Phylum Annelida
(segmented worms, bristle worms)

15,000 species

large successful phylum in water & on land

include earthworms, sand worms, bristle worms, clam worms, fan worms, leeches

worldwide distribution:

marine, brackish, freshwater and terrestrial

Body Form

elongated wormlike body

<1mm to 3 meters

hollow **tube-within-a-tube** design

one of the most successful animal designs

→ room for development of complex organs with muscle layers

→ allows for circulation of body fluids

→ provides hydrostatic skeleton

true **coelom** present

mesoderm on inside of body wall and outside of digestive system

layers of muscles inside body wall and on outside of digestive tract

with **head**-**body**-**pygidium**

some with bizzare forms

head (prostomium & peristomium)

most annelids show some degree of **cephalization** with a distinct head (=**prostomium**)

tentacles, **palps** and sensory structures

peristomium behind prostomium contains the mouth

with **pharynx** and chitinous **jaws**

body with well developed **metamerism** (=segmentation)

most prominent distinguishing feature

seen in just a few other phyla: eg arthropods, chordates

segments are separated by tissue = **septae**

each segment has it's own set of muscles and other organs

allows more efficient **hydrostatic skeleton** for burrowing and movement

offers a way to achieve greater size:

rather than increasing size of each organ

→ each organ is repeated in each segment

allows organs of each segment to become more specialized for various functions such as digestion, respiration, reproduction, locomotion, etc

the segmentation is both external and internal

essential features of segmentation:

several systems (eg. nervous, excretory) show serial repetition

segmentation is produced during embryonic development

NOT the same as asexual budding as in tapeworms

terminal **pygidium** with anus

Body Wall

epidermis a single layer of cells (columnar epithelium)

epidermis secretes a thin flexible protective **cuticle**

most annelids have **setae** → small chitinous bristles

secreted by epidermis

repeated on each segment (ie. "bristle worms")

used as anchors while burrowing

to prevent capture

some used for swimming

or as protection or camoflage

beneath **epidermis** is two layers of **muscle tissue**

thin layer of **circular muscle**

thick layer of **longitudinal muscle** (obliquely striated)

enhances use of hydrostatic skeleton

allows for peristaltic movement for digging through sediment

body cavity a true **coelom**

lined with **peritoneum** (squamous epithelium)

lines inside of body wall & outside of digestive tract

also layers of muscle along digestive tract

peritoneum also form **mesenteries** that hold blood vessels and the **septae** between segments

Movement

coelom is filled with fluid (except leeches) which serves as **hydrostatic skeleton**

annelids have 3 general types of movements:

1. **burrowing**:

waves of **peristaltic contractions** sweep down body

1st animal elongates →contraction of circular muscle

2nd animal sortens → contraction of longitudinal muscle

setae anchor hind end of body while front end pushes foreward

2. crawling:

polychaetes use parapodia alternately to move

across surface

3. swimming:

mainly polychaetes and leeches

undulating body movements

parapodia help in polychaetes

Feeding & Digestion

complete digestive tract "tube within a tube" design

muscle layers allow modification of tract into various structures:

muscular **pharynx**- to take in food, often with eversible **pharynx** with **jaws**

crop – food storage

gizzard – food grinding

intestine – digestion and absorption of nutrients

anus – elimination of undigested wastes

Respiration

through body wall in most species

body wall is richly supplied with capillaries to absorb and transport oxygen

some marine forms respire through **parapodia**

a few species have gills

Circulation

body cavity is filled with coelomic fluid which helps move food and wastes around

most annelids also have a **closed circulatory system** that more efficiently carries nutrients and wastes

several pairs of "pumping hearts" keep blood flowing

dorsal and **ventral vessel**s connected by capillary network

dorsal vessel sends blood anteriorly

ventral vessel sends blood posteriorly

dorsal vessel is main pump

several pairs of **aortic arches** (="**hearts**") help to keep pressure up in ventral vessel

blood:

most with dissolved blood **pigments** to carry

oxygen:

hemoglobin (Fe) red - most annelids
hemerythrin (Fe) red
chlorocruorin (Fe) green

(only 4 blood pigments known in animal kingdom & annelids have 3 of them)

blood also contains amoeboid cells which engulf foreign particles (like our WBC's)

annelids therefore have a double transport system for foods, gasses, wastes

fluid filled coelom

circulatory system with heart & vessels

→ foods, wastes and respiratory gasses are carried both in blood and in coelomic fluid

Nervous System

have both CNS and PNS

CNS: a pair of dorsal **cerebral ganglia** above the pharynx and **ventral nerve cord**

with paired fused ganglia in each segment

PNS: **nerves** branch off fused ganglia to supply body wall and body organs

Senses:

simple single celled photoreceptors or clusters of cells **ocelli** (= **eyespots)**

a few polychaete **eyes** have cornea, lens, retina

→ can form images

statocysts in some for balance

nuchal organ → ciliated pit in head area

also found in some molluscs and a few other invertebrates

may function in chemoreception

tentacles & **palps** → well developed sense of touch

other simple chemoreceptors

free nerve endings → tactile??

Endocrine System

neurosecretory cells in brain and ganglia

secrete **hormones** that regulate:

reproduction

secondary sex characteristics

regeneration

Excretion

one pair of **nephrida** (=metanephridia) in each segment similar to that in molluscs

(a few polychaetes have protonephridia or both)

nephric tubule:

nephrostome = funnel like opening into previous segment

coiled ciliated tubule surrounded by **capillaries**

bladder like structure

nephridipore = opening to outside

function:

wastes from coelom are drawn in

salts and organic wastes from blood are discharged into duct

useful stuff is selectively reabsorbed

in earthworms and leeches chlroagogue cells collect NH4 or urea and deposit in blood or take directly to nephrostome

some nitrogen wastes are also excreted through body wall

excretory organs also help in salt and water balance

Reproduction and Development

Annelids have both asexual and sexual reproduction

quite variable within the phylum

Asexual

most can bud to some degree

other spontaneously fragment

Sexual

monoecious or dioecious

most annelids are hermaphrodites

larva, if present = **trochophore**

Classification of Annelida

Class: Polychaeta (Bristle Worms)

mostly marine

distinct head with eyes and tentacles

segments with parapodia and lots of setae

no clitellum

Class: Clitellata (Earthworms & Leeches)

subclass: Oligochaeta (Earthworms)

mainly terrestrial and freshwater

head absent

fewer setae, no parapodia

subclass: Branchiobdellida

commensal on crayfish

no setae

posterior sucker only

subclass: Hirudinea (Leeches)

terrestrial, freshwater or marine

no parapodia or setae

fixed # of segments with "false segments" (=annuli)

anterior and posterior suckers

Class: Echiura (Spoon Worms)

shallow marine burrowing forms

once considered a separate phylum

Class: Polychaeta
(Sand Worms)

means "many setae"; also called bristle worms

10,000 species; 2/3rds of all Annelid species

sand worms, bristle worms, fan worms, clam worms, etc

largest, most diverse and most primitive class of Annelids

all are aquatic; mostly marine; worldwide distribution

a few found in freshwater

most 2-4" long (5-10 cm) ; some up to 10' (3 M)

often brightly colored

deposit feeders, filter feeders, predators, scavengers,

live in crevasses, old shells, burrows or construct tubes

some have elaborate filtering structures

eg feather duster worms

a few are pelagic → part of the **plankton**

important in marine food chains

<u>Body Plan</u>

distinct **head** with mouth and sense organs & wormlike **body** or trunk with repeating segments body segments with flaplike **parapodia**

Head

have distinct **head**

head has retractable **pharynx** with **chitinous jaws** used to capture prey

lots of different kinds of **sense organs**

1. **chemoreceptors** (nuchal glands) on palps and tentacles
2. touch receptors also on **tentacles** for locating food and shelter
3. eyes (simple eyes = ocelli; and more complex eyes)

some can focus an image = esp predators

very similar to cephalopod and vertebrate eyes

Body or Trunk

on each segment are a pair of flaplike **parapodia**, each with many **bristles** (=**setae**)

both parapodia and setae are moved by internal **muscle bands**

these parapodia have a variety of functions and create many bizzare shapes:

→ crawling or digging in the sediment; use parapodia as as legs

→ swimming, use parapodia as paddles

→ as gills for respiration

→ used as anchors while burrowing or to prevent capture

→ to create feeding currents inside tubes

→ converted into feathery appendages to filter water

→ as protection or camoflage

→ in some, parapodia modified into fans and mucous bags for feeding or to create water currents

most polychaetes are active swimmers, crawlers or burrowers in the sediment

<u>Feeding & Digestion</u>

1. predators

the most active polychaetes are **predators**

eg. clam worm or sand worm (*Nereis*)

up to 10" long

live in mucus tubes in or near low tide; but can also swim

males - irridescent bluish-greenish color

females - light green with yellow, orange-red mottling

most active at night

move out onto sand to search for food

use their jaws to capture small animals

jaws open as pharynx is everted

jaws close as pharynx is retracted

eg. Blood Worms (*Glycera*)

red worms, all marine, several species

found in shallow waters

poor swimmers but good burrowers

carnivores

on their proboscis are 4 hollow jaws that can inject poison into prey

eat other worms and organisms in the sediment

painful to humans

harvested extensively in NE US for bait

eg. Scale Worms

very abundant

flattened and coverd with scales formed by the modified parapodia

most are small; some up to 19 cm

carnivores

many are commensals with other marine inverts

2. filter feeders

many polychaetes burrow or live in tubes rather than crawling around on the sediment

many sedentary polychaetes are **filter feeders**

eg. Fanworms, tubeworms, featherduster worms)

secrete many kinds of tubes:
firm calcareous tubes
glue sand grains together
bits of shell cemented together
some burrow

most have long feathery tentacles that they extend to filter feed

resemble colorful flowers when feeding

cilia on tentacles move collected particles toward mouth

tentacles can be quickly retracted when threatened

often develop specialized food gathering structures for filter feeding

leads to tagmosis → fusion and reduction of metamerism

eg. *Chaetopterus* (parchment worm)

secretes parchment like tube

creates a continuous current through its tube to feed

tubeworm must maintain a flow of water to get oxygen and get rid of wastes

→ uses modified parapodia as paddles

can emit strong bioluminescent flashes

burrows often shared by commensal crab

3. detritus feeders

other polychaetes eat organic detritus in or on the sediment

Respiration

usually through **parapodia**

some have paired **gills** on some segments

eg. Tangleworms (*Cirratulus grandis*)

on east and west coasts of US

yellow to green; 5-6" long

front with great mass of long red hairlike filaments used as **gills**

some have no special organ and exchange across **body surface**

Excretion

protonephridia and in some **metanephridia** or both

1 pair per segment

opens into coelomic compartments

tubule absorbs any useful materials and concentrates wastes as fluid passes to nephridiopore

Senses:

eyes: simple eyespots to complex organs

esp in free moving (errant) polychaetes

in one group can form image: cornea, lens, retina

nuchal organs: ciliated sensory pits

chemoreceptors used in food gathering

statocysts in burrowers and tube building forms

Reproduction & Development

simple reproductive system

have no permanent gonads

→ gonads appear as temporary swelling of peritoneum at certain seasons

gametes are shed either

→ through genital ducts

→ or through nephridiopore

→ or through rupture in body wall

some polychaetes live most of the year as sexually immature individuals = **atokes**

after living 1 or 2 years as benthic organisms they become sexually mature and swollen with gametes = **epitokes**

head shrinks, body enlarges, gonads develop and produce egg or sperm

sometimes only part of the body makes the transformation, breaks off and the rest of the worm lives to repeat next season

eg. palolo worm

males and females gather by the millions in one spot

at night determined by phases of the moon female releases pheromone

pheromone excites male to circle about female

swarms of epitokes appear at start of moon's last quarter in October or November

→ sea is literally thick with epitokes

just before sun rises, epitokes burst to release gametes

anterior portion of worm returns to burrows

=synchronous mating

→ensure most eggs are fertilized

→predator saturation
predators have a field day; but too many prey so some are always left to reproduce

→atokes safely in their burrows to repeat next year

a Samoan holiday to feast on epitokes

Ecological Roles of Polychaetes

eg. detritus food chains

eg. prominent in marine food webs

eg. **Beard Worms (pogonophorans)**

once thought to be a separate phylum, now known to be an unusual kind of polychaete

discovered in 1900; today 150 known species

all are marine; most live in bottom ooze of deep ocean

in many the forepart bears long **tentacles** giving it a bearded appearance

thin, transparent, segmented trunk has several pairs of setae and is enclosed in a chitinous tube

the trunk ends in a small segmented opisthosoma

the best known of the group of beardworms are the **giant tubeworms** found around deep sea **hydrothermal vents**

some up to 6' long,

with a bright **red plume** that extends from the tube

giant tubeworms are part of an entire ecosystem **not based on photosynthesis**

they are the only non-parasitic animals without a digestive tract

no mouth, digestive tract or anus

they get most of their nutrients from **symbiotic bacteria** living in a large sac (=trophosome) within the trunk of the worm

the worms are bright red due to hemoglobin in their blood

the worm absorbs the hydrogen sulfide and oxygen in the waters near the vents

these bind to the hemoglobin in the worms blood and are delivered to the symbiotic bacteria in the trunk of the worm

the bacteria harvest energy from H_2S and convert inorganic elements into sugars for the worm

$CO_2 + H_2S + O_2 + H_2O \rightarrow H_2SO_4$ + sugars

giant tubeworms reproduce by releasing sperm and eggs into the water

the larvae will drift through the deep water until they locate a hydrothermal vent

they will then settle to a rocky perch

the young tubeworms do have a mouth and gut and feed

as the worm matures the mouth and gut degenerate and the area once holding the digestive systems becomes a bacteria-filled sac

tube worms seem to have few predators

although sometimes crab and shrimp will feed on the worm's red plume

eg. **Bone eating worms (*Osedax*)**

major decomposers of deep sea whale carcasses

2001 found red fuzz on whale carcasses in deep ocean

1000's of polychaetes with red plumes up to 6 cm long

new genus and species of polychaete

seem to be unique to "whale fall"

worms have no functional mouth or gut

have symbiotic bacteria that digested oil in bones

→ they degrade hydrocarbons

the bacteria live in rootlike structures of worm that extend in and throughout the bone

worm provides oxygen via blood vessels extending into the roots

Economic Impacts of Polychaetes

eg. human food (samoa)

eg. insecticides

eg. Padan – a powerful insecticide produced from a polychaete worm

eg. anticancer drugs

eg. dolastatins from sea hare (Dolabella auricularia) has potential anticancer properties

Class Clitellata

new genetic analysis indicates that what used to be 3 separate "classes" of segmented worms should more correctly be subclasses of a "new" class: **Clitellata**

the **clitellum** is part of the reproductive system of these worms

it is near the head

the clitellum is a thick, glandular, non-segmented region in these worms that secretes mucous to hold cross-fertilizing worms together while mating

and it produces a sac in which eggs are placed

Subclass Oligochaeta (Earthworms)

means "few setae"

over 3000 species

relatives of sand worms but:

no distinct head

no parapodia

and very **few setae**

most with 4 prs of short setae/segment

often present in high densities:

rich soil 1 ton of common earthworms/acre

very small aquatic worms (tubificids) up to 40,000/M^2 in rich muds

earthworms are extremely important in the texture and fertility of the soil

Aristotle referred to them as "the intestines of the earth"

Darwin wondered whether there was any other animal that has played so important part in the history of the world as earthworms

"Earthworms are miniature topsoil factories, they make soil. ALL other (terrestrial) living things eventually pass through an earthworm on the way to becoming soil. And it is likely that nearly every atom in your body (with very few exceptions) has been in an earthworm's stomach before it was part of you."

most oligochaetes are less than a few inches long

some tropical earthworms get up to 3 M long

eg. giant Gippsland earthworm

native to Australia;

average 3' long and 1" diameter, can reach 9' long

dark purple head and blue-grey body

live in deep burrow systems in clay soils along stream banks

take 5 years to reach sexual maturity

breed in warmer months; lay coccoons in their burrows

12" worm hatches in a year

a protected species – being killed from tilling the land as area converts land from grazing to farming

eg. giant Palouse earthworm

in Idaho

thought extinct but recently rediscovered

up to 3 ft long, lives in burrows 15'deep

spits at predators

mostly terrestrial →burrow in the soil

most conspicuous 'worms' on land

(roundworms are much more abundant but microscopic)

many species are common in freshwaters

eg. Aquatic "earthworms"

smaller, benthic, longer setae, more active

better developed sense organs

some have gills

generally eat algae and detritus

some with great powers of asexual budding

eg. tubifex

red worms to 10 cm long

live on bottoms of lakes, ponds and polluted streams

live in very low oxygen concentrations

have large amounts of hemoglobin

keep their heads in tubes while waving bright red tails

in heavily polluted areas banks appear bright red at low water

absorb dissolved nutrients (DOM) across skin

one unusual group lives on glaciers

eg. ice worms

small worms <1" long

only found on surface of glaciers at temperatures below freezing

they die at temperatures of 40º F (5ºC) or more

can appear by the 100's

eat algae and pollen

and a few oligochaetes are marine or brackish

Body Wall

protective layer of collagenous **cuticle** secreted by **epidermis**

surface of the body is kept moist by

pores allowing coelomic fluid to leak out and lubricate outer surface of animal

also has numerous **mucous glands**

Feeding & Digestion

most oligochaetes are **scavengers** or **detritus feeders**

feed on decaying organic matter in the soil

eat as they burrow then let digestive system extract nutrients

mouth beneath prostomium

inside the mouth is a powerful **pharynx**

in some aquatic species the pharynx can be everted as in sand worms to suck food in

the digestive tract may include:

esophagus

has **calciferous glands** that maintain calcium balance by secreting excess calcium from blood into the digestive tract

(lots of calcium in soil; lots gets absorbed, excess is secreted)

crop – for food storage

gizzard – for grinding up food into smaller pieces

thick and muscular

intestine for chemical digestion and absorption of nutrients

in some the first part of intestine is used for **digestion**

secretes digestive enzymes

most of intestine is used for **absorption**

on dorsal surface is infolding = **typhlosole**

increases surface area for absorption

on outside surface of intestine are yellowish **chloragogue cells**

→ equivalent to our liver: synthesizes glycogen and fats

→ they also travel through coelom to repair wounds

→ function in excretion: convert amino acids to urea & ammonia

Respiration

no respiratiory organs or parapodia like polychaetes

breath through skin, no lungs or gills

extensive system of **capillaries** in epidermis

Excretion

paired **nephridia** in each body segment

in aquatic forms nephridia release ammonia

in terrestrial forms nephridia release urea (conserves water)

in fw and terrestrial oligochaetes nephridia not only eliminate wastes but also eliminate excess water (osmoregulation)

also, terrestrial worms have **calciferous glands**

worms eat soil; soil has lots of calcium

high levels of calcium in blood

calciferous glands remove excess calcium from blood and deposit it in the intestine for removal

Sense Organs

rather than concentrated in head they are distributed all over body

numerous sensory cells (chemo- and mechano-receptors) on skin

chemoreceptors esp on prostomium

many free nerve endings → probably tactile

earthworms have no "eyes" but do have numerous photoreceptors in epidermis

Earthworm Reproduction

earthworms are **hermaphrodites**

cross fertilize each other

copulation involves a **double exchange** of sperm cells

mucous secreted from **clitellum** holds pair together with genital pores aligned

can last 2-3 hours

sperm is deposited in seminal receptacle

after copulation worms return to burrows

fertilization and egg laying occur a few days later

each worm secretes a sheath of mucous around **clitellum**

clitellum then secretes nourishment for egg

then envelopes mucous and food in tough chitin-like cocoon

the worm then backs out of the cocoon

as cocoon slips over the genital openings it receives an egg, then sperm

fertilization occurs in the cocoon

cocoon is deposited in soil

in 2-3 weeks a new worm emerges

Ecological Effects of Earthworms

1. Detritus food chain

eg. Night Crawler

burrow within the upper 30 cm of moist soil rich in organic matter

in soft soil earthworms move by peristaltic contractions

setae prevent back sliding

this type of movement only works because segments are separated by septa

mainly active at night

on warm damp nights, forage for leaves and organic debris

up to 54,000 earthworms /acre
→ turn over 18 tons of soil per year

prefer moist soil but if too much water they will move to surface

→ sometimes in great numbers

→ used to think they "rained" down from the sky

important in keeping soil fertile since they are constantly turning over earth and mixing organic matter into it

if all material ever moved through earthworm gut was piled on surface of earth it would rise 30 miles above sea level (5x's height of Mt Everest)

2. Food for birds and other animals

Human & Economic Impacts of Earthworms

1. Food for Humans

in some parts of Asia, Africa and Latin America people regularly eat worms

usually because there is not much other food available

a few restaurants in the US offer them as novel food fare

2. earthworms improve the productivity of farm soil

sometimes doubling or tripling crop yields

3. Fishing bait

worms are commonly used for freshwater fishing

nightcrawlers, redworms

4. Vermicomposting

using worms to recycle compost

Subclass Hirudinea
(Leeches)

500 sp

mainly freshwater

a few marine and terrestrial

most 2-6 cm long; some to 20 cm

often brightly colored

many are **carnivores**; some are **parasites**

body is dorsoventrally flattened

anterior and **posterior suckers**

fixed number of true segments

→ usuall 32 plus prostomium & pygidium

each segment with 2-14 **annuli** (=false segments)

Body Wall

coelom functions as a single large chamber

→ no septae between segments

coelom is filled with connective tissue and muscle

except for a system of spaces (=coelomic sinuses and channels) filled with coelomic fluid

→ acts as secondary circulatory system

Movement

no parapodia
(except 1 genus)

no setae

leeches have poor hydrostatic skeleton

aquatic species use muscle layers to make undulating swimming movements

can also use suckers to move like inchworms

some terrestrial forms are able to "stand up" on hind sucker to search for prey

Feeding & Digestion

most are **predators** of snails, worms and insect larvae

protrusible **pharynx** with 3 jaws armed with teeth

some are scavengers

some are blood sucking parasites

adaptations to parasitism by leeches:

attach to host with suckers

pierce skin with sharp teeth on end of proboscis

while cutting, secrete local anesthetic and histamine-like chemical that dilates blood vessels of host

consume large blood meals

→blood is sucked by muscular pharynx

while being swallowed, blood mixes with **hirudin** (anticoagulant) to prevent clotting

very slow digestion

gut secretes very few digestive enzymes

→depend on **bacterial digestion**

can live for almost a year on one meal

may take up to 200 days to digest one meal

can live for another 100 days afterwards

Respiration

most exchange gasses through skin

a few aquatic forms have **gills**

Circulation

many species have no blood vessels

coelomic fluid does the work of blood in open haemocoel

may be hemoglobin in haemocoel fluid

Nervous System

nervous system similar to other annelids

but leeches have two "brains"

→ one composed of paired cerebral ganglia around pharynx as in other annelids

→ the other in posterior of animal consists of 7 pairs of fused ganglia

simple sense organs are much better developed in terrestrial species which tend to be blood suckers

Reproduction

hermaphroditic

mating process similar to earthworms

→ cross fertilize during copulation

do have **clitellum**

→produce coccoon that receives eggs and sperm

Human Impacts of Leeches

1. **medicinal uses**

in past centuries medicinal leech, *Hirudo*, was used to suck out "bad blood"

believed many bodily disorders were the result of bad blood or too much blood

→ were collected almost to extinction in Europe

now a protected species

introduced into US but rare in nature

today leeches used in medicine to speed healing of reattached fingers and limbs

2. commonly used in **biology labs**

3. leeches have become leading **research models** for understanding how the nervous system works

4. some chemicals used by the leech in obtaining and digesting blood are being studied for treating circulatory diseases

5. leeches have also affected history:

eg. land leeches of India

live in extremely large numbers in humid forests of India

live in trees and shrubs and fall like "drops of dew" onto any humans passing underneath

their mass attack caused the retreat of a British regiment during the Sikh rebellion in India in mid 1857 (rebellion against East India Company)

Class: Echiura
(Spoon Worms)

140 species

sausage shaped worms

1 cm to 50 cm

all marine

most live in shallow waters; a few deep water forms

→many burrow in sand or mud

→other live in rock and coral crevaces

→a few live inside dead sand dollars, mollusc shells, or annelid tubes

they enter shells when young and get too large to leave

generally are deposit feeders

Body Form

cylindrical and somewhat sausage shaped

resemble sipunculans in size and general habits

body in two parts:

anterior flattened **proboscis** (=prostomium)

can be extended and retracted

posterior cylindrical **trunk**

Proboscis

has ciliated groove giving it a spoon-like appearance

proboscis is very mobile

sweeps on mud to find organic debris

can extend up to 10 times its retracted length

eg. *Bonellia* is 7 cm (~3.5") long and can extend its proboscis 1.5 meters (4.5')

no tentacles

Trunk

trunk is gray, reddish brown, or rose

body has several sets of **setae**

→hooked, anterior setae used for digging burrows

→setae at posterior end for anchorage

→ circles of setae around posterior end for anchorage and burrow maintenance

Feeding and Digestion

most are deposit feeders

collect small particles of detritus

digestive system is extremely long and coiled

mouth is at base of prostomium

anus is at posterior end of trunk

Circulation

simple closed circulatory system

Excretion

excretion by nephridia

Nervous System

simple nervous system

circumenteric nerve ring

ventral nerve cord

Reproduction & Development

dioecious

show sexual dimorphism;

- males often much smaller

gametes shed into water

external fertilization

produces **trochophore** larva

- metamorphosis to wormlike adult

some males are parasitic

- in some species (eg green spoon worm; *Bonellia viridis*) the first larvae to settle and metamorphose become females
- larvae that land on top of female become males
- the tiny male creeps up her body, into her mouth and migrates down to her uterus
- up to 20 males become parasitic in the females uterus giving her an instant supply of sperm without having to search and mate.

Human Impacts

in arctic spoon worms were once eaten by eskimos