ZOO 4377L - VERTEBRATE MORPHOLOGY LAB

LAB 7: SHARK MUSCULATURE

Name: _____ SSN: _____

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Next Week's Assignment: Walker & Homberger - pp. 165-211 of Chapter 7

Preparation: Walker & Homberger - pp. 133-156 of Chapter 7

Background

The next three labs will acquaint you with the major muscle groups of the gnathostomes and their functions. You will learn the musculature of the shark and cat in enough detail so that you can identify homologous muscles in each and compare their functions. Specifically, these labs involve:

1) Dissection and identification of muscles in a fish (the shark - this week) and a tetrapod (the cat - next two weeks).

2) Classification of muscles into groups according to embryonic origin. The shark will be used to examine the skeletal elements these muscle groups are primitively associated along with their original function.

3) Identification of these same muscle groups in more derived forms, noting changes in location and function associated with different evolutionary pathways. The cat is our primary example, but other vertebrates (in the form of demonstration dissections, if available) will illustrate different trends or intermediate forms.

Below are some trends you should note when comparing retained, ancestral muscle patterns with derived ones. Note that they usually parallel trends in skeletal structure that you have already seen. Be able to give specific examples of each trend.

1) **Axial Musculature:** In fish (including more derived forms, e.g., osteoichthyes) axial muscles tend to be massive, overtly segmented, and function primarily in propulsion (locomotion); in tetrapods, they diversify in shape, lose some segmentation, and function in support and respiration as well as new types of locomotion.

2) **Appendicular Musculature:** Where appendages consist of complex, jointed skeletal elements, the previously simple adductors and abductors (e.g., the shark) are seen to split during embryonic development and form a variety of appendicular muscles that control movement of specific parts of fins or limbs. In tetrapods these muscles also support the body. The original function of the limb muscles as abductors and adductors diversify and in some instances reverse their ancestral function (i.e., developmental/phylogenetic abductors become functional adductors).

3) **Branchiomeric (Visceral, or Branchial) Musculature:** These are the muscles of the visceral arches. Muscles of the first and second arches retain their function of jaw movement in most vertebrates. This is not surprising, since the jaws themselves are retained. However, more caudal arches are lost or reduced in tetrapods and their muscles acquire new attachments and functions, such as turning the head and moving the scapula. Some also control the larynx (can you recall the evolutionary source for the laryngeal cartilages?) and throat.

Today's Lab

Part I: Review the external morphology of the shark using pp. 40-42 (large print only) of Walker & Homberger.

Part II: Review the anatomy of the chondrcranium (pp. 54-57; large print only), visceral arches (pp. 58-61; large print only) and pectoral girdle and fin (pp. 111-114; large print only) using the skeletal mount.

Part III: Work in pairs. Pick a shark, open its bag and rinse it well. Using Walker & Homberger work through from page 146 through the second paragraph of page 154. It will take you most of the lab period to simply skin the shark so we will finish next week what we don't get done today. It is important that you do a good job of skinning since many of the muscles we are interested in are adherent to the skin.

In the interest of time skip **(B) MUSCLES OF THE PELVIC FIN** on p. 153. Also, Walker & Homberger's dissection of the **(C) HYPOBRANCHIAL MUSCLES** (pp. 150-152) is difficult and invariably results in confusion; **instead, follow the dissection described on page 4 of this handout** for this section.

Finally, when you are finished, wet down your specimen with wetting solution and put it back into its plastic bags, using binder clips to seal the bags. Write your name on the bag so you can identify your specimen next week.

You will be responsible for identifying the following structures shown in **bold**; these will be the basis of next week's quiz (assuming completion of the dissection).

? For each muscle, (1) fill in its attachments, i.e., a) origin and b) insertion); (2) give its innervation (i.e., dorsal or ventral ramus of segmental (spinal) nerve or specific cranial nerve; Table 7-1 may help); and (3) describe its action (function *sensu* Kardong), e.g.:
epaxial myomere: o & i) adjacent myosepta; n) dorsal rami of spinal nn.; action: lateral bending.
coracoarcuals: o) coracoid bar; I) adjacent myosepta; n) hypobranchial n.; action: open mouth

Items (1) and (2) will help you establish muscular homologies between the shark and cat. Recall that homologies are based on the following criteria:

1) similar anatomical construction
2) similar topological relations
3) similar embryological origin

Muscles, unlike most other structures of the vertebrate body, are primarily defined not by their shape (criterion 1), but by their attachments to skeletal elements (criterion 2) and their embryonic development (criterion 3). While the latter cannot be observed directly, it can be inferred by the muscle's innervation as their is a relatively rigid relationship between a muscle's developmental origin and its innervation.

Recall that function (action) is not a criterion of homology and not surprisingly the action of homologous muscles can vary tremendously among vertebrates. For example, the pterygoideus portion of the internal jaw adductors functions as a jaw closing (adduction) muscle in sauropsids whereas in extant synapsids (i.e., mammals) it functions to dampen the movement of the ear ossicles (to protect the inner ear organ from damaging loud noises, e.g., rock music). However, the muscles are clearly homologous based on their common attachments and innervation.

Some simple dissecting hints:

1) Scapels are for skinning (note the alliteration); once through the skin switch to scissors and blunt dissection.
2) Dull scapels are more dangerous than dull ones; change them whenever necessary.
3) Only incise the area where you are working, not the entire projected dissection.
4) Never cut what you can't see.
5) There is no reward for finishing first but there is great reward for dissecting well; impatience in anatomy is seldom rewarded.

Axial muscles (pp. 146-147); ***omit*** *caudal strip and do only strip between pectoral and anterior dorsal fin*:

myomeres

epaxial

hypaxial

myosepta

horizontal skeletogenous septum

? What lies superficial to the horizontal skeletogenous septum?

? Compare the myomeres in a lamprey with that of the shark. How do they differ? [Hint: Is the musculature in the lamprey divided into epaxial and hypaxial components?]

? What is the significance of the darker colored ("red") muscle adjacent to the horizontal skeletogenous septum?

Hypobranchial muscles (pp. 150-152). **N.B.** You may wish to ask for assistance in reflecting intermandibularis and interhyoideus to observe coracomandibularis (p. 150, paragraph3). Whatevery you do, however, do not use a scapel to incise these muscle but instead use your scissors (remember, scapels are for skinning). However, contrary to the Figure 7-10, interhyoideus does **not** lie deep to the hypobranchial muscles. Rather, it is superficial to these muscles and fuses with intermandibularis along the midline.

coracomandibular

? What is the vascularized tissue (typically pink or dark colored) lying deep to the cranial end of coracomandibular? Why is it vascularized?

"rectus cervicis"

coracohyoideus

coracoarcuals

coracobranchials

Muscles of the Pectoral Fin (pp. 152-153):

pectoral abductors

pectoral adductors

Branchiomeric Muscles (pp. 153-155):

mandibular arch (I)

- **adductor mandibulae**
- **levator palatoquadrati**
- **spiracularis**
- **preorbitalis**
- **intermandibularis**

hyoid arch (II)

- **interhyoideus**
- **hyoid constrictors**
- **levator hyomandibulae**

branchial arches (III-VII)

- **superficial branchial constrictors**
- **cucullaris**

REVIEW OF SHARK SKELETAL MUSCULATURE (Hymen figure 9-5)

I. Axial musculature - *innervated by segmental spinal nerves*

myomeres - act > lateral bending (locomotion)

horizontal skeletogenous septum - divides myomeres into **epaxial** (dorsal) and **hypaxial** (ventral) divisions innervated by dorsal and ventral rami of segmental spinal nerves, respectively

epibranchial musculature - extension of epaxial musculature above gills; innervated by dorsal rami

hypobranchial musculature - extension of hypaxial musculature below gills; innervated by hypobranchial nerve (combined occipital and spinal nn); 3 superimposed layers (from superficial to deep)

1) **coracomandibularis** - unpaired midline; act > open mouth
2) "rectus cervicis" - bilateral; comprised of:
   a) **coracohyoideus** - rostral; act > expand oropharyngeal cavity and open mouth
   b) **coracoarcuals** - caudal; act > expand oropharyngeal cavity
3) **coracobranchials** - act > expand branchial pouches

II. Appendicular musculature - forefin innervated by branchial plexus (*ventral rami* of several serial spinal nerves)

pectoral abductor - dorsal muscle mass; act > abduct and retract fin

pectoral adductor - ventral muscle mass; act > adduct and protract fin

? Given their innervation, from what portion, epaxial or hypaxial, of the myotome are the appendicular muscles derived?

III. Branchiomeric muscles - muscles associated with skeletal derivatives of the visceral arches and ***innervated by cranial nerves***

Arch 1 (mandibular arch > *innervated by CN V (trigeminal)*

adductor manidbulae - act > closes jaws

levator palatoquadrati - act > elevates palatoquadrate to open jaws(?)

spiracularis - act > operates spiracular sphincter

preorbitails - act > protract mandibular arch

intermandibularis - act > reduces volume of oropharyngeal cavity

Arch 2 (hyoid arch > *innervated by CN VII (facial)*

levator hyomandibulae - act > elevates hyomandibulae to open jaws(?)

hyoid constrictor - divisible into dorsal and ventral portions; approximates brachial arches expelling water from pouches

interhyoideus - act > reduces volume of oropharyngeal cavity

Arches 3-7 (branchial arches > *innervated by CN IX and X*)

superficial branchial constrictors - divisible into dorsal and ventral portions; approximate brachial arches expelling water from pouches

cucullaris - levator muscles of arches 3-7; partly homologous to mammalian trapezius (disputed); act > open pouches