# Section 2: Body Plan and Morphology

**Hydrostatic Skeleton**

The nematode body is supported by a **hydrostatic skeleton**, a structure that relies on internal fluid pressure to provide shape and facilitate movement. This system is particularly effective in organisms with soft or flexible body walls.

In nematodes, the **pseudocoelom**, a fluid-filled body cavity, serves as the primary component of the hydrostatic skeleton. The pseudocoelomic fluid creates turgor pressure against the surrounding musculature and cuticle. This pressure is maintained by the elasticity of the cuticle and the activity of the longitudinal muscles, forming a dynamic framework that allows the body to remain rigid yet flexible.

The hydrostatic skeleton operates in conjunction with the nematode's muscular system, allowing efficient movement without the need for bones or other rigid structures. By alternating contractions of longitudinal muscles on either side of the body, nematodes generate the undulating waves characteristic of their motion. This system not only enables locomotion but also supports the nematode's internal organs, helping maintain their positions and ensuring proper physiological function even during vigorous activity.

**Longitudinal Muscles and Sinusoidal Movement**

Nematodes rely exclusively on **longitudinal muscles** for movement, distinguishing them from other worm-like organisms that also possess circular muscles. These longitudinal muscle bands are arranged in four quadrants, running the length of the body. The contraction and relaxation of muscles on one side of the body, coupled with the rigidity of the hydrostatic skeleton, produce the nematode's **sinusoidal motion**, or wave-like thrashing.

This movement is particularly well-suited for navigating the narrow spaces of soil, plant tissues, or host environments. The flexibility provided by the hydrostatic skeleton allows nematodes to bend and twist, while their longitudinal muscle activity ensures forward or backward propulsion. However, the absence of circular muscles means that nematodes cannot crawl or use peristaltic motion, limiting their mobility to environments where sinusoidal movement is effective.

### Species Profile: Onchocerca volvulus

The agent of river blindness (onchocerciasis), Onchocerca volvulus is a parasitic nematode transmitted by blackflies (Simulium spp.). Adult worms form subcutaneous nodules in human hosts, releasing microfilariae that migrate through the skin and eyes. Chronic infections can lead to severe itching, skin damage, and blindness, making this species a major focus of global public health initiatives aimed at its eradication.

**Muscle Arms and Nervous System Integration**

One of the most unique features of nematode muscle anatomy is the presence of **muscle arms**—protrusions from muscle cells that extend to the nerve cords. This is the reverse of the typical arrangement in animals, where nerves branch out to reach muscles.

In nematodes, the muscle arms connect directly to the dorsal and ventral nerve cords, which run longitudinally along the body. This adaptation enhances neural efficiency, allowing precise and coordinated control of the nematode’s movements. Such an arrangement is especially advantageous in parasitic species, where rapid responses to host defenses or environmental changes are critical for survival.

**Feeding and Digestive System**

Nematodes exhibit specialized adaptations for feeding, enabling them to exploit a wide range of diets, from detritus and bacteria to host-derived nutrients. Their **complete digestive system**, extending from mouth to anus, is simple yet effective.

**Tri-Radiate Pharynx**

A key feature of the nematode digestive system is the **tri-radiate lumen** of the **pharynx** (tri, "three"; radius, "ray"). The pharynx is a muscular, pumping organ that creates strong suction to draw food particles into the digestive tract. The tri-radiate structure ensures an efficient flow of ingested material while resisting collapse under pressure.

**Feeding Styles**

* **Free-Living Nematodes**: Most free-living nematodes feed on bacteria, fungi, algae, or organic debris in their environment. Their pharynx is well-suited for processing these small particles.
* **Parasitic Nematodes**: These species exhibit structural modifications tailored to their host's tissues. For instance:
  + Plant parasites may possess **stylets**, needle-like structures used to pierce plant cells and extract their contents.
  + Animal parasites often develop **teeth** or **cutting plates** to attach to host tissues and consume blood or other fluids.

The intestine, composed of a single layer of epithelial cells, efficiently absorbs nutrients and transports waste to the posterior anus. This simplicity allows nematodes to meet their energy needs across diverse environments.

### Species Profile: Scottnema lindsayae

Endemic to Antarctica’s McMurdo Dry Valleys, Scottnema lindsayae is one of the hardiest nematodes on Earth, thriving in freezing, arid conditions where few other organisms survive. This species feeds on soil microbes and plays a crucial role in nutrient cycling in one of the most extreme environments on the planet. Its ability to endure subzero temperatures and prolonged desiccation makes it an important model for studying adaptations to extreme climates.

**Amphids and Phasmids**

Nematodes possess specialized sensory organs known as **amphids** and **phasmids**, which play critical roles in environmental sensing and survival.

**Amphids**

Located on the head near the mouth, amphids are paired chemosensory organs that detect a wide range of chemical cues in the environment. These cues are essential for nematode behavior, allowing them to locate food, recognize potential hosts, and navigate their surroundings. Amphids are most prominent in free-living nematodes, where chemical detection is crucial for survival in varied habitats like soil and aquatic environments. The amphid structure is often adapted to the nematode's ecological niche, with free-living species relying heavily on their sensitivity to chemical gradients for feeding and movement.

**Phasmids**

Phasmids are sensory structures located in the tail region of nematodes. They are more commonly found in parasitic species, where they may assist in host recognition and interaction. These structures play a role in detecting environmental changes within a host organism, helping the parasite adapt to shifts in host physiology or immune defenses. While phasmids are often absent in free-living nematodes, their presence in parasitic species highlights their role in facilitating host-parasite dynamics.

Together, amphids and phasmids exemplify the remarkable sensory adaptations of nematodes, enabling them to thrive in diverse and often challenging environments.

**Cuticle and Structural Support**

The **cuticle**, a multi-layered collagenous structure, serves as both a protective barrier and a flexible framework. It is essential for resisting mechanical damage, withstanding osmotic pressures, and providing shape to the body.

The cuticle also features fine annulations and grooves that may aid in locomotion and interaction with the surrounding environment. Its composition varies among species, reflecting adaptations to free-living or parasitic lifestyles. For instance:

* **Free-Living Nematodes**: The cuticle is typically thinner and more flexible, facilitating movement through substrates like soil or water.
* **Parasitic Nematodes**: The cuticle is often thicker and layered, offering resistance to host defenses, including digestive enzymes and immune responses.

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