

ZOO 4377L - VERTEBRATE MORPHOLOGY LAB

LAB 6: THE HEAD SKELETON

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

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**N.B. Preparation for next week's lab (Shark Muscular System)**

**1) Walker & Homberger: pp. 133- 156 of Chapter 7.**

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Preparation: Walker & Homberger - Chapter 4 (pp. 52-94).

Background

Perhaps nowhere is the relationship between ontogeny and phylogeny more clearly evident than in the vertebrate head skeleton. Its final form reflects both its own embryonic development and its long evolutionary history. In this lab, consider the fate of the three embryonic skull components (chondrocranium, splanchnocranium, dermatocranium) in the specimens you examine. What remains of each in the adult skull? How do different vertebrate groups differ in their expression of these components? Remember - we are mostly looking at adult material. These represent the result of evolutionary modification of homologous parts. Embryonic development, along with the fossil record, provides clues to the nature of these homologies.

Today's Lab

The lab is organized into 7 sections although the seventh is strictly observational. The numbers below refer to the sections, each containing the appropriate material. The first 5 sections are straightforward identification. *You are responsible only for the structures specifically identified in this handout and only structures appearing in bold will appear on the quiz.* Additional sections illustrate a few evolutionary trends and patterns evident in the vertebrate head skeleton. Be able to identify the asked-for structures and understand the concepts illustrated by the skeletal material. The instructor(s) will assist. There is a lot of material to absorb and commit forever to memory, so work efficiently. A written description of each element will help in your learning and identification of the structures.

**1) Head and Visceral Skeleton of the Dog Shark (*Squalus acanthias*), a Cartilaginous Fish**

Work through pages 54-61 (omitting section (B) Sagittal Section of the Chondrocranium)) identifying as many of the structures labeled in bold as possible. For the quiz you will be responsible for the following structures:

**rostrum**  
**orbits**  
**occipital region**  
**foramen magnum**  
**cranial cavity**  
**occipital condyle**

**otic capsules**  
**nasal capsules**

**visceral arches**

**mandibular arch (I)**  
**palatoquadrate (I)**  
**hyoid arch (II)**  
**basihyal**  
**ceratohyal**  
**hyomandibular**  
**branchial arches (III - VII)**

- ? Using Figure W&H 4-4 as a guide, sketch a branchial arch in lateral view and label the following components:  
basibranchial  
hypobranchial  
ceratobranchial  
epibranchial  
pharyngobranchial
- ? What type of jaw suspension does *Squalus* possess? Anatomically, what does the term mean?
- ? Which of the cartilages bear teeth? Do the teeth differ morphologically from one another? What terms describe this condition?
- ? Are there more than one row of teeth in each arch? Why is this?

## 2) **Head Skeleton of Bowfin (*Amia calva*), a Bony Fish**

You will recall that the extant actinopterygians (ray-finned fish) are divided into two monophyletic sister groups: The primitive Chondrostei and the derived Neopterygii. Within the Neopterygii, the bowfins (Ammiiformes) form the sister group to the most successful radiation of vertebrates known, the teleosts. Thus, the bowfin (*Amia calva*) is an excellent (and local) choice for studying the dermal component of the skull. Work through pages 61 and 62 using figure 4-6 and 4-7 to identify as many of the structures labeled in bold as possible. For the quiz you will be responsible for the following structures:

**dermal roof**  
**quadrate (I)**  
**articular (I)** - ventral portion of jaw articulation; best seen internally  
**hyomandibular (II)**  
**palatal series**  
**lower jaw series**  
**opercular series**  
**gular series**

- ? Which of the above are endochondral rather than dermal bone ossifications? Hint: They are all three derived from the visceral arches.

- ? Which bones of the skull bear a marginal (as opposed to medial) row of teeth? Do the teeth differ in shape? What terms describes this condition?
- ? What type of jaw suspension does *Amia* possess? (See p. 58 and Figure 4-4).
- ? Also displayed is the skeletal mount of an advanced teleost, the perch (*Perca falvescenes*). In which of the above areas does the perch appear to differ most from the *Amia*?

### 3) Head Skeleton of the Mudpuppy (*Necturus maculosus*), an Amphibian

Work through pages 68-73 omitting Section (B) [The Chondrocranium] to identify as many of the following structures as possible. The accompanying figure (necturus.tif) shows the skull of *Necturus* in lateral view and should help in your identification. For the quiz you will be responsible for the items which appear in **bold**:

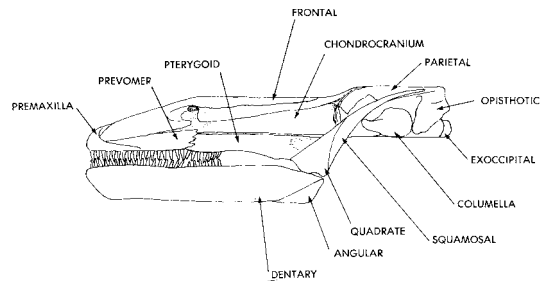


FIGURE 5. Lateral view of the skull and lower jaw of *Necturus*.

**premaxilla**

**frontals**

**parietals**

opisthotic (endochondral)

prootic (endochondral)

**squamosal**

**quadrate (endochondral; arch 1)**

exoccipitals (endochondral)

**foramen magnum**

ethmoid plate (endochondral)

vomer

pterygoid

parasphenoid

stapes (arch 2)

lower jaw

**dentary**

splenial

angular

mandibular cartilage

Hyoid apparatus (see Figure 4-12)

**hyoid arch** (derived from visceral arch 2)

hypohyal

ceratohyal

**branchial arch 1** (derived from visceral arch 3)

basibranchial 1

ceratobranchial 1

epibranchial 1

branchial arch 2

basibranchial 2

ceratobranchial 2

epibranchial 2

branchial arch 3

epibranchial 3

- ? What respiratory structure do they branchial arches support in *Necturus*?
- ? Which bones of the skull bear teeth? Do the teeth differ in shape? What terms describes this condition?

#### 4) **Head Skeleton of a Turtle (sp?), a primitive Sauropsid (Reptile)**

The unidentified turtle skull we have is not a snapping turtle (*Chelydra* sp.) but clearly belongs to a closely related species so that the descriptions in W&H are applicable. Work through pages 73-79 noting we currently lack a hyoid apparatus (Section D) to identify as many of the following structures. For the quiz you will be responsible for the structures which appear in bold. **N.B.** Annoyingly, your text incorrectly refers to the various emarginations of the dermal roof as “fenestrae”. The more proper term emargination (L., e + *margo*, to deprive of its edge) should be used.

nares  
choanae  
orbits  
posttemporal emarginations (“fenestrae”)  
subtemporal emarginations (“fenestrae”)  
[infra orbital emarginations (“fenestrae”) - extremely reduced in this specimen]  
tympanic cavity  
foramen magnum  
occipital condyle  
dermatocranium  
**premaxilla**  
**maxilla**  
zygomatic (jugal)  
quadratojugal  
prefrontals  
**frontals**  
**parietals**  
postorbitals (how do they differ from *Chelydra*?)  
**squamosal**  
vomer  
palatines  
pterygoids  
chondrocranium  
**supraoccipital**  
**exoccipitals**  
**basioccipital**  
opisthotic  
prootic  
basisphenoid  
visceral cranium  
**quadrate (arch I)**  
[epipterygoid (arch I) - rudimentary]  
**stapes (arch II)** - often these gracile bones fall out in preparation of the skull;  
however you should see its articulation with the fenestra ovalis of the prootic  
lower jaw (visceral and dermal cranium)  
**articular (arch I)**  
**dentary**

surangular  
coronoid  
prearticular  
angular

- ? What sort of temporal fenestrae do turtles have? In what traditional amniote group does this place them (Anapsids, Diapsids, Synapsids)?
- ? What is unusual about the nares in turtles? Since the “agnathans” have a single midline nares, is this a primitive or derived trait? How would you test this with a cladogram?
- ? What other major sauropsid group is edentate? Since turtles are the most primitive group of Sauropsids, does this mean that an edentate condition is ancestral for all Sauropsids? How would you test this with a cladogram?

##### 5) Head Skeleton of the racoon (*Procyon lotor*), a Mammal (derived Synapsid)

Although the dissector uses the cat as its example, we have better material for the racoon. The skulls are similar enough in form so that you can use your dissector’s illustration as a guide. Work through pages 83- 94 to identify the structures listed below. For the quiz you will be responsible for the structures which appear in **bold**.

###### complete skull

dermatocranium

**premaxilla (incisive)**

**maxilla**

lachrymal

**zygomatic**

**nasal**

**frontals**

**parietals**

vomer

palatine

pterygoid processes and hamulus

**dentary**

chondrocranium

**occipital (dermal and endochondral)**

ethmoid (endochondral)

dorsal and middle nasal conchae

cribiform plate

perpendicular plate

sphenoid

basisphenoid (endochondral)

alisphenoid (endochondral; actually part of viscerocranium)

presphenoid (endochondral)

ventral nasal concha

**temporal**

squamous portion

petrosal portion (endochondral)

auditory bulla

tympenic portion (dermal; mammalian autoapomorphy)

visceral cranium  
malleus (endochondral; arch I)  
incus (endochondral; arch I)  
stapes (endochondral; arch II)

- ? What are the chondrocranial homologues of the petrous portion of the temporal bone of mammals in the turtle and mudpuppy?
- ? What are the visceral cranium homologues of the 3 ear ossicle of the mammals to the turtle and mudpuppy?
- ? What 4 endochondral bones and pair of dermal bones make up the mammalian occipital bone?
- ? Which bones of the skull bear teeth? What type of teeth are present?

#### bisected skull

##### **cranial cavity**

rostral, middle and caudal cranial fossae

##### **petrous portion of temporal bone**

##### **sella turcica**

nasal (periorbital) sinuses

sphenoidal

frontal

ethmoid

cribriform plate

perpendicular plate

##### **nasal conchae (turbinates)**

dorsal

middle

ventral

- ? What sensory apparatus lies within the petrous portion of the temporal? What does petrous mean (see Brown's *Composition of Scientific Words*)?
- ?
- ? What endocrine gland rests within the sella turcica? What does sella turcica mean(see Brown's *Composition of Scientific Words*)?
- ? With what physiological condition are turbinates associated? If a fossil dinosaur skull were found to have turbinates, what would you conclude?
- ? What does ethmoid mean (see Brown's *Composition of Scientific Words*)? Does this description apply to racoons? What about humans?
- ? Find the following foramina and then identify which cranial nerve(s) passes through it:  
cribriform foramina

optical canal  
 orbital fissure  
 foramen rotundum  
 foramen ovale  
 internal acoustic meatus  
 stylomastoid foramen  
 jugular foramen  
 hypoglossal canal

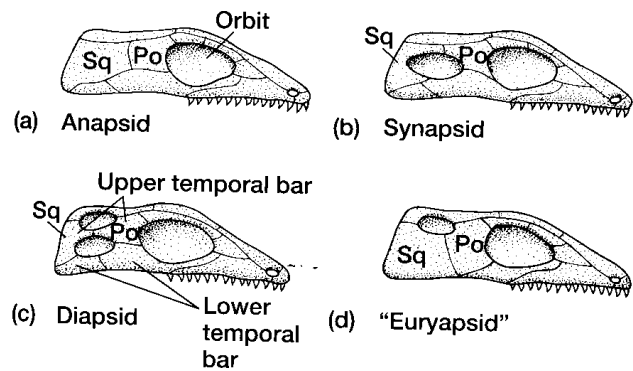
? What roughly is the relationship between location of the above foramina along the rostral-caudal axis and the number of the cranial nerve which exits through it?

disarticulatedskull

In front of you are the elements of a disarticulated raccoon skull. How many of these isolated elements can you identify? You may want to come back to this when you finish all the stations?

**6) Amniote skull types**

In front of you are the following skulls:  
 loggerhead turtle (*Carretta caretta*)  
 tuatara (*Sphenodon sp?*)  
 green iguana (*Iguana iguana*)  
 alligator (*Alligator mississippiensis*)  
 raven skull (*Corvus corax*)  
 opossum (*Didelphis virginianus*)



The major amniote groups are traditionally classified and named based upon openings associated with the jaw adductor musculature in the temporal and cheek regions of the dermatocranium. Two types of openings exist: Emarginations and fenestrae. Emarginations (L. *e + margo*; to deprive of its edge) refer to the elimination of bone proceeding dorsally from the ventral margin of the cheek or rostrally from the caudal margin of the temporal roof, or both. Fenestrations (L. window) refer to openings between adjacent bones in the cheek or temporal roof, or both. Note that only fenestrae create apsides (G. *αψις*) or arches, one for each fenestra, and the major amniote groups take their names from the number of arches found in the dermatocranium, e.g., anapsid, synapsids and diapsids. Using your new-found knowledge of temporal fenestration, answer the following questions:

- ? Which of these is an anapsid?
- ? Among the Saurians or Diapsids, which [hint: two] forms have retained the primitive diapsid condition (i.e., 2 temporal bars)?
- ? How has the iguana modified its skull from the original diapsid condition?
- ? How has the bird modified its skull from the original diapsid condition?

- ? Which of these is a synapsid?
- ? Which of these organisms has a kinetic skull (i.e., the upper jaw is mobile relative to the braincase)?

## 7) **Survey of craniate skulls - In Progress**

In front of you for your enjoyment are a wide array of tetrapod skulls.

Some points to consider:

Compare the weight of the parrot skull to a comparable sized mammal; which is lighter and why?

Note the variation in bone density within the bat skull, both in macroscopic view and in x-ray (jaws and inner ear dense, neurocranium transparent); why?

Compare temporal fossa of various mammal groups, particularly carnivores vs ungulates. In which is the temporal fossa larger (indicating a larger temporalis muscle)? In which is the masseteric fossa larger (indicating a large masseter muscle)? Why is this so?

How much of the aracari bill is bony? Why might this be (Hint: Between bone and bill (keratin), which is heavier?)?

Compare the three caviomorph rodents (the guinea pig, unknown caviomorph and the capybara). Aside from size, is there much variation in morphology (shape)?