Comparative Anatomy Biol 440  Final Exam guide

The final is worth 120 points. Comprehensive questions: There will be no more than 25 points of comprehensive questions. The comprehensive questions will ask you to integrate what you have learned previously and discuss the various anatomical systems in more general ways - you will draw on previous material to answer the question. You will need to remember the basic anatomy discussed in those earlier sections but not the small details such as (pleurocentrum, uropygial gland, columella, ceratobranchial...). Think about the major groupings of vertebrates (amniote vs. anamniote, aquatic vs. tetrapods, endotherms vs. ectotherms) and how their anatomy varies among different systems. You should be able to study for the comprehensive part by reviewing your notes and paying attention to when there are major differences in those groups (aquatic vs. tetrapod etc.) The section of the final that covers new material will have the same general format of the previous exams - fill in the blank and short answer questions. All of the fill in the blank questions will be on new material.

The final exam material starts with the urinary system. You are not responsible for the peripheral nervous system, including anatomy of spinal nerves. You are responsible for cranial nerves. You are not responsible for endocrine glands beyond those we discussed in class. Know the form and function of the pituitary. You should know what the anterior and posterior pituitary secrete. For the following hormones, you should know where they are secreted and what they do: oxytocin, ADH (vasopressin), FSH, LH, prolactin, progesterone. You should understand the feedback mechanism at mammary glands involving oxytocin and prolactin and inhibition of FSH and LH and embryonic diapause.

Chapter 20 – Urinary system – pp. 633-641

I assumed you knew what nephrons are and their basic anatomy – if not the first pages are a good introduction. Not responsible for renal tubule evolution or Fig. 20-4. Not responsible for holonephros, the hypothetical ancestral kidney. Should understand archinephros, pronephros, mesonephros, opisthonephros, metanephros and Fig. 20-5 C,D, Fig. 20-6. Not responsible for histological details (i.e. what types of cells make up different tissues). Not responsible for relationship of allantois and bladder/urethra. Know basic differences in forms of nitrogenous waste and what vertebrates excrete them. Not responsible for Fig. 20-10, Table 20-1. Not responsible for chemical formulas/diagrams of excretory products. Not responsible for water/salt balance issues of freshwater vs. saltwater fish, amphibians, reptiles, endotherms beyond what was noted in class. Not responsible for anatomical details not mentioned in class (renal calices, vasa recta, etc.) nor physiological details on loop of Henle (active transport, counter-current system).

Chapter 21 – Reproductive system – pp. 658-660, 661-674, 678-680

Not responsible for histological details of gonad structure (you can get this in a class devoted to... histology). Understand indifferent stage and anatomy present at that stage and what happens during anatomical sex determination. Not responsible for meiosis info nor spermatogenesis/oogenesis, or Fig. 21-5, 21-6. For the sections on various male anatomy, know testis, scrotum, gubernaculum, cremaster muscle, pampiniform plexus, inguinal canal, spermatic cord. Not responsible for anamniote section p.663. Some information on testes descent and aquatic mammal testes are in focus 21-1 but it also includes extra information that you are not responsible for (Frey, Werdelin and Nilsonne). Not responsible for ovary section p.664, beyond the basic difference in yolk formation in mammalian vs. nonmammalian ovaries. For sections on male reproductive passages, look at chondrichthians (Fig. 21-12 B) and amniotes. For sections on female reproductive passages, look at chondrichthians, bony fish (Fig. 21-15 B, C, D) and eutherian mammals. Know uterus shapes. Know extra-embryonic membranes of an eutherian mammal. You should understand deciduous vs. nondeciduous placentas, but not responsible for epitheliochorial, hemochorial placenta. You should understand the differences in the four placenta types we discussed in class. Know urorectal septum and cloaca in eutherian development (Fig. 21-23), and
corpora cavernosa. The section on female reproductive hormones was a part of lectures on the endocrine system in class (p.682-685).

Chapter 12 – Chemoreceptors, Mechanoreceptors, photoreceptors – 397-403, 406-429, Fig. 12-29, 433

Understand the transducer function of receptor cells. Read the sections on olfaction and vomeronasal organ (starting on p.398) – you don’t have to worry about histological details not discussed in class (i.e. sustentacular cells, basal cells). Understand what happens during olfaction and gustation, differences in olfaction for choanates vs. non-choanates (Fig. 12-3), turbinate bones. Understand differences in how pheromones reach the VNO (or Jacobson’s organ) for those with or without hard palates. Not responsible for proprioreceptors. Read sections on lateral line and electoreceptors (starting on p.406). Read the section on inner ear and hearing (starting on p. 413). Again, not responsible for extra histological details. Should understand neuromasts, cupula, “hair” cells, stereocilia, endolymph, semicircular ducts, utriculus, sacculus, ampulla, lagena, otoliths, tectorial membrane, basilar papilla, basilar membrane, cochlea, organ of Corti, Weberian ossicles, eustachian tube, linear vs. angular motion. Understand how the swim bladder can aid in hearing. Know inner, middle, outer ear, function of middle ear. Know how hearing works in mammals. Note tensor tympani, stapedius p.420 that I will mention in a later lecture. Not responsible for ear of sauropsids or lissamphibians. Photoreceptors – median eyes and image-forming eyes. For median eye, just understand what the pineal can do. Beyond basic understanding of eye function, know pectin, tapetum lucidum. Understand accommodation. Not responsible for eye development, or details on nerves in retina (ganglion cells, bipolar cells, etc.) or vascular tunic (zonule givers, ciliary processes, etc.).

Chapter 14 – Nervous system, Brain– pp. 473-477, Fig. 14-6, 14-9

You will be responsible for brain structures mentioned in lecture. Not responsible for five regions (myelencephalon, metencephalon, etc.) Understand meninges and CSF, subarachnoid space, choroid plexus, ventricles, arachnoid villi. In lecture I discussed basic anatomy of human brains, so you will not need to know about other comparative brains. You should know the function of the corpus callosum, 4 lobes of cerebral cortex, motor cortex, somatosensory cortex, medulla oblongata, cerebellum, thalamus, pineal, superior and inferior colliculus.

Chapter 13 –Spinal cord and peripheral nerves – pp. 456-462

You are only responsible for the section on cranial nerves. You should know what branchiomeric nerves are and a basic understanding of what a spinal nerve does (motor and sensory information, dorsal root and ventral root) helps you to understand branchiomeric nerves. Not responsible for functions or names of specific branches off of cranial nerves found in the reading.

Chapter 15 – Endocrine system – pp. 504-505, 510-516, 682-685

Not responsible for endocrine structures that I didn’t discuss in class (pancreas, adrenal gland, kidney, etc.) Not responsible for molecular differences in hormones (i.e. protein vs. steroid). I discussed the pineal and melatonin during lectures on the CNS. The last range of pages is in the reproduction chapter when we discussed LH, FSH, oxytocin, prolactin, estrogen, progesterone, induced vs. spontaneous ovulators, and feedback during lactation. Take a look at the feedback mechanism involving lactation, suckling, prolactin and oxytocin. Information on embryonic diapauses is available from lecture notes. Not responsible for FSH and LH in males. You are not responsible for glands derived from the pharyngeal area.

Helpful things to know for the final exam. Information can be found in notes from lecture.

Urinary:
What are the two main functions of the vertebrate kidney?

What embryonic tissue will differentiate to form kidneys in vertebrates? Where is the nephric ridge found? Is it mesoderm (yes) is it from somites? (no) Does the nephric ridge develop all at once?

I assume you know basic functions of kidneys, i.e. that they contain nephrons, glomeruli, peritubular capillaries. Much reabsorption of salts, water, glucose, amino acids takes place along peritubular capillaries. The loop of Henle allows for urine to be more concentrated than the original filtrate from blood.

The capillaries at peritubular capillaries can get their blood from renal portal system in vertebrates other than mammals.

Know regions of ‘tripartite’ kidney. Which develops first? Is it found anteriorly or posteriorly? What is the archinephric duct? Know pronephros, mesonephros and metanephros. What vertebrates have a metanephric stage, which ones do not? What happens during the mesonephros stage? What does the archinephric/mesonephric duct do during this stage?

How is a metanephric kidney different from a mesonephric kidney (besides location)? How is a metanephric kidney drained? What is an opisthonephros and what vertebrates have it? How is function divided along an opisthonephric kidney of a male shark? When did you have a mesonephros? What kidney functions during the adult stage in amniotes?

What basically is a cloaca? Eutherian mammals lose their cloaca during development – how does this happen?

How else can nitrogenous waste be carried in blood besides ammonia? What vertebrates eliminate nitrogenous waste as ammonia, urea or uric acid?

Gills in fish perform many functions that kidneys perform in land vertebrates. What are these functions? How are fresh water fish vs. marine fish different in what happens at their gills to deal with water/salt balance?

How are endotherms different in their need to eliminate nitrogenous waste compared with ectotherms?

How do birds vs. mammals concentrate their urine/nitrogenous waste elimination? Know what happens in a bird cloaca to concentrate nitrogenous waste and conserve water for the body. Why can’t mammals do this in the same way? What do mammals do instead to save water? How do desert mammals do this to more of an extreme?

What animals have a salt gland and what does it allow them to do to find water in a salty water environment?

Reproductive:

What reproductive anatomy is found in all vertebrates (male or female) during the ‘indifferent’ stage? What causes the differentiation towards maleness? What can the archinephric/mesonephric duct become? (it remains in males) What can the mullerian tube become? (it remains in females) What does an ostium do and where is it found?
Know oviparous vs. viviparous and semelparous vs. iteroparous

Where are sperm stored after being created in the testes via spermatogenesis? Where do testes form within the body?

Why do male mammals have their testes in a scrotum? How is this helpful to them? What would happen if testes remained in the abdominal cavity instead? What does the gubernaculum do? What does the pampiniform plexus do? Dolphins and whales don’t have scrotums but are endothermic, what do they do? What is a cremaster muscle? How do birds deal with effect of high temperatures on sperm viability?

Why is external fertilization possible for bony fish eggs but not shark (Chondrichthyian fish) eggs? Are chondrichthyian fish (skates, sharks, rays) all oviparous or viviparous or are both styles present in this group? What are the different ways (there are three) that baby sharks can be provided nourishment as they develop inside a uterus?

How is the design of a teleost ovary different from that of a typical vertebrate? What does this allow them to do? What is r-selection?

How does fertilization typically occur in bony fish? how about sharks? Can bony fish have internal fertilization? What is a gonopodium modified from? Do sharks ever have external fertilization? (they don’t) What structures help with internal fertilization in sharks?

How can fertilization occur in amphibians, birds, reptiles, mammals? What intromittent organs (penis-like structures) are found in snakes and lizards?

What does corpora cavernosa do in mammalian penises? What is a baculum? Name an organism with a baculum.

What do seminal vesicles, bulbourethral glands and prostate gland do to contribute to seminal fluid? What is the purpose of seminal fluid?

Know duplex, bipartite, bicornuate, simplex uteruses. How are they basically different from each other? What happens with Mullerian tubes to make these different shapes? Name an organism for each type of uterus. How do males have different penis design if females in their species have a duplex uterus?

Know extra-embryonic layers in amniotes: amnion, allantois, chorion. What do they do? Do you know the order of the layers? which is closest? Which is a surface for gas exchange in bird and reptile embryos? Which later merges with the chorion to help make a placenta in eutherian mammals? What layer is the maternal contribution to the placenta?

Know which placentas are deciduous (invasive) vs. non-deciduous (non-invasive). What does deciduous mean? Know types of non-invasive placentas (cotyledonary, diffuse) and invasive (discoid, zonary). Which type has caruncles? What is a caruncle? How does an embryo ‘invade’ a placenta during human development?

Central nervous system:

Know relationship bw dorsal hollow nerve cord and central nervous system. What is neurocoel? What happens to neurocoel once the brain is developed?
What are the three meninges layers found in mammals? Which is closest to the brain, which is outermost, middle? Where is CSF flowing? What does choroid plexus do, where is it found? Where is CSF absorbed?

Know differences between what is called “white matter” vs. “gray matter”. What is the function of the corpus callosum? Is it white or gray matter? Where is gray matter generally found in the brain? What is the pattern of gray vs. white matter in the spinal cord?

What does the ‘cortex’ of the cerebrum refer to? What are gyri and sulci? Where is the central sulcus?

Know the locations and basic functions associated with the four lobes of the cerebral cortex. Where is the somatosensory cortex found? What happens when this area is stimulated? What is sensed? Can you name senses that aren’t located along the somatosensory cortex? What is proprioception?

Where is the (primary) motor cortex? What happens when it is stimulated?

What is the function of the medulla oblongata? thalamus? pineal? What does the pineal secrete? What senses are associated with superior vs. inferior colliculi? What is the function of melatonin? What is the function of the cerebellum?

What is a dermatome? How is a dermatome related to spinal nerves? Are spinal nerves metameric?

What are the names and functions of cranial nerves 1 to 12? How are branchiomeric nerves similar to spinal nerves? What cranial nerves are branchiomeric (dorsal) nerves? What areas do these nerves serve?

Sensory:

What are chemoreceptors? How are they basically formed for how they function (i.e. cilia, receptor protein) What is gustation, olfaction?

What happens at olfactory receptor cells when a person smells something? How many different olfactory receptor cells are there approximately? How does this compare with variety of receptor types in other senses? Does an odorant only bind to one receptor type typically? Where are olfactory receptor cells in non-choanates vs. choanates?

How do turbinate bones help enhance olfaction?

What organ senses pheromones in most vertebrates? Where is the vomeronasal organ found? How can pheromones access the VNO in vertebrates with secondary palates vs. those without? What does flehmen behavior specifically do to help pheromone detection? Do humans make or sense pheromones?

How many different receptor types are there for gustation?

What is a neuromast? a cupula? What are hair cells? How is a neuromast designed for mechanoreception? How are neuromasts used in lateral lines of fish? What does a lateral line detect?

How do electroreceptors basically work? Name an organism with electroreceptors.

What is the outer, middle and inner ear? What organisms have a middle ear? Which have an inner ear? Where are hair cells in the inner ear?
What do hair cells within ampulla along semicircular ducts detect? What is angular motion? What do hair cells in the sacculus detect? How is detection helped with otoliths? What are otoliths? What is linear motion? Where in the vertebrate inner ear is hearing detected? What organisms have a lagena? cochlea? How does a lagena or cochlea help enhance hearing?

What organisms have ear bones? Which tetrapods have 3 ear bones, which have 1? What is the name of this single ear bone? How is having 3 ear bones better for hearing? What adaptations might some fish have to help hear high pitched (high frequency) sounds? What is the function of the eustachian tube? Is it derived from a branchial/pharyngeal pouch during development? (hint: yes!)

How do the basilar membrane, tectorial membrane and hair cells work together to detect sound in mammals? What is the organ of Corti? How are different pitches (frequencies) detected?

Know basic anatomy of the eye: sclera, cornea, lens, choroid, iris, ciliary muscle, retina. How is refraction important for vision? How is refraction achieved? How is refraction modified when focusing on near vs. far objects? What happens to the lens of older people, requiring them to use reading glasses? What is myopia?

How is the layering of cells in the retina ‘backward’ in vertebrates? Are non-vertebrate eyes like this? (no)

Know rods vs. cones. What is different at the fovea/macula portion of the retina? How does this help alleviate issues of the ‘backwards’ retina?

What happens within a photoreceptor, such as a rod, when phototransduction occurs?

What causes the ‘blindspot’ along the retina?

How can night vision be enhanced in vertebrates? What are thermoreceptors? What type of radiation do thermoreceptors detect?

Reproductive endocrine hormones:

How do endocrine hormones basically work to cause responses? Name some endocrine glands.

What is different about the two portions of the pituitary - the neurohypophysis (posterior pituitary) vs. adenohypophysis? How are they different in how they develop (i.e. tissues they come from)? How are they different in how they are controlled by the hypothalamus? Name some hormones from the adenohypophysis and neurohypophysis.


What releases chorionic gonadotropin? What is its effect on the corpus luteum and progesterone? What hormone drop causes oxytocin and prolactin to be released? What do these hormones do?

What effect do high levels of prolactin have on FSH and LH and thus the corpus luteum and progesterone levels? What is embryonic diapause? How can a kangaroo that has just given birth have another
pregnancy already? What causes the development of that embryo to proceed or be halted? How is this continual ‘assembly line’ of developing young a good strategy for some marsupials?

Also note the paragraph at the beginning of this guide, outlining the cumulative questions for the exam.

Sample questions:

1. The_________________________ of an adult male amniote was originally the archinephric (or mesonephric) duct during its embryonic development.

2. The ______________________ in the brain sends signals from the brain stem up to the correct location in the cerebral cortex. It also helps draw our attention to important stimuli and ignore unimportant stimuli.

3. A __________________________ has a longer basilar membrane compared to an amphibian, which means that it can ___________________________________________ (a property provided by long basilar membrane) (3 points total)

4. A freshwater fish will have this happen at their gills ___________________________________________ (as opposed to a saltwater fish)

5. In a non-choanate, olfactory receptors are found in the ____________________________

6. A mammal has a hard palate and thus will have air pass through its ____________________________ in order for pheromones to be brought to the VNO to be detected.

7. Circle the creatures that are oviparous:         turtle    perch    cat    dogfish    bird

8. The 6th cranial nerve has this function __________________________________

9. A _________________________ is an example of an organism that would have the smallest cerebellum relative to body size among vertebrates.

10. A seabird like an albatross can drink salt water and not dehydrate because they have a _________________

11. A __________________________ mammal has an unusually large medulla portion of their kidney.

12. A __________________________ is an example of a mammal with a non-invasive placenta.

13. The hair cells in __________________________ (structure) are imbedded in a gel that acts as a capacitor, storing electrical charge.

14. Fish usually eliminate much nitrogenous waste by having it diffuse from their ___________________________, instead of leaving a urogenital pore.

15. __________________________ will cause the release of melatonin from the pineal.

16. What do Weberian ossicles do? ____________________________

17. The __________________________ releases hormones in response to hormones it receives via a portal system from the hypothalamus (be specific).

Answers:
1. ductus deferens or vas deferens  
2. thalamus  
3. bird or mammal; hear high pitched sounds or wider range of sound  
4. actively transport salt to blood  
5. olfactory sac  
6. incisive duct or incisive foramen  
7. circle turtle, perch, bird  
8. eye muscle control (abducens)  
9. frog or any amphibian  
10. salt gland  
11. desert  
12. sheep, cow, pig, horse (anything with cotyledonary or diffuse placenta)  
13. ampullae of Lorenzini  
14. gills  
15. darkness or night  
16. transfer sound vibrations from swim bladder to the saccus (to better detect high pitched sounds)  
17. anterior pituitary or adenohypothesis

(6 points) Where does refraction take place in the eye of mammals? What muscle helps control refraction? Why is refraction necessary?

(5 points) What is unique about the anatomy of the ovary in teleosts? Why is it this way?

(3 points) What tissues from the fetus help form the placenta in a placental mammal?

(3 points) Define opisthonephros and list an organism with an opisthonephros.

(8 points) A) From what portion of mesoderm does your kidney develop and where is this portion of mesoderm found? B) How did this tissue go through different developmental stages as your (human) kidney formed..what portion developed first, and second and so on? What drains the kidney at these different stages?

(7 points) What part of the pituitary uses a portal system? Describe how the portal system works. Name two hormones released from this portion of pituitary.

(5 points) Describe two basic differences between the axial skeleton of an aquatic vs. tetrapod vertebrate. (Use anatomical terms)

(8 points) Describe the hormonal feedback mechanism of delayed implantation/embryonic diapause found in marsupials (Include which hormones are involved and what they do). Why would an organism want to delay implantation?

(5 points) Once sound waves are brought to the cochlea, what specifically causes sensory cells to be triggered for hearing?

(5 points) a) Name the three layers of meninges. b) Between what layers does CSF flow? c) What is the blood brain barrier?