

# ZOO 4377L - VERTEBRATE MORPHOLOGY LAB

## LAB 2: LAMPREYS

Name: \_\_\_\_\_

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### **N.B. Preparation for next week's lab (Hemichordates & Protochordates) 1) Walker & Homberger - Chapter 1 (pp. 1-15)**

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Preparation: Walker & Homberger - Chapter 2 (pp. 16-28)

#### **INTRODUCTION**

Today we will examine the anatomy of a representative of the most "primitive" (least derived) class of vertebrates, the jawless fish or "agnathans". You will recall from your craniate phylogeny handouts that the hagfish (Myxinoidea) are currently considered the most basal group among craniates and that the lampreys (Petromyzontoidea) are slightly more derived, being the sister taxon to the Gnathostomata or jawed vertebrates, and forming with latter the clade Vertebrata.

You will recall that all organisms are mosaics of primitive and derived features. Thus, the lamprey is not representative in all ways of the ancestral "agnathan" that gave rise to the jawed vertebrates (Gnathostomata). Instead, it has retained several primitive characters that link it to the fossil forms (e.g., notochord with arcualia, lack of jaws, single nasal opening) but in other aspects of its anatomy, it has diverged significantly from the ancestral condition. For example, the feeding apparatus and digestive system of the lamprey are highly derived, being specialized for a parasitic "blood-sucking" adaptation. It is highly improbable that "blood-sucking" represents that ancestral feeding strategy (given the absence of any suitable host), and thus the feeding apparatus and digestive systems of the fossil "agnathans" was quite different.

- ? From your package of vertebrate phylogenies (specifically, Phylogeny of Living Vertebrates (Pough et al., 1996)), list the synapomorphies (shared derived characteristics) that unite the lampreys (Petromyzontoidea) and the Gnathostomata (jawed vertebrates) to form the (monophyletic) clade Vertebrata.

#### **DISSECTION OF ADULT LAMPREY:**

**N.B.** Use the text descriptions on page 19 to locate the position of your transverse sections rather than Figure 2-3; the latter contains some inaccuracies. It is important that your cuts be as close to perpendicular to the longitudinal axis of the body as possible.

Work in pairs for dissection; follow the instructions and identify structures in Walker & Homberger pp. 16-25. Refer to demonstration dissections and models in lab as needed. Answer all questions (preceded by a "?") in your handout and turn in your handout at the end of next week's lab period. Please note that in section 2 a function is requested for each structure marked by a "!". Structures appearing in **bold** will form the basis for next week's quiz. Hint: To help you study for the

quiz, you might wish to record how to identify the structure while doing today's lab (e.g., **dorsal aorta** - vessel ventral to notochord)

**sea lamprey** (*Petromyzon marinus*; Gr., rock + sucker + sea)

- in traditional (evolutionary) taxonomy lampreys belong to the superclass "Agnatha" (G. without jaws; also called the "Cyclostomes" (G. circle mouth)) which consists of 2 extant classes: Myxiniiformes (hagfishes) and Petromyzontiformes (lampreys)
- the lamprey is descended from the earliest class of vertebrates ("Agnathans") but like all extant vertebrates is a mosaic (mixture) of primitive and derived features
- particularly derived is its feeding apparatus and digestive system; lampreys attach to other fishes by means of a suctorial dermal funnel, rasp away the flesh of their prey with their protusible tongue, and then suck their prey's blood
- also derived is the eel-like body and absence of bone (secondarily lost)
- although adult lampreys are marine, they spawn in fresh water where their larvae (ammocoetes) hatch and burrow into the substrate to live as filter feeders; when the larvae are approximately 12 cm in size they metamorphose into an adult and migrate to the sea

**1) EXTERNAL MORPHOLOGY**

Somatology (W&H Figure 2-1):

Record the following measurements for your specimen:

- weight (gms):
- total length (cm):
- snout-gill slit (last) length:
- snout-vent length:
- vent-tail length:
- circumference at lateral eyes:
- circumference at 4th external gill slit
- circumference posterior to external gill slits:
- circumference between cranio-dorsal and caudo-dorsal fins
- maximum height of cranio-dorsal fin:
- maximum height of caudo-dorsal fin:

? Define the borders of the three body regions using anatomical landmarks:

**head:**

**trunk:**

**caudal:**

Sketch and identify the fins:

**craniodorsal fin**

**caudodorsal fin**

**caudal fin**

? Which of these is symmetrical about the frontal plane?

Make a cut across one of the dorsal fins in the frontal plane and look at the cut surface under a dissecting scope to see the **fin rays**, cartilaginous rods which support the fin.

Identify the following parts of the **buccal funnel**:

- fringed by **papillae**

? What do these do (i.e., what is their biological role)?

- lined with **horny teeth** (the non-linugal ones)

? What do these do (i.e., what is their biological role)?

? Are the horny teeth true teeth (i.e., comprised of dentine covered by enamel)?

? If not, of what are the horny teeth made?

In the roof of the mouth identify the protrusible **tongue** and the *mouth opening* just dorsal to it

? Smaller horny teeth are found on the tip of their tongue. What is their biological role?

#### Dorsum of the head region

##### **median nostril**

? The nostril carries water to what sensory organ via what channel/passage?

##### **pineal eye**

? Where is the pineal eye located relative to the median nostril?

##### **lateral eyes**

? Are there eyelids present?

##### **external gill slits**

? How many are there on each side? Are they bilaterally symmetrical?

#### Anterior head region

Note the bumps and pores which form the **lateral line system**.

? What sensory modalities (types of sensation) do these sensory organs detect?

? Make a sketch map of their distribution in 1) cranial, 2) dorsal, 3) lateral and 4) ventral views.

#### Ventral surface

- locate the **cloaca** (L., sewer)

- spread the opening to observe the **urogenital papilla**

? What 2 organ systems are associated with this structure?

- the **anus** lies cranial to the papilla

FYI In ancient Rome, a euphemism for going to the lavatory was to “make an offering to ‘Cloacina’”, the Roman goddess of sewers.

## **2) TRANSVERSE SECTIONS**

Using the *text* (i.e., written, **not** illustrated) directions on page 19 of Walker and Homberger, make the 7 cross-sections (transverse plane) described. Note that Figure 2-3 *incorrectly* illustrates the location of the cuts. It is important that you make the transverse sections as perpendicular to the long axis as is possible. Using Figures 2-3 and 2-4 identify the following structures and provide a function for all structures preceded by a “!”.

? Define the transverse plane:

Section A - Transverse section at level of lateral eyes

! **pineal eye**

! **olfactory sac**

! **hypophyseal pouch**

- ! carotid artery
- ! **lateral eyes**
- ! lingual cartilage - median
- ! oral glands

Section B - Transverse section at level of the 4th external gill slit

- ! **arcualia**
- ! **spinal cord**
- ! **notochord**
- ! **dorsal aorta** - filled with pink latex
- ! cranial (anterior) cardinal veins (may not be identifiable)
- ! **esophagus**
- ! **respiratory tube** - ventral to esophagus
- ! **internal gill slit**
- ! **external gill slit**
- ! ventral aorta

Section C - Transverse section at level of the heart

- ! **myomere**
- ! **dorsal aorta**
- ! **esophagus**
- ! **heart** - the following chambers of the heart may not be discernable in all sections
  - sinus venosus
  - atrium
  - ventricle
- ! pericardial cavity
- ! pericardium

- ? On this segment (or any more distal segment) reflect the skin (about 3 cm wide) on one side from dorsal midline to ventral midline to expose the shape of the myomeres in lateral view. Make a sketch of your dissection, recording the shape of the myomeres and myosepta.

Section D - Transverse section at level of the liver

- ! **dorsal aorta**
- ! caudal (posterior) cardinal vv
- ! **liver**
- ! **intestine**
- ! **pleuroperitoneal cavity**

Section E - Transverse section at level of caudal trunk

- ! **myomere**
- ! **caudal (posterior) cardinal vv**
- ! **gonads (ovary or testes)**
- ! **kidneys**
- ! **intestine**

- ? What is the sex of your specimen? How can you tell? You may have to compare your animal to those of your classmates. Lampreys are an example of semelparous organisms (L, once + birth), organisms that reproduce only once and die; e.g., salmon, bamboo, yucca. The opposite of semelparity is iteroparity (L, repeat +

birth) which describes organisms capable of repeated reproduction. Are humans semelparous or iteroparous?

Section F - Transverse section through the tail

- ! caudal ray fin
- spinal cord**
- notochord**
- ! caudal artery
- ! caudal vein

### 3) SAGITTAL SECTION

Sagittal section - use the prosected specimen or ask the instructor for assistance in making your own, if sufficient specimens are available. The mounted wet-specimen model and Walker & Homberger Figure 2-3 can assist you.

- ! **buccal funnel**
  - ! **horny teeth**
  - ! tongue
  - ! **lingual cartilage**
  - mouth
  - ! **median nostril**
  - pineal eye**
  - olfactory sac**
  - ! **brain**
  - ! chondrocranium
  - notochord**
  - ! **velum**
  - ! **respiratory tube**
  - internal gill slits**
  - esophagus**
  - spinal cord**
  - myomeres**
  - heart**
  - ! atrium
  - ! sinus venosus
  - ! ventricle
  - pericardium and pericardial cavity
  - liver**
  - intestine**
  - gonads (ovary or testes)**
  - kidneys** - deep to gonads
  - veins (best seen emptying into heart)
    - cranial (anterior) cardinal vv
    - caudal (posterior) cardinal vv
    - common cardinal
  - ! hepatic
  - dorsal aorta** (filled with latex)
  - ventral aorta (filled with blood; best seen exiting ventricle)
- 

### 4) ORGAN SYSTEMS - this section can be done outside of lab

Using the text pages noted, review the anatomy and function of the following organ systems.

Skeletal and muscular systems (pp. 19-20)

**notochord**  
**brain**  
**arcualia**  
**spinal cord**  
chondrocranium (see Figure 2-5)  
**lingual cartilage**  
branchial basket  
**myomere**  
**myosepta**

Nervous system and sense organs (p. 22)

**brain**  
**spinal cord**  
**olfactory sac**  
**hypophyseal pouch**  
**pineal eye**  
**lateral eyes**  
    lens  
    retina  
    pigmented layer

Digestive and respiratory systems (pp. 23-24)

**oral cavity**  
**oral glands**  
**esophagus**  
**intestine**  
**liver**  
**pleuroperitoneal cavity**  
**respiratory tube**  
**velum**  
**internal gill slits**  
**brachial pouch**  
**external gill slits**

- ? Trace the structures of the adult digestive tract (i.e., serially list the structures/organs through which food passes) starting from the buccal funnel and ending at the cloaca.

Circulatory system (pp. 24-25)

**pericardial cavity**  
**heart**  
    sinus venosus - midline  
    sinuatrial aperture  
    atrium - left side  
    atrioventricular aperture  
    ventricle - right side  
ventral aorta  
    afferent branchial arteries (deoxygenated)  
    efferent branchial arteries (oxygenated)  
**dorsal aorta**  
    caudal artery  
    carotid arteries

caudal (posterior) cardinal vv  
cranial (anterior) cardinal vv  
right common cardinal v  
hepatic v

- ? Diagram the circulatory system starting with the caudal vein of the venous system and ending with the dorsal aorta of the arterial system.

#### 4) LARVAL LAMPREY (ammocoetes; Gr, sand + bed)

Like the majority of craniates, aside from amniotes, lampreys have indirect development meaning that their life cycle involves a larval stage. [Larvae are free-living, sexually immature forms that differ from the adult in morphology, nutrition and habitat.] In the case of the lampreys, sexually mature adults leave their ocean or large lakes and enter streams to spawn and die (i.e., they are semelparous). Approximately three weeks later the eggs hatch and the hatchlings (larvae) burrow into the sand (hence, ammocoetes) to live as filter feeders for 5-7 years. [Filter feeders obtain nutrients by drawing water across sieve-like structure which catch or filter the nutrients suspended in the water. We'll have lots more to say about filter-feeders in next week's lab on "protochordates and hemichordates."] When the larvae reach approximately 12 cm in length, they metamorphose into the adult form (this involves changes to the sense organs, oral regions, and pharynx) and swim downstream to the ocean or lake to begin their "bloodsucking" lifestyle. Kind of like kids going off to college.

#### Larval lamprey slides (ammocoetes)

Use Walker/Homberger, pp. 25-28; to identify the following features; make sure you are using the correct slide :

#### **Station 1: Whole mount** (see Figure 2-7)

dorsal fin  
caudal fin  
chromatophore  
**myotomes** (segmentation difficult to see)  
**spinal cord**  
**brain**  
**notochord**  
median nostril  
hypophyseal pouch  
lateral eye  
inner ear  
upper lip  
mouth opening  
**oral tentacles**  
oral cavity  
**velum**  
**pharynx**  
**gill pouches**  
gill lamellae  
external gill slits  
**subpharyngeal gland**  
esophagus  
intestine  
**cloaca**  
liver  
gallbladder

heart  
pronephric kidney

**Station 2: Cross section through pharynx** (see Figure 2-8)

**spinal cord**

**notochord**

**myotomes**

**dorsal aorta**

ant cardinal vv

arcualia - depends upon the section

**pharynx**

branchial pouches

**gill lamellae**

internal gill slits

external gill slits

**subpharyngeal gland**

ventral aorta

hypopharyngeal ridge

epipharyngeal ridge

**branchial basket cartilages**

- ? How would you develop the adult dorsal fin morphology from the larval (juvenile condition).  
That is, would all parts of the dorsal fin grow at an equal rate or unequal rate.  
This is called differential growth or allometry.
- ? What two functions do the gill pouches serve in the larva? Which is retained and which is lost in the adult? Why?
- ? In regards to the respiratory function of the gills, how does the flow of water across the gill differ between the larva and adult (i.e., how does the water flow across the gills in the larva and the adult). Why is this change necessary for the adult?
- ? What muscular structures are used to produce the current flow across the gills in the larva?  
In the adult? What function does the velum serve in adult?
- ? To which structure in "protochordates" may the subpharyngeal gland be homologous?  
What is the purpose of its secretions in the larva? What structure does it change into at metamorphosis?