of nitrogen given to broilers is eliminated through faeces and urine and ends in water flows and underground aquifers. Think that an adult pig produces four times as many faeces as a human being and that in an industrial plant can live about 50 thousand pigs with a very high production of daily shedding! When agriculture and breeding are balanced (as occurred before intensive breeding and partly still takes place), a cycle is created in which agricultural production is limited by the amount of manure needed to fertilize fields and manure in turn depends on how much fodder is available to feed animals. The coming of chemical fertilizers has allowed to free agriculture from breeding and the rhythms of industrial production create so much manure that farmed fields aren't sufficient to absorb it all: for this reason, shedding in excess must be disposed as waste. Finally, we shouldn't forget that zootechnology prevents water from playing its crucial role of

penetrating into land and reunite with underground waters (that are drawn by humans) as this activity compacts soil, reduces the infiltration capacity, dries damp areas and deforests to introduce crops.

## Breeding and biodiversity

We live in a time of great threat to biodiversity, today in fact the loss of animal and plant species is hundreds of times faster than in the past centuries. Zootechnical activities causes substantial effects on aspects related to biodiversity and reduction of varieties of life forms as deforestation, soil impoverishment, pollution and climate change that, for that matter, breeding actively contributes, are causes determining a great loss of biodiversity. The impact is also due to the high number of heads of cattle currently raised that represent 20% of the biomass of all animals existing in the world and that occupy 30% of lands that were once inhabited by wild animals. Which are the aspects of breeding having the most negative impact on biodiversity? Breeding conditions based on pasture surely create conflicts with wild fauna (for example, as they're source of disturbance and menace to predators as wolves and foxes and for bordering protected areas) but the greatest damage is related to the increase of agricultural activity that, in developed countries and especially Europe, has modified soil use and has led to the abandonment of pastures.
The loss of meadows, which had allowed in the past centuries the development of so many different types of ecosystems, has determined the decline of many of these ecosystems. The numerous surveys undertaken in recent years to understand how to preserve biodiversity highlight that zootechnology has a substantial impact on the environment: WWF has identified breeding as a menace to almost 40% of the world's classified ecoregions, the Conservation International organization has registered that, on a total of 25 areas with high biodiversity (hotspots) in the world, up to 23 suffer negative effects due to the substantial existence of zootechnical activity. Finally, an analysis presented by the Red List of Threatened Species (drafted by the International Union for Conservation of Nature – IUCN) highlights that the greatest part of threatened species sees its habitats reducing to give way to activities related to breeding, especially cereal crops to produce fodder. Breeding, in particular intensive industrial breeding, thus pushes agriculture to incentivize monoculture of corn, wheat, sunflower and few other cereals that are indispensable to produce great amounts of fodder. As these are intensive crops, though, substantial amounts of herbicides, pesticides and fertilizers are required. The latter are often distributed in doses superior to those that crops can absorb and thus penetrate in the land polluting underground water later employed by humans to drink. Moreover, farmers once grew also for their own consumption many varieties of vegetables (that have now literally disappeared) and ensured rotation of farming lands – a technique allowing to prevent impoverishment conditions). Today, instead, fields are extended to the greatest possible extent, trees and shrubs are eliminated to allow big machinery to move easily but in this way there is no more space for every form of animal and plant life: hedges, streams, plants and shrubs constitute in fact crucial habitats for many varieties of birds and small rodents that today don't find the conditions to live in corn crops or the opportunity to live or are rather substituted by allogen species coming from other climates and other continents but that adapt better to new conditions. Monocultures therefore are indispensable for this type of farming that has as effect the reduction of biodiversity in addition to the alteration of landscape, enormous water consumption, the use of chemical products in amounts never seen before. In Italy this phenomenon is visible also in the landscape: in all the Po Valley starting from the first Alp slopes to the Adriatic sea, land is dominated by monocultures, especially corn, considered the king of cereals and grown in very few varieties, the most profitable.

## Diseases and breeding

The production of animal food is undergoing a great transformation on a global scale that could entail an increase of the risk of transmitting diseases from animals to humans (zoonosis). Excessive concentration of heads of cattle in breeding factories should be avoided to limit this risk as well as improving the system for monitoring diseases and preserving

public health. Cattle production and density have substantially increased, often in proximity to urban centres, especially with regards to industrial pigs and poultry breeding factories: in industrialized countries, the greatest part of chickens and turkeys is produced in plants that can contain from 15 thousand to 50 thousand animals. The tendency towards industrialization with regards to the zootechnical production can be observed also in developing countries where traditional systems have been substituted by intensive production units, especially in Asia, South America and in some parts of Africa. The concentration of thousands of animals in factories increases the chance of transmission of pathogens. Moreover, great amounts of sewage and manure that can contain a high number of pathogens accumulate in rooms for penned animals. Much of this waste is disposed on the soil with no further treatment exposing thus wild mammals and birds to the risk of infection. Among risk factors for the spreading of illness is the fact that pigs and poultry industrial production is based on an impressive movement of live animals. In 2005, for example, almost 25 million pigs (heads), more than two million per month, were commercialized at an international level. This also as a consequence of the drastic reduction of the number of slaughterhouses per unit area (multinational companies, in fact, have bought and merged small family-run slaughterhouses). This has increased the distance from breeding factories and the butchering location increasing the chance of epidemics of viral diseases among animals: cattle is transported to slaughterhouses in awful hygienic conditions and the fast pace of butchering make operators little concerned about operations that could pollute meat (for example, intestine cleansing). In these conditions highly pathogenic diseases develop as swine fever and avian flu (H5N1 virus) and other viruses common among commercial poultry and to a lesser extent among pigs with the risk that these might affect humans and spread rapidly. Meat producers are obliged to apply basic biosafety measures; production sites shouldn't be built close to human settlements or wild birds populations; factories should be clean and regularly disinfected and involved personnel must receive appropriate training on issues relevant to food safety. In addition to aspects connected to hygiene-sanitary conditions of raised animals it's crucial to know what they are fed. The so-called "mad cow" disease (BSE – bovine spongiform encephalopathy) has been caused exactly by uncontrolled nutrition and breeders that have repeatedly fed bovines with infected animal flours, transmitting disease also to animals ready for slaughter. As the disease becomes evident after several months of incubation, infected animals that had become numerous, were commercialized before symptoms were registered and disease spread to humans: infectious protein molecules can be found in bones and bone marrow and survive high cooking temperatures of meat. We shouldn't forget, with regards to biosafety, that breeders must often resort to intense use of antibiotics to contain the chance of infection in animals that are highly stressed by conditons of overcrowding in fenced areas (actually antibiotics in small doses also make animals gain weight and save on fodder costs). This entails an increase in the resistance to medicines by a group of bacterial strains present in the body of animals that, in turn, makes it more difficult to treat human nutrition diseases transmitted by cattle as antibiotics don't have effect on bacteria.

## Many types of breeding

Factors as climate (for example tropical or desert), as the structure of lands (for example flat or mountainous), as the availability of resources (for example water) but also other elements as cultures and local economies make breeding systems acquire different forms in terms of its dimension as well as type of techniques used. In the world there are many types of breeding that are very different from one another; let's just think about how different is nomad horse and yak breeding in Mongolia from breeding of bovines in our farmsteads! The different existing breeding systems in the world can be classified, according to FAO, in two macro-types according to the main aim of their system. The first type regards all mixed systems of production where agriculture and breeding coexist: practically, breeding is both intensive and extensive and is practised along with farming of irrigated or non-irrigated soils (that are nourished by rainfall). Bovines, ovines, caprines, pigs, poultry and laying hens are raised. Agricultural enterprises structured in this way produce, besides food for their own consumption or for trade, also nourishment for animals (both in terms of fodder and agricultural waste). Raising animals provides meat, eggs and milk but in some parts of the world, as Asia for example, animals also offer an efficient help for work in the fields. These systems are widespread in some areas of Northern America, Europe, Southern

Asia and Africa. An example are family-run agricultural enterprises in Europe as farmsteads in the Po Valley.
The second type regards, instead, exclusive animal production systems that is all those system whose only aim is breeding. In particular, this system is characterised as follows:

***Intensive breeding systems "without land".***

These are intensive production systems that work as a real industrial factory: most of the eggs and meat we eat are produced in this way. Raised animals generally are pigs, chickens, laying hens and sometimes also bovines. These breeding farms "without land" are mainly widespread in Northeast America, Europe and Asia, more generally in rich and highly populated areas where the request for meat is very high.

***Extensive "pasture" breeding systems***

These are extensive production systems that, thanks to the presence of broad uncultivated lands, allow animals to pasture freely: with this system are raised mainly bovines to produce meat and milk, ovines and caprines. Extensive breeding is widespread mainly in Central and Southern America, in particular, Argentina, Brazil and Peru but also in Australia and Europe.

## How do breeding farms work?

Animals can be raised in different ways as intensive breeding farms, industrial breeding farms and pasture breeding farms also called extensive. Let's have a closer look.

***Extensive breeding farm or "pasture"***

In this system animals can pasture freely and munch grass. If temperatures are very low animals have the chance to shelter in stables where they are fed by humans. It's an independent system that possesses lands for pasture and to produce nourishment for animals, either hay or cereals. Animal density, that is the relation between the number of animals and the portion of land where they are raised, is low; zootechnical waste is used as natural fertilizer (manure) on the fields of the agricultural enterprise with no need to dispose of it as waste. Even if it's responsible for only a small part of the global animal production, this system of production occupies up to 28% of the land surface free of ice, infact, the low density of animals in relation to the occupied area (less than 10 animals per hectare) requires extended portions of soil. Pasture breeding should determine, therefore, a strong competition for land (in terms of availability and uses) and for other natural resources to satisfy the demand for meat and milk currently registered: hence, all existing lands wouldn't be enough, even if converted to pasture! Extensive breeding is widespread especially in Southern and Central Italy and in the islands where firms raising bovines are generally small or medium sized with an average number of bovines, for example, around 10-20 heads of cattle.

***Intensive breeding farms***

In intensive breeding farms, instead, animals are raised in contained space and the density of heads of cattle is quite high. With this intensive system are raised mainly bovines to produce meat and milk and suines. Animals raised with intensive methods can be raised with free stabling, that allows animals to move freely and develop their own muscle groups or fixed stabling, a system that is still widespread: basically, animals are tied to their placement and in this way they're not allowed complete freedom of movement. Sometimes animals can't behave naturally: veals, for example, are separated from their mother a few days after birth to be raised in individual placements closed by wooden fences and separated from other animals. To make meat more tender and white, as we consumers like it more, veals are fed only semi-liquid pudding, made with artificial milk and lacking iron, as this substance is usually responsible of the pink-red colour of meat. Typical nutrition of bovines, instead, is based on cereals, used because they make an animal's weight increase fast: thanks to a diet based on maize, corn and soy, infact, the weight of a veal increases 15-fold in only 14 months while in the past were required about 5 years!! To further accelerate the growth process in some non-EU countries fodder for animals contains animal-based protein rich flours derived from other animals. EU has banned the use of these animal-based flours (with the exception of those based on fish), considering the high probability that epidemics of diseases transmissible to humans might occur (when humans eat their meat): an example know to all is the

BSE, also called “mad cow disease”. Breeding factories that can reach big dimensions containing even up to 800/2000 heads of cattle per establishment, often need to buy cereals from other companies for animal nourishment and must dispose of their production waste, as zootechnical waste, somewhere else. This system, in Italy, is concentrated in the Po Basin between Lombardy, Piedmont, Veneto and Emilia Romagna where small-sized breeding factories are more numerous (41% of establishments count less than 10 heads of cattle). Here can be found between 60% and 80% of bovines, suines and poultry raised in the whole of Italy. In the Po Basin, in fact, is typical the production of corn, one of the main elements of the diet of animals raised intensively in this area.

***Industrial breeding farms “without land”***

Finally, there is the industrial breeding system, defined as a zootechnical system “without land”, as it can be achieved completely independently from the geographical and climatic context where it’s located; it’s an intensive system, used mainly for the production of meat and eggs that allows to produce more in little time: in breeding factories without land are raised mainly pigs, chickens and laying hens. These animals are raised inside big barns that are illuminated and aired artificially and are fed with food imported from other places. Often their chance of movement is prevented by metal cages where they are placed: this occurs for pigs as well as laying hens and chickens. Unfortunately, these industrial breeding factories are also known for some operations that often don’t respect the well-being of animals. In these breeding farms, for example, suines can count on a cage that is 60 cm wide and 2 metres long; they can’t root nor turn around, they’re raised on cement pavements and hence can’t dig holes to cool inside mud, as would be typical of their behaviour: in these highly stressed condition (along with other operations that we’re not going to report due to their bluntness) bring them to bite their tail – that is pre-emptively cut off – and interact aggressively. Also for hens and chickens that live in cage in a living space equivalent to an A4 paper, are undertaken operations that prevent aggressions and injures (for example, the beak is cut off to avoid hurting). Moreover, the concentration of animals in one location only forces breeders to use antibiotics to avoid sreading of diseases among them.

# What you can do?

## The amount of meat we eat

Current meat consumption have grown a lot in comparison to the past: FAO has estimated that they have been raising globally by almost 400% in comparison to 1961. Today in industrialized countries meat per head consumption is around 80k. In Europe, in 2002, have been consumed 74,3 k of meat per capita but in Italy the European average has been overcome with 90,4 k of meat consumed per capita! Globally meat consumption is destined to grow more, especially in developing countries where incomes are in constant increase and 30 k per head consumed today will become 36 k in 2020. China, instead, will increase its meat consumption by 55% in comparison to 1993, reaching 73 k per head. As for our regards, in industrialized countries, consumption will increase to reach overally 90 k per head per year. As we have seen, meat, eggs and cheese production can have a strong impact on the environment and not always can preserve the well-being of animals, especially if these are raised with an intensive and industrial system. To understand how we “consumers” can choose the less harmful products for the environment and for our health we should think about the different actors involved in the animal production chain and identify which tools are available for them to produce more sustainably. Consumers, finally, can lower their meat consumption and make sustainable buying choices.

## Knowing our consumption

Paying attention to how much meat we eat in the form of a steak or ham (because often we don’t think about this but cold cuts are meat!) is the first step to start a sustainable dietary path. It’s not necessary to become vegetarians to eat sustainably, we only need to be aware that food consumption has an impact on the environment and we must act as a

consequence. Modifying our consumption is the only solution to eat sustainably. Let's see how we can modify our meat consumption.

## Integrating our diet

It's generally better to lower our meat consumption, especially red meat: a kilogram of beef meat, in fact, is responsible for the emission in the atmosphere of the same amount of $CO_2$ emitted by an average European car every 250 kilometres and burns sufficient energy to keep a 100 watt light bulb lighted for 20 days!! Moreover, according to some experts an excessive consumption of meat would have negative effects on our health: it would increase, in fact, occurrence of cancer, vascular diseases, diabetes and obesity. Proteins that our body needs can be also found in non-animal derived foods: it's important to know this to substitute sometimes meat with legumes (chickpeas, beans, lentils) or other food produced with less energy cost and limited impact on the environment as quinoa.

## Eating local products

Favouring local products, or the so-called "zero-kilometre products" is a good solution to avoid long trips of animals and food coming from the other side of the world. This solution, at the same time, allows to emit in the atmosphere, indirectly, less amounts of greenhouse gases. You can also address farmsteads of your area to buy meat, cold cuts, cheese and other dairy products. You can also collect fresh milk from raw milk distributors spread in farmsteads and also in our cities and remember to bring your own empty bottle to fill it! In this way, besides preventing greenhouse gas emissons you will prevent squandering packaging and you will also save money as, avoiding the production chain phases, milk costs less!

## Eating biological products

The choice of biological products today is still influenced by their price that is higher in comparison to traditional foods. Buying biological products directly from producers in the so-called "farmers markets" or directly in farms is a solution to avoid the overpricing problem. Buying biological food means choosing products that have been produced without pesticides, herbicides and chemical fertilizers reducing their impact on the environment and avoiding soil and groundwater pollution by these substances. Moreover, the well-being of animals raised with this system is respected.