



Department of Biology

BIO2135

Animal Form and Function

University of Ottawa

Professor : Dr. Adam Oliver Brown

Final Exam

Wednesday April 15, 2020

Worth 35% of your final mark

Instructions :

1. This is an OPEN book exam.
2. Write your name and student number at the top of every page because the exam booklets will have the pages separated during correction.
3. Make sure that the exam booklet is complete – there are 8 pages in total, including the cover pages.
4. Write your answers directly in this exam booklet without exceeding the space provided.
5. Read the questions carefully and answer using complete sentences only, no point form allowed.
N.B. Do not use drawings, tables or diagrams – they do not replace written explanations and will not be marked.
6. Think hard, reflect well and write coherently in the time allotted, you have 80 minutes.
7. Good Luck!

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Definitions	/10 points
Fill in the blanks	/20 points
Short Answer	/35 points

Total	/65 points
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Part 1: Definitions (2 points each) – Define and/or explain the meaning and implications of the following terms as they relate to the content of this course.

1- Fick's Law :

An equation used to solve the diffusion coefficient that describes diffusion. It shows the importance of diffusion and how it is modified by 3 factors.

Aspects that can modify the diffusion coefficient are surface area, thickness of membrane, and concentration gradient across the membrane.

2- Urostyle :

A sacral vertebra running through the pectoral girdle of the skeleton is unique to amphibia. It forms at the base of the vertebral column.

The vertebra lacks flexibility, but makes up for it by being robust and allowing amphibia to endure falls without sustaining injuries when landing after a jump.

3- Cloaca :

A cavity located on the posterior end of an organism that is involved in excreting wastes and sexual reproduction. It is present in all tetrapods.

The cloaca contains the genital opening or pore for sexual reproduction and the anus to excrete undigested material.

4- Supracoracoideus muscle in birds :

Powerful flight muscles used as elevator muscles to generate lift when the wings are brought back up.

They are attached to the keel, which allows them to be bigger and therefore more robust for flight.

5- Altricial chicks :

Naked (unfeathered) and helpless chicks of the Aves. They are entirely dependent on their parents to provide warmth, food, and protection until they can fly.

They are completely different from precocial chicks.

Part 2 : Fill in the Blanks (1 point each) – Write the name or word that corresponds most appropriately to the following zoological descriptions:

- 1- Most of the Echinodermata have their body plan flattened along this axis.

Oral-Aboral Axis

- 2- The name of the exvaginations from the skin of Echinodermata that allow for diffusion between the coelomic fluid and the external water environment.

Dermal Branchia

- 3- The name of the second stage of larval development in Echinodermata.

Late Bipinnaria

- 4- The most taxonomically diverse Class of the Phylum Echinodermata.

Class Ophiuroidea

- 5- The minimum number of chambers in the heart of a Chordata.

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- 6- The name of the protein that forms all extensions in the tegument of Tetrapoda.

Keratin

- 7- The name of the cladistic taxonomic group that includes all descendents of Vertebrata that have jaws. Gnathostomata

- 8- The name of the cladistic taxonomic group that includes all descendents of Vertebrata that can lay eggs on dry land. Amniota

- 9- The protective substance that is produced in large quantities by hagfish (Class Myxini). Slime

10- These body appendages are absent in jawless fish but present in all other fish.

Paired Fins

11- The name of the single bone in the proximal portion of the posterior limb of

Tetrapoda. Femur

12- The name of the reproductive structure that is transferred from a male animal to a female, which contains sperm and often other substances as well. Spermatophore

13- The name of the component of an amniotic egg which is responsible for the storage of nitrogenous metabolic waste products. Allantois

14- The spectrum of light that is perceived by some snakes, allowing them to see their prey in the dark. Infrared

15- The name of the muscle in birds that is responsible for the downbeat of the wings.

Pectoral muscles

16- The name for the hypothesis that bird flight originated from ancestral birds that were running and taking big soaring leaps. Cursorial Hypothesis

17- The name of the organ in the digestive system of birds that is responsible for the secretion of digestive enzymes that will promote extra-cellular digestion.

Proventriculus

18- The name of the structures that attach to the hooks in the vane of a bird feather and assure its rigidity. Barbules

19- Compared to other vertebrates, this layer of the mammalian skin is the thickest and most complex. Dermis

20- The region in the reproductive tract of placental mammals where the development of the embryos take place. Uterus

Part 3 : Short Answer (5 points each) –

Describe and/or explain the following concepts in the space provided.

- 1- Name and describe the hypothesis by which a larva of Urochordata could represent the ancestors of all Vertebrata.

In Hemichordata and Chordata, there is a distinct juvenile phase and adult phase, which is defined by the presence of one or more of the 5 characteristics found in several stages of the lifecycle that define chordata (This includes Neural Tube, Notochord, Pharyngeal slits, Post-anal tail, and Endostyle).

According to the Garstang hypothesis, it is theorized that a new species arises by retaining the juvenile characteristics, making the adult phase the ancestral form of the juvenile phase. This brings about pedomorphoses, where the adult animal retains its juvenile characteristics and thus becomes a different organism.

In general, this demonstrates that not only a species can evolve into many others, but that the life stages of a single species can evolve into separate organisms overtime.

- 2- Describe the feeding modes and mechanisms of Asteroidea.

Asteroidea are predatory animals that feed predominantly on clams and oysters.

They use tube feet to pry open the shell of the bivalvia, located on the ventral, oral side of the asteroidea. When the shell is open, it inverts its first stomach, the cardiac stomach outside of the mouth and into the shell.

The cardiac stomach contains enzymatic juices to digest the soft viscera of the bivalve inside.

After complete digestion, the asteroidea reverts the stomach back into its mouth, now containing the nutrients from its prey, where the second stomach, the pyloric stomach leads the food into the Asteroidea's cecum and body. The water-vascular system is known to have a role in transporting the food to various parts of the body.

3- Describe the role and function of the counter-current circulatory system in fish.

Water is oxygen-poor, and requires a special adaptation in fish to take in oxygen. This is known as the counter-current circulatory system, where the flow of blood and the flow of water travel in different directions to maximize diffusion.

Arches separate the gills, and 2 layers of filaments make up each gill. The filaments are filled with capillaries and will participate in the counter-current circulatory system.

Water with an oxygen concentration greater than blood will come in contact with the gills, and will diffuse oxygen to try and reach an equilibrium with the oxygen in the blood. However, because water and blood are flowing in opposite directions, an equilibrium can never be reached. Therefore gas exchange with oxygen occurs indefinitely and allows the organism to receive a large amount of oxygen to fulfill metabolic needs. This leads to morphological behaviors in fish, such as constantly moving so that a constant flow of oxygenated water comes in contact with the gills.

If blood and water flowed in the same direction, then an equilibrium will be reached and gas exchange would end, this will not give the fish an ideal amount of oxygen, and cannot fulfill metabolic needs.

4- Compare and contrast the circulatory systems of amphibia and mammals. Explain the consequences of those differences on each of the two animals.

Amphibia have a 3-chambered heart, this organ is not efficient at delivering oxygen to the body, because the pulmonary and systemic arteries split at one point, causing a mix of oxygenated and unoxygenated blood to travel to the body and deliver poor oxygenated blood to the tissue. The result of this circulatory system has reduced endurance and activity in amphibia, causing them to rely on ambush attacks to capture prey. In addition, permeable skin on amphibia allow them to perform gas exchange with the air, and capillaries are formed to send deoxygenated blood to the skin to become oxygenated. However, this skin is prone to desiccation and the amphibia must keep its moist at all times.

Mammalia have a 4-chambered heart, which is vastly improved from the 3-chambered mechanism. 2 arteries will travel to and fro the lungs, and 2 other arteries travel to and fro the heart. There is never any mixing of oxygenated and deoxygenated air as the mammalia respire, creating an efficient system that grants the organism great endurance and activity. A mammalia's skin is not permeable though, unlike the amphibia, but their circulatory system is already vastly improved so it is unnecessary. The diaphragm of mammals morphologically adapted to improve respiration. The thoracic cavity can expand to inflate the lungs as large as possible, and expiration causes the thoracic cage to push up against lungs to squeeze out all of the residual air to ensure no mixing of air.

5- Describe the form and function of the bird respiratory system.

Aves share a 4-chambered heart the same as mammalia, but their unique trait is parabronchi and air sacs.

Flight is an endurance-heavy activity and requires a lot of oxygen to maintain the metabolic activity in the tissues and muscles. Morphologically, aves developed 9 air sacs in their respiratory system, 5 in the back, 4 in the front. The role of these air sacs is to increase the flow of air for the respiratory system.

In addition, the parabronchi creates a one-way path for air to flow through the ave, where air enters one end and leaves through another, never creating any mixing of deoxygenated and oxygenated air.

In the cycle, the first inhalation brings new air into the posterior air sacs, and the first expiration moves the air to the parabronchi to interact with capillaries. The next inhalation moves the air toward the anterior sac, and the last expiration removes this air entirely from the air sacs.

In this cycle, no mixing of air is observed, only a constant flowing motion that allows for efficient flight.

6- Describe the detailed trajectory that is taken by the mammal blood as it travels through the heart and around the circulatory system.

Deoxygenated blood travels from the systemic veins to the right chamber of the heart (right atrium), the beat of the heart pushes this oxygen-poor blood into the right ventricle and to the pulmonary veins toward the lungs.

In the alveoli of the lungs, interaction with oxygen, carbon dioxide, and capillaries causes oxygen to diffuse into the oxygen-poor blood and CO₂ to flow out of it.

The newly oxygenated blood is then returned to the heart through the pulmonary artery and enters the left chamber (left atrium), is pumped into the left ventricle where it leaves the heart through the systemic arteries to transport the oxygen to organs and muscles to the body. At capillaries of the tissues, oxygen, CO₂, and nutrients are exchanged and the blood becomes deoxygenated and travels through the veins back to the heart to continue the cycle.

In addition, there are coronary arteries that deliver oxygen to the heart in order to renourish it and allow it to continue functioning.

- 7- Explain the evolutionary consequences of sessile life on animal morphologies, feeding strategies and defense.

Sessile organisms will have reduced activity due to having reduced or absent organs that are not needed such as muscles, locomotory appendages, and a complex digestive system. Echinodermata, Hemichordata, and Chordata include organisms that are considered sessile, and have adapted a simple digestive system that makes up primarily a mouth, long intestine, and anus to ensure the food they ingest stays in their body long enough to extract as much nutrients as possible.

These types of organisms will rely on large abundance of food that the organism will always have access to, such as plankton or food particles suspended in water. Classes Holothuroidea, Pterobranchia, Crinoidea and sub-phylums Urochordata and Cephalochordata include organisms that use filter-feeding to obtain food without using movement.

Crinoidea and Urochordata tend to be suspended in the water and are not anchored to the ground. Filter-feeder sessile organisms morphologically develop fan-like structures with a great surface area to capture small food particles and ingest them through a simple digestive system.

In terms of defense, some develop asexually produce zooids that will ensure survivability if the organism is damaged or killed by currents or predators, this trait is unique to Pterobranchia, which are organisms that also defend themselves by retreating into calcareous tubes. Echinoidea are known to use venomous spines as deterrents from predators. Though they are sessile, they are still capable of movement in search of algae. Movement in a sessile organism is inefficient, slow, and rarely used. Organisms like Asteroidea and Echinoidea will only move to evade predators or currents, but this can use a lot of energy to use their tube feet to 'swing' away to safety.

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End of the exam