Name: 17 October 2014, 11:30 am
Student #: Room ALEX 200

ZOO*2090 Vertebrate Structure and Function
Midterm Examination – Fall Semester 2014
Examiner: Fred Laberge

1- (3 marks) Zhu and colleagues recently published evidence showing that the fossil placoderm fish *Entelognathus* has osteichthyan-like marginal jaw bones. They used this evidence to propose a new phylogeny of the gnathostomes. In the space provided below, draw a phylogenetic tree that illustrates their hypothesis about jawed vertebrate (gnathostome) relationships. The hypothesis is as follows:

→ That placoderms represent the basal gnathostome group and that a taxon made up of chondrichthyans and acanthodians represents the crown of the gnathostome tree (most derived groups).

2- (1 mark) What distinguishes vertebrates from more basal chordates?

Vertebral column or backbone

3- (2 marks) Describe two features of the fossil impressions of *Haikouichthys* or *Metaspriggina* that suggest they were vertebrates.

Two of: Vertebral elements around notochord or eyes of Haikouichthys**. Sense organs (eyes or nasal sacs) or external gills** of Metaspriggina**.**

4- (3 marks) Associate using arrows:

Embryonic germ layer	Derivative in adults
Ectoderm	Epidermis of skin
Mesoderm	Bones and muscles
Endoderm	Digestive tract

5- (1 mark) Order these stages of embryonic development from earliest to latest.

differentiation – neurulation – cleavage – gastrulation – organogenesis

cleavage – gastrulation – neurulation – differentiation – organogenesis

6- (1 mark) Why do flying or swimming animals need to avoid creating turbulence during locomotion?

Because turbulence increases drag a lot. It is more costly to move when the animal faces added drag

7- (3 marks) How are teleost fish gills organized to increase the surface area for gas exchange between the environment and blood circulation?

Many gill filaments (1) bearing many gill (or secondary) lamellae (1), containing abundant blood capillaries (1).

8- (3 marks) Associate using arrows:

Bone	Location in body
Meckel`s cartilage	Lower jaw
Operculum	Pharynx
Centrum	Vertebra
Cleithrum	Pectoral girdle
Ilium	Pelvic girdle
Radius/ulna	Lobe fin

7A- (2 marks) Draw the heart of a teleost fish. Label the four chambers found between the common cardinal/hepatic veins and the ventral aorta.

→ Sinus venosus, atrium, ventricle, bulbus arteriosus (0.5 mark for each chamber)

7B- (1 mark) What anatomical structures are located between the heart chambers receiving and pumping blood? What is the function of these structures?

Valves (0.5). Prevent backflow of blood in wrong direction (or allow unidirectional pumping) **(0.5)**

8- (1 mark) What is the anatomical difference between *Tiktaalik* and *Acanthostega* that defines them as fish and tetrapod, respectively?

Chiridium or joints and digits instead of lobe fins

9- (3 marks) –Contrast the following three taxa: Crossopterygii, Tetrapodomorpha and Stegocephalia.

Crosso → Actinistia, Tetrapoda and "Rhipidistia", Tetrapodomorpha → Tetrapoda and advanced sarcopterygians, Stego → Vertebrates with a chiridium

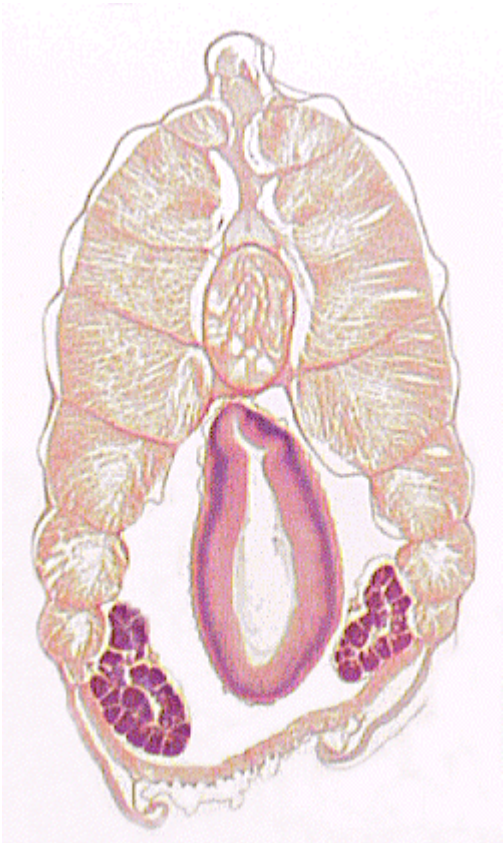
10- (1 mark) Order these vertebrate innovations from earliest to latest.

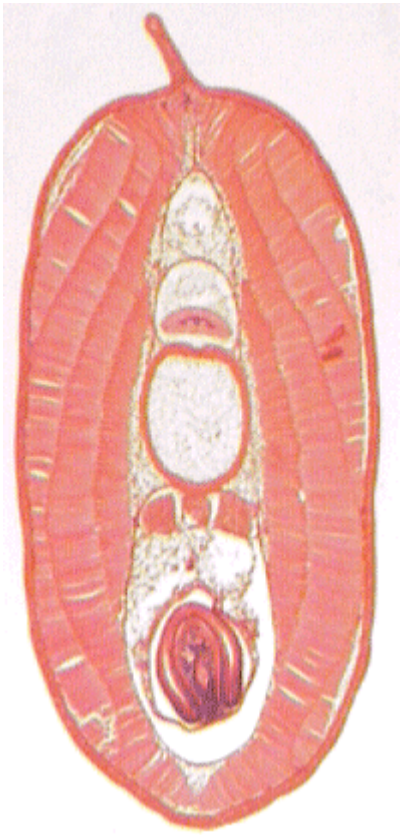
jaws – dermal bony armour – bony endoskeleton – conodont apparatus

conodont apparatus – dermal bony armour – jaws – bony endoskeleton

Lab Questions (5 marks)

Q1- Examine these photos carefully and then respond to the questions below. You may use point form.

A) 

 B)

To what subphylum do these organisms belong?

A) _____

B) _____

C- List three vertebrate "innovations" visible in a comparison of these two cross-sections?

MULTIPLE CHOICES **(1 mark each)**. Circle the best answer.

M1- Which of the following is NOT a recognized hypothesis about the origin of chordates?

a) Chordates evolved from a larval urochordate ancestor
b) Chordates evolved from a deuterostome prechordate ancestor with an active lifestyle that underwent inversion of the body axis
c) Chordates evolved from a protostome ancestor that underwent inversion of the body axis
d) Chordates evolved from an echinoderm larva ancestor

M2- The Reynolds number used to estimate drag depends on …

a) Propulsive force
b) Animal shape and fluid viscosity
c) Animal mass
d) Skeleton design

M3- What is heterochrony?

a) Juveniles become sexually mature adults directly without metamorphosis
b) The slowing down of developmental processes as an individual age
c) Change in the timing of developmental events across generations
d) Mutation in homeotic genes

M4- Which of the following was NOT a characteristic of the earliest bony fishes?

a) Wide mouth gape compared to their ancestors
b) Teeth on dermal bones that contribute to the jaws
c) Bony armour over most of the body
d) Large eyes

M5- Sarcopterygian fishes of the Devonian period. They were large predators with lots of sharp teeth.

a) Conodonts
b) Rhipidistians
c) Holocephalans
d) Ostracoderms

M6- Type of fish scale topped by thick layers of enamel found in the integument of paleonisciformes, such as the modern bichirs (*Polypterus*).

a) Elasmoid
b) Cosmoid
c) Ctenoid
d) Ganoid

M7- Which mechanism is NOT used to ventilate fish gills?

a) Ram ventilation
b) Air gulping
c) Dual suction pump
d) Tidal ventilation

M8- What innovation resulted from the loss of the operculogular bones and the link between the shoulder and skull in fish?

a) Choanae
b) Terrestrial locomotion
c) Lungs
d) Neck

M9- Which option describes the correct direction of blood flow in a fish?

a) Heart → Ventral aorta → Gills → Dorsal aorta → Body
b) Heart → Dorsal aorta → Gills → Ventral aorta → Body
c) Heart → Body → Dorsal aorta → Gills → Ventral aorta
d) Heart → Gills → Ventral aorta → Dorsal aorta → Body

M10- A group that includes all descendants of an ancestral form is called …

a) A phylogenetic group
b) A monophyletic group
c) A paraphyletic group
d) A polyphyletic group

TOTAL (40 marks)