A. William Allen

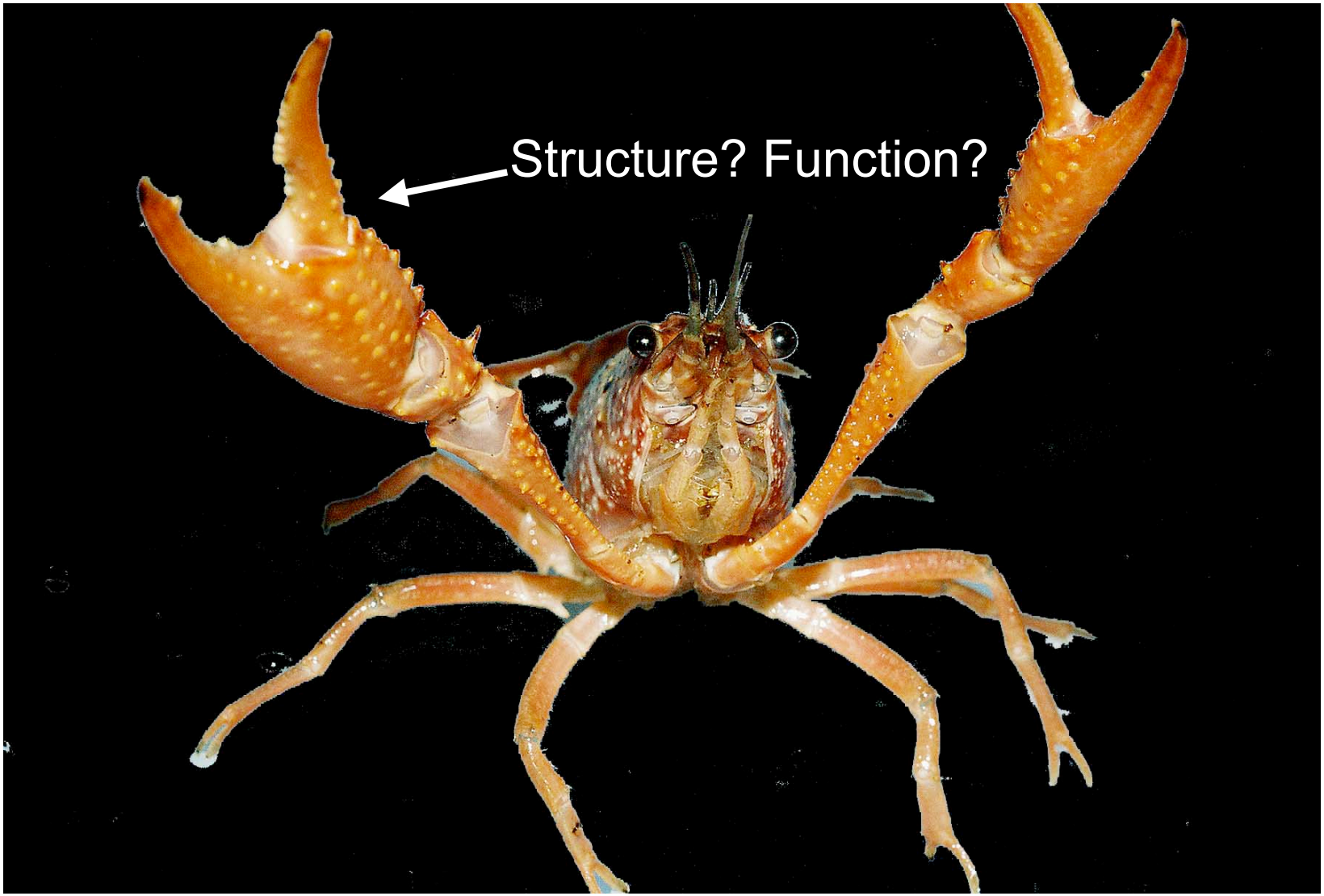
Office hours:
Monday 10:00 AM to 1:00 PM
or by appointment
PAI 1.22G

Reminder:
Exam I on Monday March 30
7:30-9:00 PM
Covers labs 1-7

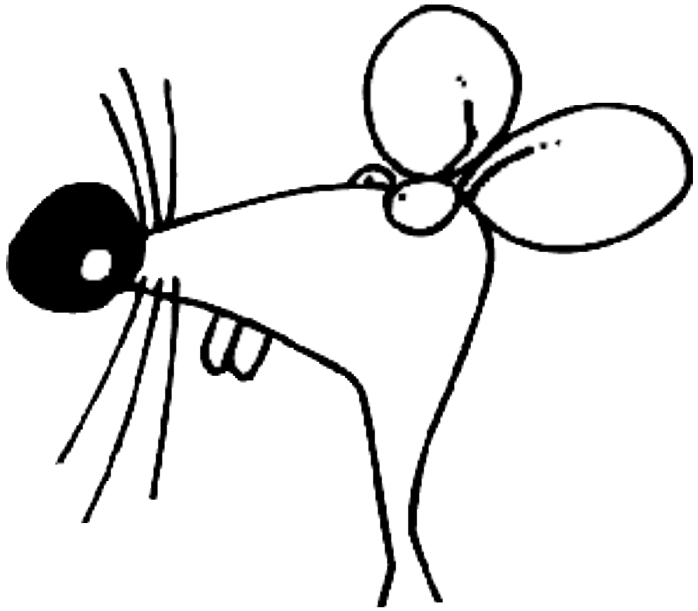
Bring #2 pencil

Go to the Exam room assigned by lecture time

- 8:00 AM lecture room JES A121A
- 9:00 AM lecture room UTC 2.112A
- 2:00 PM lecture room BUR 106


Structure? Function?

Rattus norvegicus Dissection



Rat Dissection Objectives

- A. Describe structures of the rat, using anatomical directions.
- B. Describe the major systems of the rat, and compare these system with those of the crayfish and humans.
- C. Relate the physiology of the major systems of the rat to its anatomy.

Anatomical terminology

ANATOMICAL Directions

- Cranial (Anterior)/Caudal (Posterior)
- Dorsal/Ventral
- Lateral/Medial
- Proximal/Distal
- Superior/Inferior

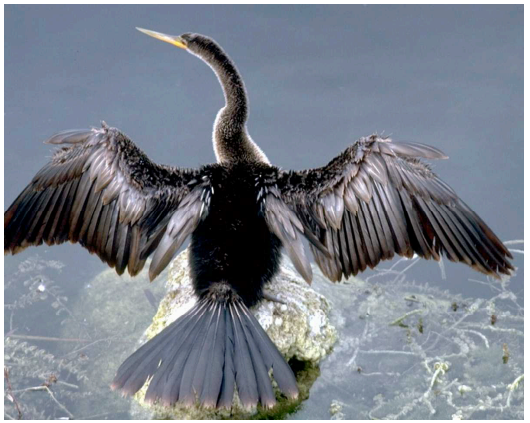
Structures performing similar functions may or may not share a common ancestry.

- Homologous
- Analogous

Homologous

- Organs which are equivalent morphologically and of common evolutionary origin but which may be similar or dissimilar in appearance or function.

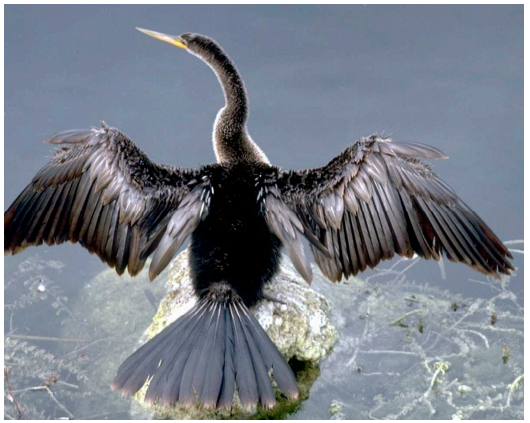
- bird wing vs. reptile forelimb



Analogous

- Organs which are similar in appearance and/or function but which are neither equivalent morphologically nor of common evolutionary origin.

- bird wing vs. insect wing.



A. Analogous B. Homologous

- 1. Rat Testis & Ovaries
- 2. Rat Vas Deferens & Oviduct
- 3. Crayfish mandibles & rat jaw

Taxonomy

- Phylum: Chordata
- Subphylum: Vertebrata
- Class: Mammalia
- Order: Rodentia
- Family: Muridae
- Genus: *Rattus*
- Species: *norvegicus* or *rattus norvegicus*

Phylum Chordata

- Invertebrates
  - Urochordates (tunicates)
  - Cephalochordates (lanclets)
- All vertebrates

Chordate Characteristics

{Structures in embryo stage}

- 1. Notochord (gives name to phylum)
- 2. Dorsal, hollow nerve cord
- 3. Pharyngeal silts/pouches
- 4. Segmented body & Postanal tail

Few notes on notochord

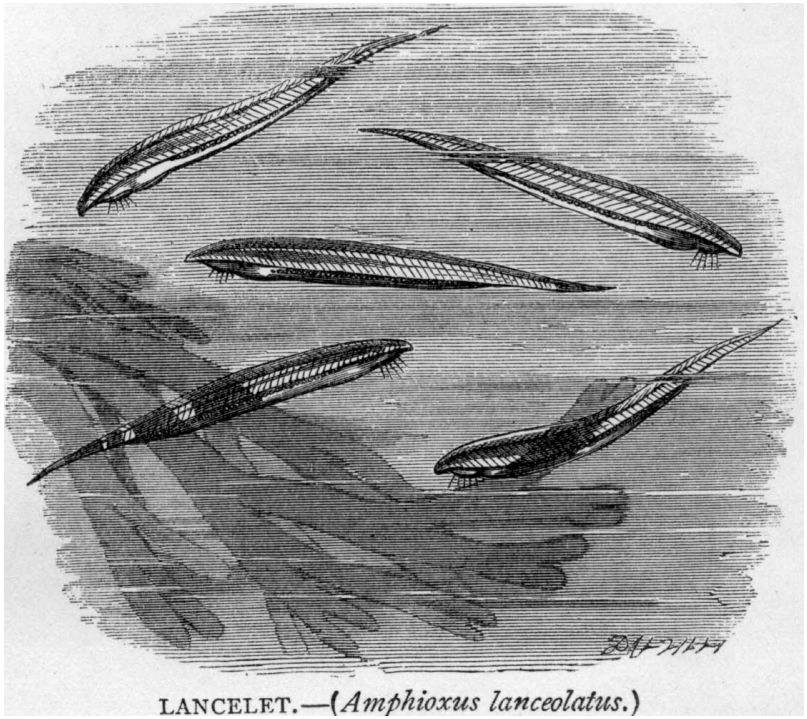
- Hollow tube between gut and neural tube
- Persists in adult of some invertebrate chordates and primitive vertebrates.
- Remnants only remain in material of invertebral disks in other vertebrates

Fate of pharyngeal pouches in mammals

- Parts of face
- Muscles of mastication, facial expression
- Eustachian tubes
- Bones of middle ear
- thymus and parathyroid glands

INVERTEBRATE CHORDATES

Cephalochordates (lanclets)



LANCELET.—(*Amphioxus lanceolatus.*)

Urochordates (tunicates)

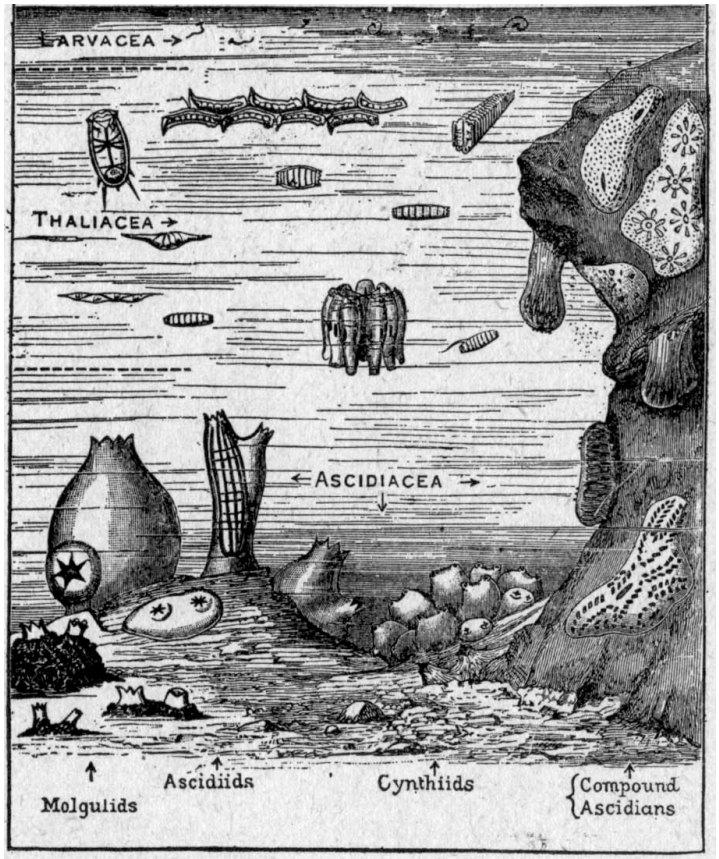
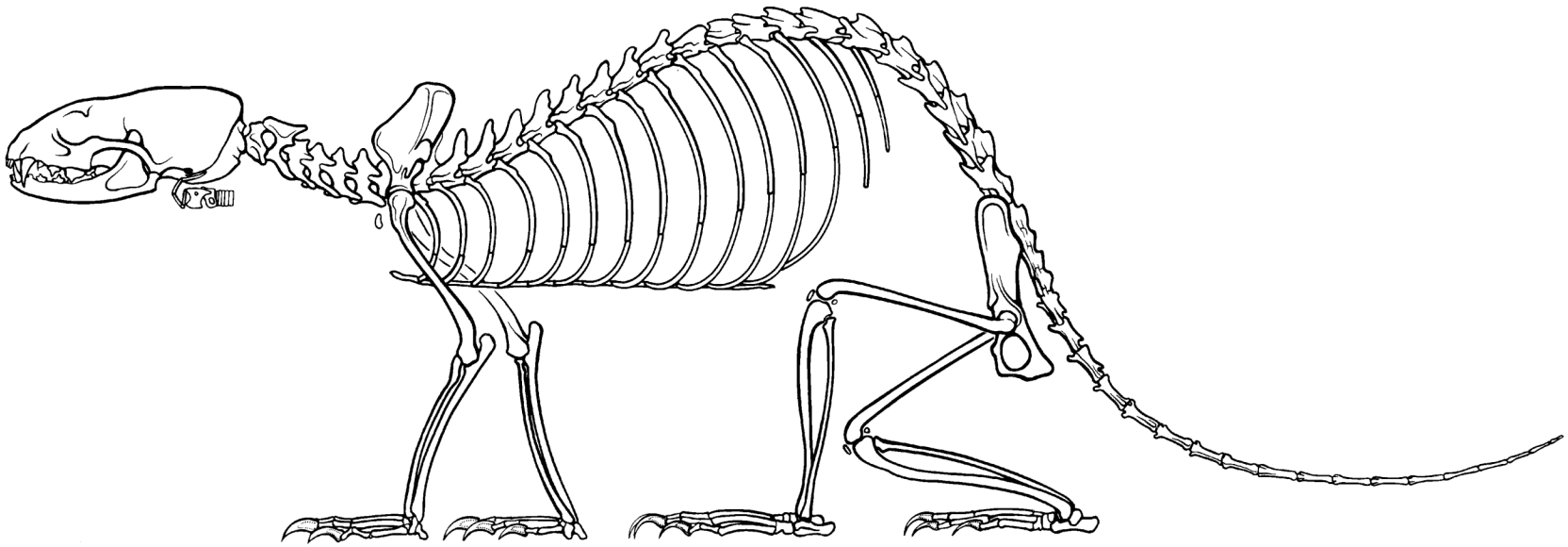


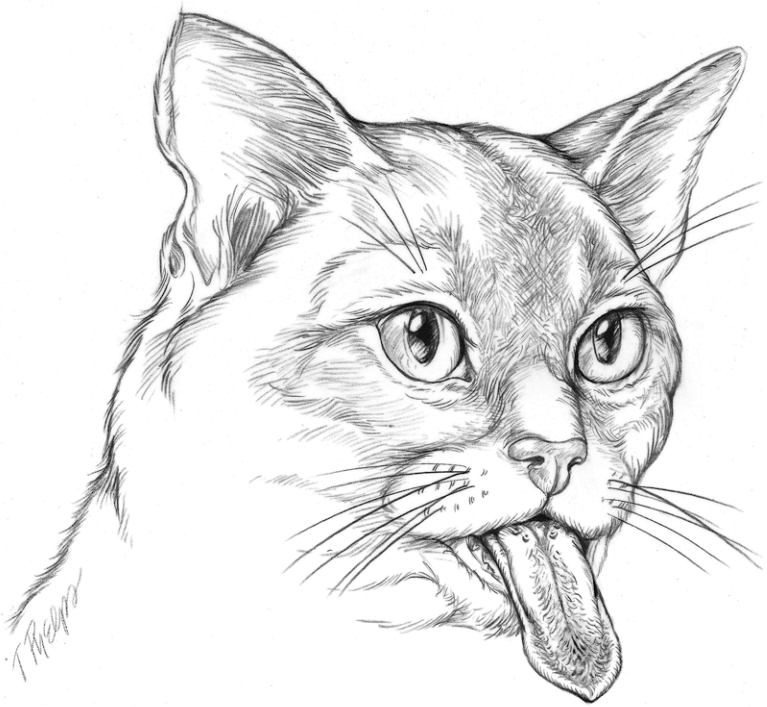
FIG. 337.—Sketch of the chief kinds of TUNICATA found in the sea.

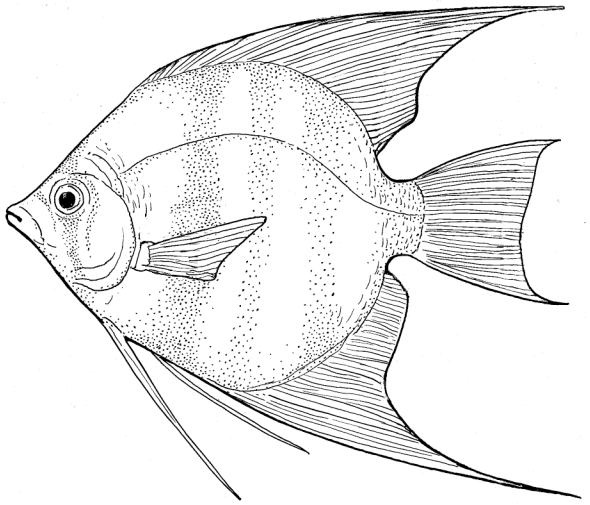
Vertebrate Characteristics

- 1. Presence of notochord (at least in embryo)
- 2. Presence of a pharynx with slits in its wall (at least in embryo)
- 3. Occurrence of a dorsal tubular nervous system
- 4. Development of vertebrae



VERTEBRATES





Rattus

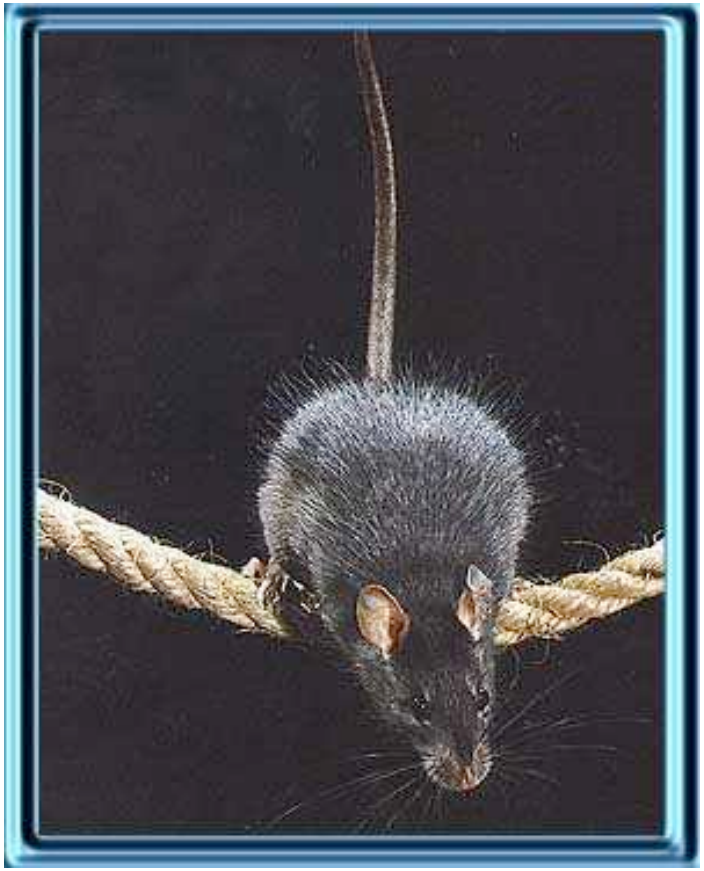
- *ORDER: RODENTIA*
  - *Possess chisel-like continuously growing incisor teeth*
- *FAMILY: MURIDAE*
  - *Rattus rattus* ("black rat")
  - Rattus norvegicus (Norway or house rat)

Naming conflict

Different species or same species but different subspecies?

- Norway Rat *Rattus rattus norvegicus*
  - *Rattus norvegicus*
- White Laboratory Rat (albino)
  - *Rattus norvegicus albinus*
- Black (Ship) Rat
  - *Rattus rattus*

Rattus rattus (black rat)



- Black rat (also called the common rat or the ship rat) originated in Southeast Asia
- Black rat well established in Europe by 1100 AD following Crusades
- Black rat sails to North American coast by 1584.

http://www.the-piedpiper.co.uk/th1b.htm

The Black Death-bubonic plague

- Black rat is the rat of the great plagues and of the "Pied Piper" story (circa 1284).
- The Black Death is the setting for Giovanni's Boccaccio's 1350s tales in the *Decameron*
- In more contemporary times, Albert Camus explores the black death phenomenon in his novel *The Plague*

http://en.wikipedia.org/wiki/Image:Holbein-death.png

THE PIED PIPER OF HAMELIN 1284

"Well, yes he is good, but basically all he's done is rewrite old Beatles melodies."


RESEARCH
LAB
TOOS

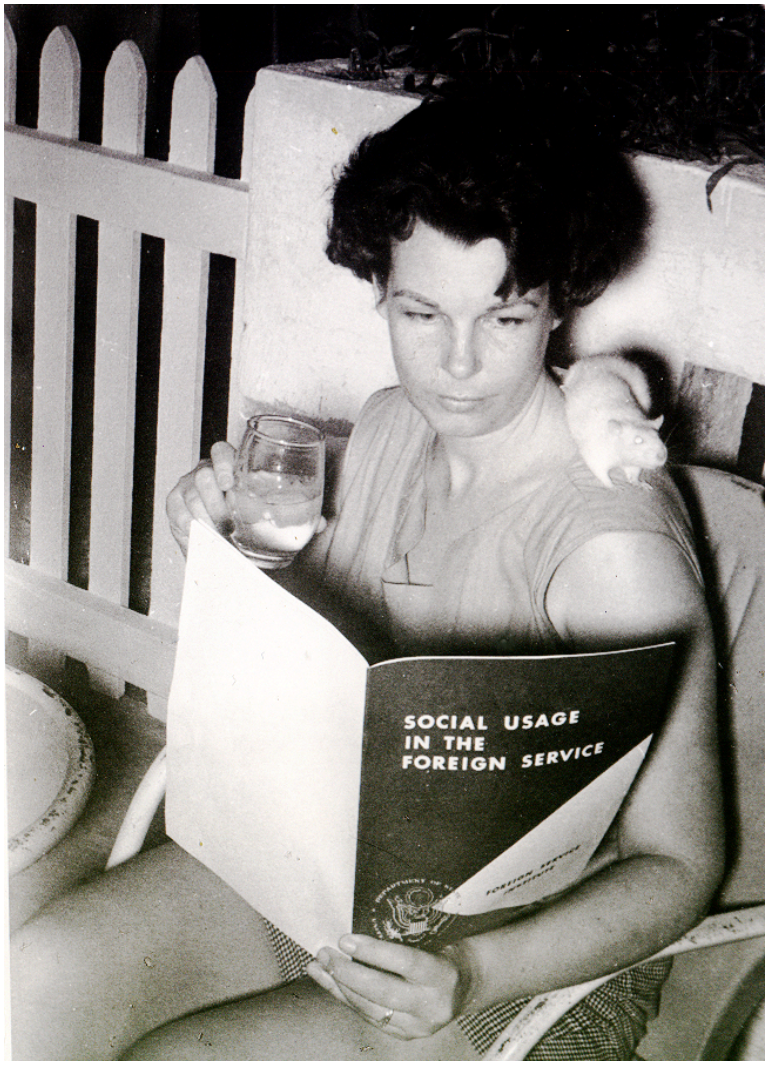
Rattus norvegicus (brown rat)

- Norway rat carried to China by ocean ships and then by overland caravans or Asiatic waterways to Europe in early eighteenth century.
- Norway rat reaches England before 1730 and makes its way to North America in latter part of that century.
- The larger Norway rats dominate habitats.
- When coexisting, Norway rats prefer basements and lower floors and Black rats are partial to attics and upper stories.

http://en.wikipedia.org/wiki/Brown_rat

Rattus norvegicus albinus

- *A representative vertebrate*



-Nocturnal omnivores

-poor vision

-rely on smell and touch

Thoughts on rats

- "From the point of view of all other living creatures, the rat is an unmitigated nuisance and pest. There is nothing that can be said in its favor. It can live anywhere and eat anything. It burrows for itself when it has to, but, when it can, it takes over the habitations of other animals, such as rabbits, and kills them and it swims.
- It carries diseases of man and animals–plague, typhus, *trichinella spiralis*, rat-bite fever, infectious jaundice, possibly foot-and-mouth disease and a form of equine 'influenza.' Its destructiveness is almost unlimited."

  - Zinsser, H. (1937). *Rats, lice and history*. Boston: Atlantic-Little Brown, p.202-203.

Invertebrates and Vertebrates

Compare and contrast

Evolutionary Lines of Coelomates

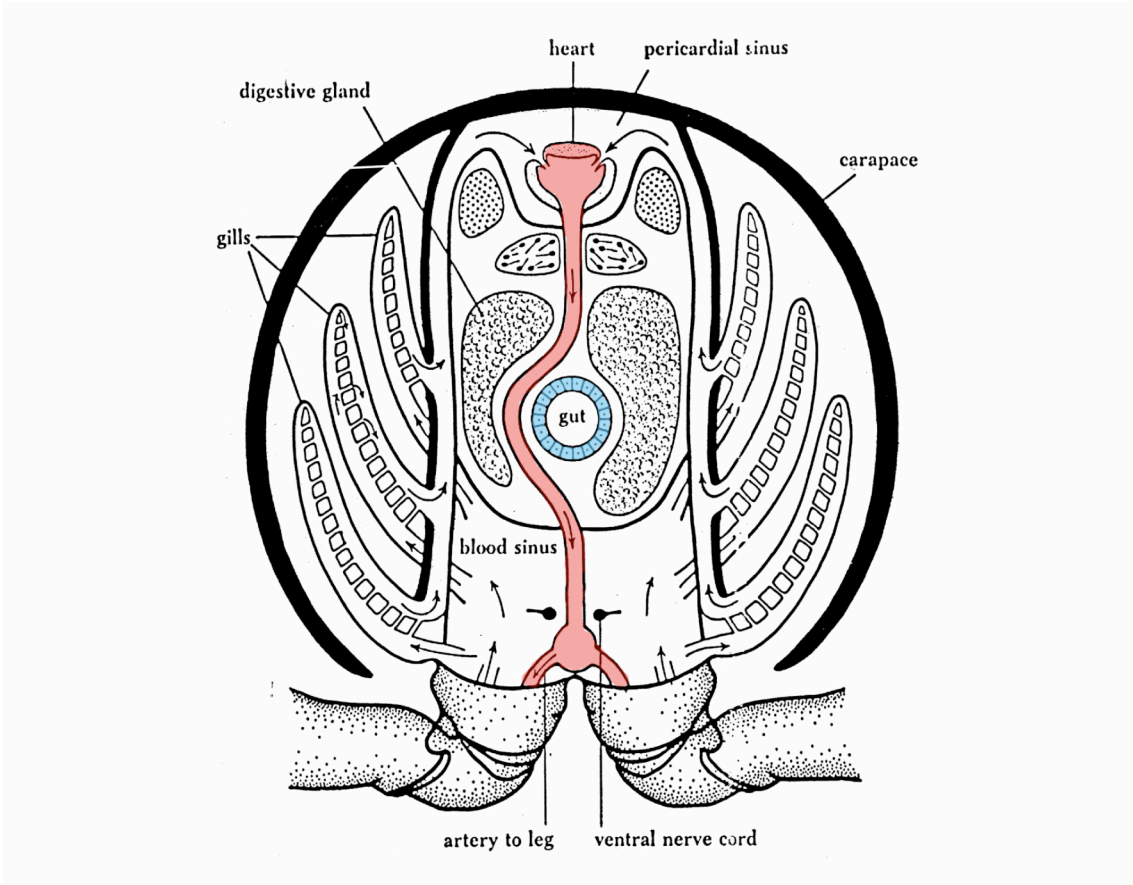
- Protostomes (annelids, mollusks, arthropods)
- Deuterstomes (echinoderms, **chordates**)

A couple of Basic Body Plans

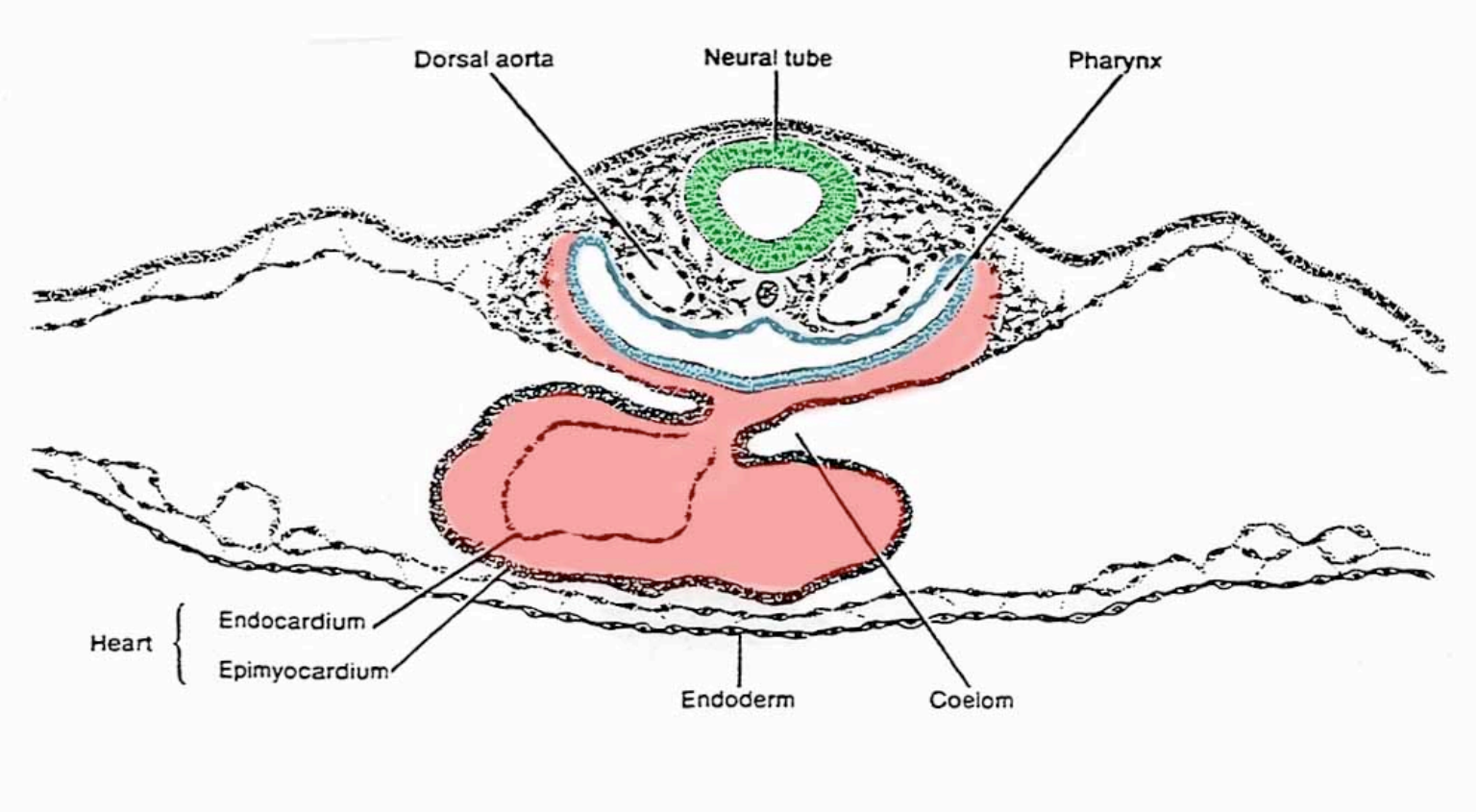
- Invertebrates (animals without backbones, make up about 95% of all animal species)

- Vertebrates (chordate animals with backbones, vertebrae)

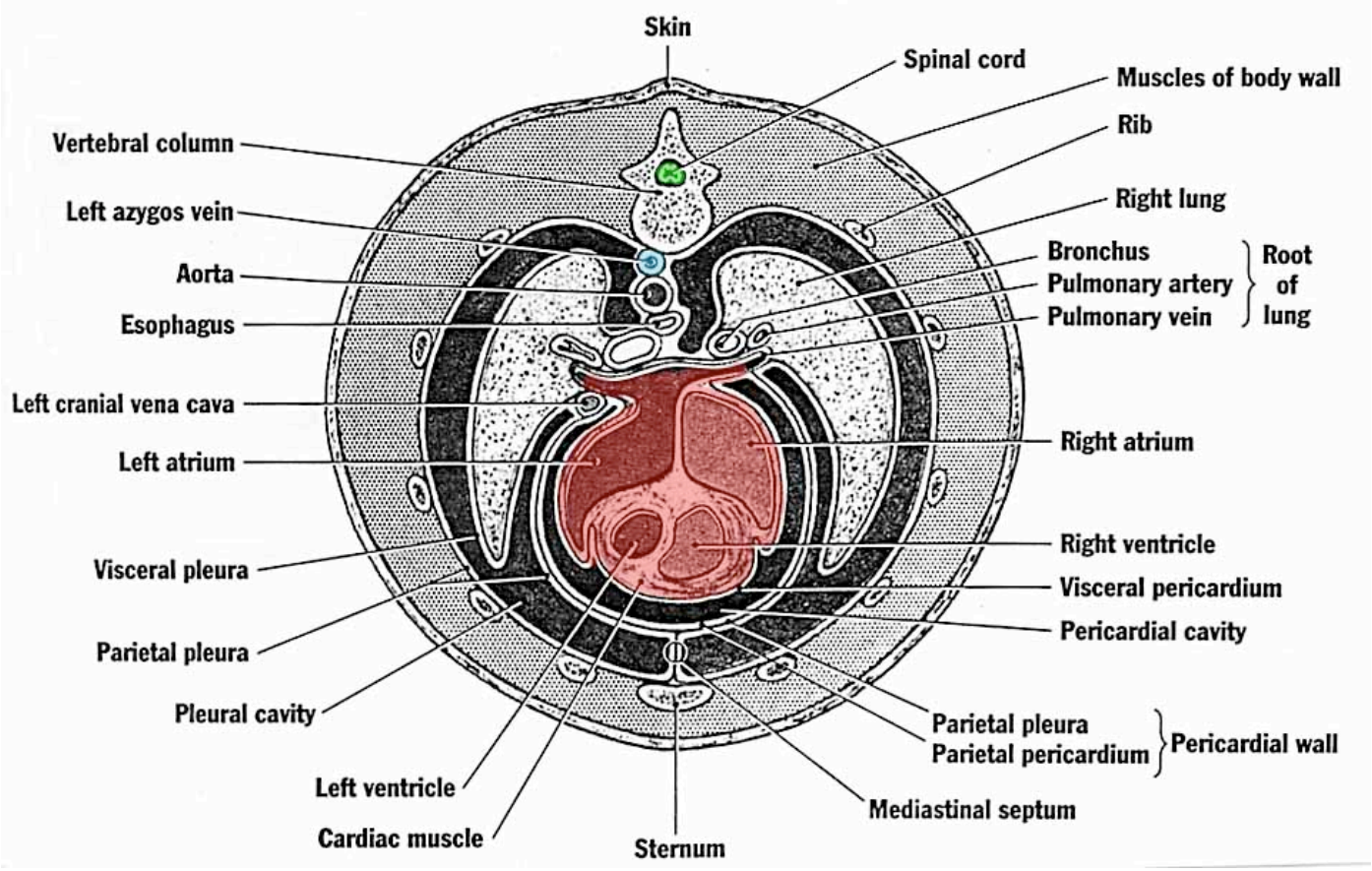
Crayfish Body Plan



33 Hr Chick Embryo body plan



RAT TRANSVERSE SECTION



Geoffroy Saint-Hilaire 1830

- Suggested body plan of vertebrates was a flipped over version of invertebrate plan.
- Now known that vertebrates and invertebrates have the same master control genes using the same body-building instructions to build very different kinds of animal bodies.

A. Dorsal B. Ventral C. Medial

ORGANS	CRAYFISH	RAT
HEART	dorsal	ventral
NERVE CORD	ventral	dorsal
GUT	Medial	medial

Comparison between representative vertebrate and invertebrate

Comparisons

	Crayfish	Rat
Circulatory system	Open Heart--->arteries	Closed Double circuit
Excretory system	Green gland Ammonia	Kidney Urea
Nervous system	Ganglion/nerves	CNS/PNS
Special sensory organs	Antennae, compound eye	Single lens eye, nose, tongue, ear
Gas exchange	Gills	Lungs

Comparisons continued

	Crayfish	Rat
Mechanical digestion	Gastric mill (cardiac mill)	Teeth (jaws)
Chemical digestion	Digestive gland	Mouth, stomach, pancreas
Food absorption	Digestive gland	Small intestine
Role of hind gut	Pass undigested food to anus	Absorb water/pass undigested food to anus

More comparisons

	Crayfish	Rat
Male morphology	Testis, vas deferens, genital pore	Testis, vas deferens, urethra
Female morphology	Ovary, oviduct, genital pore	Ovary, oviduct, uterine horns, vagina
Fertilization	External fertilization	Internal fertilization

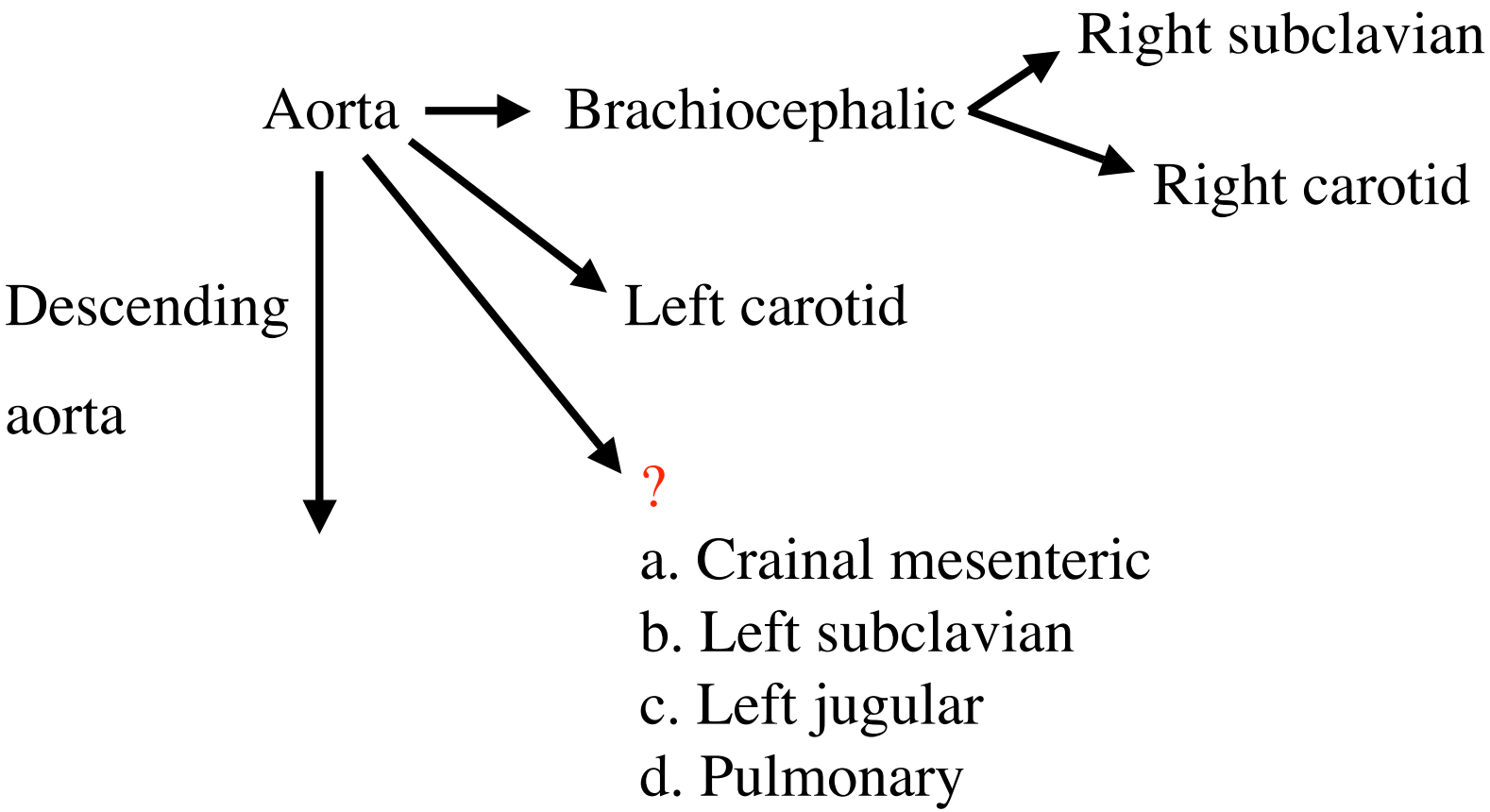
A. Crayfish (invertebrate) B. Rat (vertebrate)

- 1. Open circulatory system?
- 2. Excretory system: Kidney-->urea?
- 3. Nervous system: ganglion & nerves?
- 4. Mechanical digestion: gastric mill?
- 5. Food absorption: small intestine?
- 6. Male morphology: testis, vas deferens, genital pore?
- 7. Female morphology: ovary, oviduct, uterine horn, vagina

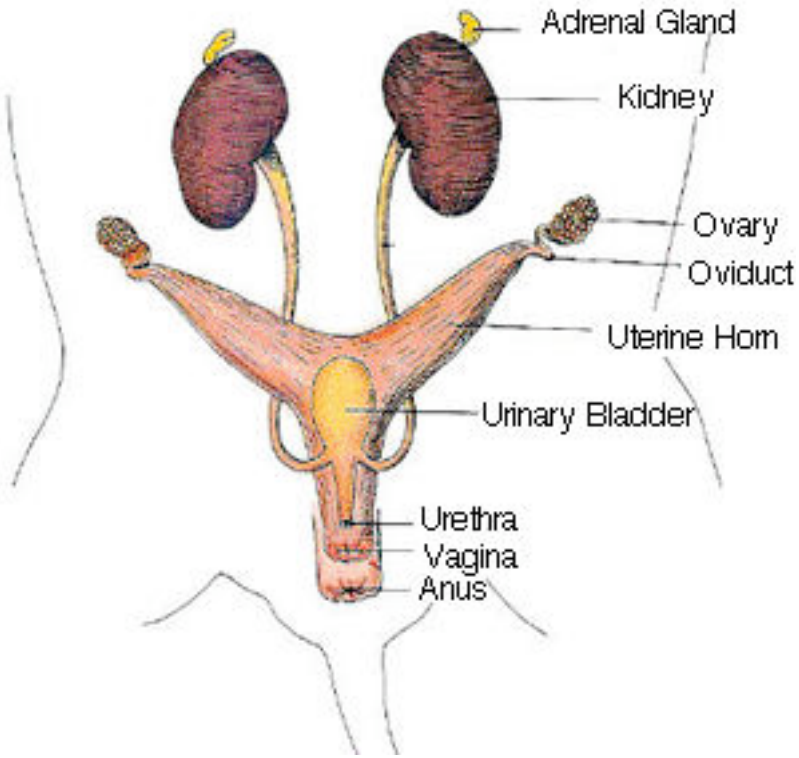
Some Points for Dissections

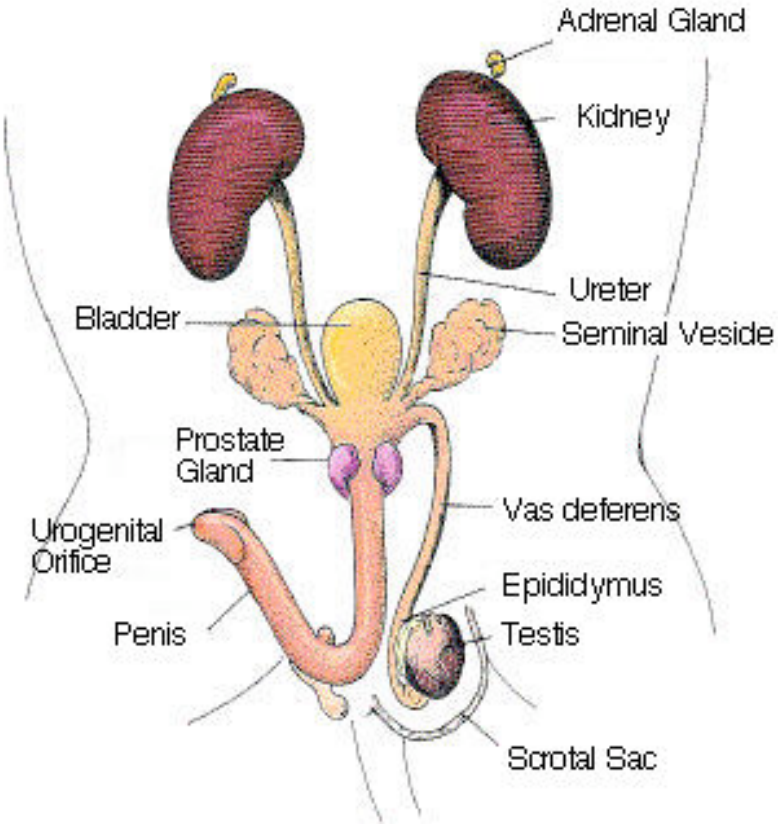
- Read & follow directions carefully
- Examine diagrams and atlas photographs
- Turn dissecting pan to comfortable position
- Separate veins, arteries, and organs from connective tissue with probe.
- Trace one system at a time.
- Compare rat body plan and systems with crawfish dissection.

For example, trace major blood vessels (red latex: arteries, blue latex: veins)



Compare & Contrast





http://images.google.com/imgres?imgurl=http://www.biologycorner.com/resources/rat-1.gif&imgrefurl=http://www.biologycorner.com/bio3/rat_guide.html&h=267&w=180&sz=16&tbnid=hUYnmDZcTAXbhM:&tbnh=113&tbnw=76&prev=/images%3Fq%3Drat%2Bdissection&start=3&sa=X&oi=images&ct=image&cd=3

THE PIED PIPER OF HAMELIN

- *In 1284, the town of Hamelin is suffering from a terrible plague of rats. The town council tries everything to get rid of them -- without success. At last, the Mayor promises 1000 florins to the one who can put an end to the plague. A stranger dressed in bright red and yellow clothes shows up and says he can rid Hamelin of the rats. At night, the stranger starts to play a soft tune on a flute, luring all the rats out of the houses and barns towards the river Weser, where they drown.*
- *The Mayor refuses to pay the piper: "Playing a tune on a flute is not worth 1000 florins. Get out of Hamelin!"*
- *But the piper returns on a Sunday morning, when all the grown-ups are at church. Again he starts to play a tune on his flute. This time, all the children follow him, as he walks out of the gate to the mountains. Suddenly, a cave opens in the mountain. The piper walks into the mountain, still followed by the children, and the cave closes again. The children were never seen again in Hamelin.*

http://www.ims.uni-stuttgart.de/~jonas/piedpiper.html

- The diversity of Hox-related features in arthropods (segment morphology, appendage number and pattern) and vertebrates (vertebral morphology, limb and central nervous system pattern) suggests that Hox genes have played an important role in morphological evolution. Recent studies of many different types of animals suggest that much of animal diversity has evolved around a common set of Hox genes that are deployed in different ways and regulate different genes in specific groups.1