Any member of the Annelida phylum of segmented worms. All have encircling grooves usually corresponding to internal partitions of the body. A digestive tube, nerves, and blood vessels run through the entire body, but each segment has its own set of internal organs. The three main classes are: Polychaeta (marine worms), Oligochaeta (freshwater or terrestrial worms), and Hirudinea (leeches).

Summary Article: Annelida
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(Ἄνελιδα) [Lat., anellus=a ring], phylum of soft-bodied, bilaterally symmetrical (see symmetry, biological), segmented animals, known as the segmented, or annelid, worms. Over 12,000 known species are grouped in three classes: the earthworms and freshwater worms (oligochaetes), the leeches (hirudineans), and the marine worms (polychaetes). Annelids are found throughout the world, from deep ocean bottoms to high mountain glaciers. They live in protected habitats such as mud, sand, and rock crevices, and in and among other invertebrate animals, such as sponges. Many live in tubes they secrete around themselves.

Annelid Characteristics
Segmented Bodies

The fundamental characteristic of the phylum is the division of the body into a linear series of cylindrical segments, or metameres. Each metamere consists of a section of the body wall and a compartment of the body cavity with its internal organs. The external divisions, which may be seen in the common earthworm, correspond to the internal divisions. The annelid body consists of a head region; a trunk, made up of metameres; and an unsegmented terminal region called the pygidium. In some primitive members of the phylum the metameres are identical, or very similar to one another, each containing the same structures; in more advanced forms there is a tendency toward a consolidation of some segments and a restriction of certain organs to particular segments. Because of the soft nature of the annelid body, fossils are not common. Fossils of tube-dwelling polychaetes have been found, but there is scarcely any fossil record for earthworms and none for leeches.

The Body Wall

The body wall is covered with epidermis overlaid with a thin, pliant cuticle secreted by the epidermal cells. The body wall consists of well-developed, segmentally arranged muscles used for crawling and swimming movements. Most annelids possess short external bristles called setae, or chaetae, composed of chitin. Setae are used to grip the soil, to hold the animal in a tube, or to increase the surface areas of appendages for swimming.

Digestion

The digestive system of annelids consists of an unsegmented gut that runs through the middle of the body from the mouth, located on the underside of the head, to the anus, which is on the pygidium. The gut is separated from the body wall by the body cavity, called the coelom. The segmented compartments of the coelom are usually separated from each other by thin sheets of tissue, called...
septa, which are perforated by the gut and by blood vessels. Except in the leeches, the coelom is fluid filled and functions as a skeleton, providing the animal with rigidity and the resistance necessary for muscular movement. If the worm is punctured, it loses its ability to move properly, since functioning of the body muscles is dependent on the maintenance of the fluid volume in the coelom. In primitive annelids each compartment of the coelom is connected to the outside by ducts for the release of sex cells, and by paired excretory organs, or nephridia. These openings are closed except when functioning, thus preventing the loss of coelomic fluid. In more advanced species both excretory and reproductive functions are sometimes served by a single type of duct, and ducts may be absent in certain segments.

Circulation

Characteristics of the circulatory system vary within the phylum. The blood usually contains hemoglobin, a red oxygen-carrying pigment; some annelids have a green oxygen-carrying pigment, and others have unpigmented blood. The circulatory system is usually closed, i.e., confined within well-developed blood vessels; in some polychaetes and leeches the circulatory system is partly open, with blood and coelomic fluid mixing directly in the sinuses of the body cavity. Blood flows toward the head through a contractile vessel above the gut and returns to the terminal region through vessels below the gut; it is distributed to each body compartment by lateral vessels. Some of the lateral vessels are contractile and serve as hearts, i.e., pumping organs for driving the blood.

Respiration

Some aquatic annelids have thin-walled, feathery gills through which gases are exchanged between the blood and the environment. However, most annelids have no special organs for gas exchange, and respiration occurs directly through the body wall.

The Nervous System

The nervous system typically consists of a primitive brain, or ganglionic mass, located in the head region, connected by a ring of nerves to a ventral nerve cord that runs the length of the body; the cord gives rise to lateral nerves and ganglia in each segment. Sense organs of annelids generally include eyes, taste buds, tactile tentacles, and organs of equilibrium called statocysts.

Reproduction

Reproduction is sexual or asexual. Asexual reproduction is by fragmentation, budding, or fission. Among sexually reproducing annelids hermaphrodites are common, but most species have separate sexes. Fertilized eggs of marine annelids usually develop into free-swimming larvae. Eggs of terrestrial forms are enclosed in cocoons and hatch as miniature versions of the adults. The ability to regenerate lost body parts is highly developed in many polychaetes and digochaetes.

Class Polychaeta

The vast majority of the more than 8,000 known species of polychaete worms are marine; some, however, are found in fresh or brackish water. They are abundant from the intertidal zone to depths of over 16,405 ft (5,000 m). The polychaetes, so named because of the numerous setae (chaetae) they bear, range in length from less than 1/8 in. to more than 9 ft (2 mm to 3 m), but most are from 2 to 4 in. (5–10 cm) long. Their colors are often brilliant, and some species are iridescent. The class has usually been divided on the basis of mode of existence into two groups, the errantia and the sedentaria.

Errant Polychaetes

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Errant polychaetes include actively crawling or swimming forms which may, however, also spend time in burrows or crevices, or under rocks on the seashore. A familiar errant polychaete is the clamworm, *Nereis*, widely used as bait. Errant polychaetes swim, crawl over the ocean bottom, or tunnel through surface sediments. Many are predators on small invertebrates; some are scavengers. In most the first few body segments bear sensory projections called cirri, while the remaining body segments bear conspicuous leglike appendages called parapodia. The parapodia, along with undulations of the body, propel the worm in crawling and swimming; parapodia are tipped with bundles of setae, usually made of chitin. Most errant polychaetes have well-developed head regions, which bear eyes, sensory tentacles, and a specialized organ, the nuchal organ, thought to detect chemicals. The anterior end of the gut often forms a protrusible structure, the proboscis, sometimes equipped with strong chitinous jaws and used in feeding. The setae of some polychaetes, e.g., the tropical fireworm, are composed of calcium carbonate rather than chitin and are hollow. These brittle setae are easily broken off and contain a toxin that produces a painful reaction in humans. In the scaleworms, a series of overlapping scales form a covering over the animal's upper surface. In the sea mouse these scales are completely covered by long, slender, feltlike setae projecting from the parapodia.

**Sedentary Polychaetes**

Sedentary polychaetes are usually adapted to living permanently in tubes or burrows; some attach themselves to rocks or piers. Many sedentary polychaetes, like the lugworm, *Arenicola*, live in burrows in sand or mud. The majority, however, are tube builders. Tubes of different species vary greatly in their composition and structure. They may be composed of sand, shell, or other particles held together with mucus, or made entirely of organic substances secreted by the worm that harden on contact with water. The tubes may be straight, branched, spiraled, or U-shaped. Most are permanently attached to a substrate, and the worm seldom or never ventures outside; however, the tube worm *Cistenides* moves about the seafloor, dragging along its delicate tube of sand grains. Sedentary polychaetes have greatly modified head regions for specialized feeding habits. Many are adapted for feeding on organic matter deposited on the ocean floor. For example, the lugworms have a simple, thin-walled, jawless proboscis, which is used to draw sand into the gut, where organic matter is removed. Other worms have feeding tentacles that extend from the tube opening and creep along the mud or sand, picking up organic deposits. Still others of the Sedentaria are filter feeders: the beautiful feather-duster worms have a crown of feathery, ciliated tentacles that extend from the tube opening to sweep small planktonic organisms from the water. The tentacles are quickly withdrawn if the animal is startled. The parapodia are reduced in the sedentary polychaetes, and the setae of many tube-dwelling forms are hooked to help the worm hold itself to the wall of its tube.

**Polychaete Anatomy**

The structure of the digestive tract of polychaetes is variable, reflecting the diversity of feeding types. Respiration is entirely through the body wall in some polychaetes, and partially so in most. Many species have thin-walled extensions of the body surface, i.e., gills, used for gas exchange; most commonly the gills are extensions of the parapodia. The tentacles of feather-duster worms are used for respiratory exchange as well as for feeding. A polychaete may have a single pair of excretory tubes or a pair in each segment. Sedentary polychaetes have various modifications to insure that wastes will be deposited near the mouth of the tube or burrow, where they are washed away.

**Polychaete Reproduction**

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Most polychaetes reproduce sexually, and the sexes are separate. Sex cells develop from masses of tissue in the metameres and leave by way of tubules or by rupture of the body wall. In most cases fertilization of the eggs by sperm occurs externally in seawater and results in the formation of free-swimming larvae. Variations include internal fertilization, laying of egg masses that are attached to objects with mucus, and brooding of developing eggs in the worm’s body. Some errant polychaetes, including the clamworm, undergo extreme changes in appearance and become active swimmers at the time of year that the sex cells mature; males and females swarm to the surface of the sea to spawn. In some of these species the portion of the body containing the sex cells breaks free and engages in swarming and spawning, leaving the asexual portion behind to regenerate its lost parts. Swarming generally occurs at night and is correlated with particular phases of the moon. Some species perform a kind of nuptial dance, swimming in circles as they spawn. In some species the worms liberate a luminous secretion, which produces circles of light on the ocean surface as they dance. The most famous swarming polychaete is the tropical palolo worm, a name sometimes applied to all swarming polychaetes.

**Archiannelida and Myzostomaria**

Two groups of polychaetes that are sometimes regarded as separate classes are the Archiannelida and the Myzostomaria. The former group includes a variety of minute marine worms living in surface mud, in tidepools near the high-tide line, and in the interstitial spaces of mud and sand in some subtidal areas. All archiannelids are scavengers. They have a ciliated epidermis and only a few body segments; many resemble the larvae of other polychaetes. The Myzostomaria are a small group of marine worms parasitic on certain echinoderms (crinoids, starfish, and brittlestars). They are disk-shaped and flattened, with a series of reduced parapodia with hooked setae; they often match the color pattern of the host.

**Class Oligochaeta**

This class includes about 3,500 species of earthworms and freshwater worms. The members of the class range in length from about 1/32 in. to 10 ft (0.5 mm–3 m), but most are comparable to the polychaetes in size. Oligochaetes occur in a variety of habitats throughout the world. Most are burrowers in the soil, but the class also includes worms that inhabit wells, marshes, and swamps. Other species live under rocks on the seashore, in the leaves of tropical trees and vines, on the surface of glaciers, or on the gills of freshwater crayfish.

**Oligochaete Anatomy**

Like the polychaetes, oligochaetes have bodies divided into segments. However, they lack parapodia and, with a few exceptions, have relatively few and inconspicuous setae. The setae are usually arranged in four bundles on each segment; those of aquatic forms are longer than those of land forms. The setae of an earthworm may be felt as a roughness if one rubs a finger along its side.

Oligochaetes are less varied in their external form than the polychaetes, but are much more numerous. As many as 4,000 oligochaetes have been counted in 1 square meter of lake bottom, and about 9,000 in 1 square meter of meadow soil. In almost all oligochaetes, the head is a simple cone-shaped structure without sensory appendages. Light is detected by photoreceptor cells in the skin, usually concentrated toward the front of the animal.

**Oligochaete Digestion**

The mouth, located under the head, leads to a relatively simple, straight digestive tract consisting of a
pharynx, an esophagus, and an intestine, terminating in an anal opening. Terrestrial oligochaetes tunnel through the ground, swallowing soil as they go. The digestive tract of such a worm is specially modified for this rough diet. Typically it has a thin-walled storage area, or crop, and a muscular gizzard for grinding the soil to remove the organic matter that is the actual food of the worm. Specialized calciferous glands remove excess calcium, magnesium, strontium, and phosphate and regulate the level of these ions in the blood. Solid wastes are egested and plastered against the burrow wall, or ejected from the mouth of the burrow; the ejected material is called castings. Earthworms, through their burrowing and digestive processes, are largely responsible for the mixing and aeration of the soil. Not all oligochaetes have soil diets; some of the small aquatic worms are active predators on other small invertebrates. Excretion is typically carried out by a pair of tubes in each segment.

**Oligochaete Circulation and Respiration**

The circulatory system is that typical of the annelids and has many contractile vessels, or hearts. Although a few aquatic forms have gills for respiration, most oligochaetes lack such specialized structures and use the capillaries of their body walls for respiratory exchange. Oxygen dissolved in the soil water diffuses through the moist epidermis of the worm. If earthworms are forced to the surface, as when their burrows are filled with rainwater, they suffocate as a result of desiccation.

**Oligochaete Reproduction**

All oligochaetes are hermaphroditic, and nearly all cross-fertilize by copulation. Male and female reproductive organs are located in separate segments. The copulating pair exchange sperm, which are stored in the body of the recipient worm until its eggs are mature. The worm then secretes a cocoon into which it deposits the eggs and the sperm; fertilization and development of the eggs occur in the cocoon. When the young emerge they are miniatures of the adults. The cocoon is secreted by a glandular region, the clitellum, consisting of several thickened segments. The clitellum of an earthworm is a conspicuous saddle-shaped region near its front end.

**Class Hirudinea**

This class includes the 500 species of leeches, flattened, predacious or parasitic annelids equipped with suckers used for creeping. Leeches range in length from about 1/2 in. to 8 in. (1 cm–20 cm); most are under 2 in. (5 cm) long. They are commonly black, brown, green, or red, and may have stripes or spots. Leeches are primarily freshwater annelids, but some live in the ocean and some in moist soil or vegetation. The majority of leeches are predators on small invertebrates; most swallow their prey whole, but some suck the soft parts from their victims. Some leeches are parasites rather than predators, and suck the body fluids of their victims without killing them. The distinction is not sharp, as many predatory leeches take blood meals on occasion.

**Leech Anatomy**

Leeches are the only annelids with a fixed number (34) of body segments; each segment has secondary subdivisions known as annuli. A clitellum, less conspicuous than that of oligochaetes, is present; there are no parapodia. A leech has a small anterior sucker and a larger posterior one; the leech crawls by moving the anterior sucker forward, attaching it, and drawing up the posterior sucker. Most leeches can swim by rapid undulations of the body, using well-developed muscles of the body wall.

The coelom differs from that of other annelids in that it is largely filled in with tissue. Coelomic fluid is contained in a system of sinuses, which in some leeches functions as a circulatory system; there is a

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tendency in this group toward the loss of true blood vessels. The blood of some leeches is red. In others the blood lacks oxygen-carrying pigments and is therefore colorless; the oxygen dissolved directly in the blood is sufficient for respiration. Gas exchange occurs through the body surface of most leeches, although many fish-parasitizing leeches have gills.

The sense organs consist of sensory cells of various types, including photoreceptor cells, scattered over the body surface. There are also from 2 to 10 eyes, consisting of clusters of photoreceptor cells and located toward the front of the body.

**Leech Predation and Digestion**

Many leeches have a proboscis used for swallowing the prey or for sucking its fluids; others have jaws for biting. Many parasitic leeches are able to parasitize a wide variety of hosts. Most of the marine and some of the freshwater leeches are fish parasites. The medicinal leech, *Hirudo medicinalis*, is one of a group of aquatic bloodsucking leeches with jaws. Another group of jawed bloodsuckers is terrestrial; these leeches live in damp tropical vegetation and drop onto their mammalian prey. Most parasitic leeches attach to the host only while feeding; a single meal may be 5 or 10 times the weight of the leech and provide it with food for several months. The digestive tract of bloodsuckers produces an anticoagulant, hirudin, which keeps the engorged blood from clotting. A few leeches attach permanently to the host, leaving only to reproduce. Predatory leeches are active at night and hide by day.

**Leech Reproduction**

Like the oligochaetes, leeches are hermaphroditic and cross-fertilizing, although fertilization is internal. In some species the sperm are enclosed in sacs, called spermatophores, that are attached to the outside of the partner; the sperm pass through the body wall to the ovaries, where the eggs are fertilized. In other species the sperm are not enclosed and are transferred directly into the body of the partner by copulation. A courtship display is seen among some leeches at the time of mating. The fertilized eggs are deposited in a cocoon, secreted by the clitellum; the cocoon is buried in mud or affixed to submerged objects. The young emerge as small copies of the adults.

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