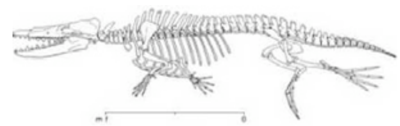
Developmental Biology & Physiology Concept List



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Course title:

Institution:

Semester:
Year:
Instructor:

Are you / where you...

- ❑ **The instructor of the course**
- ❑ **A teaching assistant in the course**
- ❑ **A student taking the course**

While not exhaustive (and we would appreciate it if you would concept statements below if you cover them and they are not listed), the list will enable you to make explicit to yourself, your teaching assistants and your students, which concepts you intend to cover.

It will also enable your teaching assistants (and students) to indicate what concepts they thought you covered.

Concept statements you should add to your list:

We would very much like to get a copy of your list, since this list can be more informative than the typical syllabus. Please mail or email it to us at
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CONCEPT STATEMENT AREA	emphasized	Mentioned	Not covered
Developmental Basics – 18 statements			
1.The generation of distinct cell types requires the generation of molecular and cellular **asymmetries**. A single cell can be asymmetric or **polarized**.	❑	❑	❑
2. Cytoplasmic asymmetries can be in the form of differentially distributed RNAs or proteins, and usually both.	❑	❑	❑
3. Cytoplasmic asymmetries lead to differential patterns of **gene expression** in the cells that come to reside in different regions of the embryo.	❑	❑	❑
4. In some species, where the sperm enters the egg is predetermined. In other species, the site of sperm entry serve to establish asymmetry.	❑	❑	❑
5. Asymmetries can be generated by the relative positions of cells within an embryo; surface cells can differ from internal cells.	❑	❑	❑
6. **Differential gene expression** in turn leads to altered cytoplasmic and nuclear composition. It is this process that generates differentiated cells; cells with distinct morphologies and functions within the organism.	❑	❑	❑
7. Changes in **chromatin organization** occur during the process of differentiation can are involved in the stability of the differentiated state. These are an example of **epigenetic** changes.	❑	❑	❑
8. Cellular asymmetries can lead to asymmetries in intercellular interactions, which in turn can stabilize or direct further cellular asymmetries.	❑	❑	❑
9. Inductive interactions between cells can involve **juxtacrine** (direct contact, surface-mediated), **paracrine** (short range secreted factor-mediated) and **endocrine** (long range secreted factor-mediated) signaling events between cells.	❑	❑	❑
10. Often interactions between groups of cells are required in order to respond to an inductive signal. Rarely do individual cells differentiate independently of their neighbors, rather groups of cells differentiate to form a tissue. This is known as the **community effect**.	❑	❑	❑

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Developmental Basics – continued			
11. Cells can respond differently to differences in level of inductive signals. This behavior underlies **morphogenic/inductive gradients**. These gradients can lead to new cell types and new inductive signals.	❑	❑	❑
12. The regulated movement of cells and changes in cellular morphology are critical to both the patterning of inductive interactions and the process of **morphogenesis** during development and organ formation.	❑	❑	❑
13. The timing of inductive events is critical to normal developmental events.	❑	❑	❑
14. Inductive signaling is mediated by **secreted factors** and **cell surface ligands**, **membrane and intracellular receptors** and the intracellular **signal transduction pathways** that they regulate.	❑	❑	❑
15.For each positively acting factor there are generally **antagonists** and **co-factors** that modulate 'signal strength' and specificity.	❑	❑	❑
16. Signal transduction pathways often regulate **gene expression** by regulating the activity of transcription factors. Signal transduction pathway can also regulate protein activity involved in cell morphology, movement, division or survival.	❑	❑	❑
17. It can be assumed that a number of inductive events underlie each aspect of embryonic development. These are not necessarily additive; they can involve complex and non-linear interactions.	❑	❑	❑
18. The formation of organs, and the tissues that compose them, is based on a similar process of inductive interactions.	❑	❑	❑
Organ and Tissue Basics – 7 statements			
1. An organ is a functional and anatomically distinct component of a multicellular organism.	❑	❑	❑
2. Organs are often integrate into larger systems. For example, the heart is a critical component of the cardiovascular system, while the stomach is part of the gastrointestinal system (alimentary canal).	❑	❑	❑

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Organ and Tissue Basics – continued			
3. Glands are organs that secrete one or more substance. Endocrine glands secrete directly into the blood stream while exocrine glands secrete onto an epithelium via a duct.	❑	❑	❑
4. Organs are generally composed of one or more cell types or tissues.	❑	❑	❑
5. Organ function is regulated and coordinated directly by neural signals via the autonomous nervous system and by hormones secreted by glands that are themselves often under neural control.	❑	❑	❑
6. Organ function can in turn influence the nervous system.	❑	❑	❑
7. Normally the interactions between organ systems leads to **homeostasis** that is the body's ongoing adaptation to changes in its internal and external environment.	❑	❑	❑
Physiology Basics – 9 statements			
1. All animal cells have an electrical potential across their plasma membrane; this is known as the resting potential. It arises from the concentration gradients of Na+ and K+ across the membrane, established and maintained by the action of the Na+, K+ ATPase, and the plasma membrane's differential permeability for Na+ and K+	❑	❑	❑
2. Excitable cells, such as neurons and muscle cells, have voltage-gated ion channel proteins in their plasma membrane. Activation and inactivation of these channels gives rise to a traveling wave of potential change across the plasma membrane called the action potential.	❑	❑	❑
3. Action potentials have a constant amplitude. The cells of the nervous system (neurons) encode and transmit information primarily through the frequency and patterns of action potentials, not in terms of action potential size.	❑	❑	❑
4. Action potentials move along neurons with a distinct directionality. They generally arise in the region adjacent to the neuronal cell body (the soma) known as the axonal hillock. They pass down the axon.	❑	❑	❑

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Physiology Basics – continued			
5. Neurons interact with one another, or with muscle or gland cells, through structures known as synapses. At a chemical synapse a chemical neurotransmitter is released by the presynaptic cell and binds to neurotransmitter receptor proteins on the surface of the post-synaptic cell. At an electrical synapse, the electrical wave in the presynaptic cell is directly passed to the post-synaptic cell through gap junction-like membrane proteins.	❑	❑	❑
6. The binding of the neurotransmitter to neurotransmitter receptor can either induce (excite/depolarize) or inhibit (hyperpolarize) the generation of action potentials or other response (contraction of muscle cells, release of hormones by exocrine cells) in the post-synaptic cell.	❑	❑	❑
7. The activity of a synpase is determined by the rate of transmitter release and removal, by either uptake or destruction.	❑	❑	❑
8. Typically, synapses are made on the non-axonal parts of a neuron, known as the dendrites and soma. Generally these regions cannot generate action potentials. The activity of the synaptic neuron will be determined by whether the net synaptic inputs lead the depolarization of the hillock region above a 'threshold'. In this way, a neuron acts to integrate the incoming signals that impinge upon it.	❑	❑	❑
9. Complex behaviors, including memory and consciousness, are generated through the electrical and chemical activities of networks of neuronal interactions .	❑	❑	❑
Cardiovasculature and Respiratory - 19			
1. The heart is a muscular pump whose periodic contraction (beat) causes blood to flow through the circulatory system.	❑	❑	❑
2. Within the circulatory system, blood carries oxygen O2 and carbon dioxide CO2 (the respiratory gases), nutrients, waste products, and hormones to and from every cell in the body.	❑	❑	❑
3. The respiratory gases are exchanged (uptake of oxygen, release of carbon dioxide) within the lungs.	❑	❑	❑

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Cardiovasculature and Respiratory - continued			
4. Vertebrates have a closed circulatory system, consisting of a heart, arteries, capillaries and veins.	❑	❑	❑
5. The amount of blood leaving the heart each minute (cardiac output) is the product of the heart rate (number of beats/minute) and the amount of blood pumped with each beat (ml/beat).	❑	❑	❑
6. The pressure in the aorta (just outside the heart) is determined by the product of the cardiac output and the total peripheral resistance.	❑	❑	❑
7. Peripheral resistance is a function of arterial diameter which can be controlled by smooth muscle cells that surround these vessels; their state of contraction is controlled by the autonomic nervous system.	❑	❑	❑
8. The pressure at any point in the circulatory loop is determined by the volume of blood that is contained there and the compliance at that point.	❑	❑	❑
9. The pressure gradient across an organ or tissue and the resistance to flow (a function of vessel diameter) determines the flow/minute through the organ or tissue (the perfusion rate).	❑	❑	❑
10. The cardiovascular system is homeostatic. It acts to hold constant the pressure in the aorta (mean arterial pressure) by controlling the function of the heart (heart beat rate, contraction strength) and the circulatory resistance.	❑	❑	❑
11. The resistance to blood flow in an organ or tissue is determined by the local metabolic activity and blood vessel diameter; signals from the autonomic nervous system regulate blood vessel diameter.	❑	❑	❑
12. Most animals are aerobic. To survive they require molecular oxygen (O2), which they use as an electron acceptor (producing water) during respiration. O2 is obtained from the atmosphere. Its presence in the atmosphere is due to its release as a waste product during photosynthesis.	❑	❑	❑
13. Aerobic organisms produce carbon dioxide as a waste product, it must be disposed of into the atmosphere	❑	❑	❑

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Cardiovasculature and Respiratory - continued			
13. O_2 is captured from the atmosphere in the lungs and carried to the tissues (where it is used by the cells). Carbon dioxide (produced in the cells) is carried from the tissues to the lungs, where it is released, by the circulatory system.	❑	❑	❑
14. Air, which consists of ~20% O_2 and little (~0.035%) carbon dioxide, is brought into the lungs by the contraction of the inspiratory muscles (define?). This leads to a sub-atmospheric pressure in the lungs. Air flows in through the respiratory tree driven by the resulting pressure gradient.	❑	❑	❑
15. Air leaves the lungs (containing much less O_2 and significantly higher levels carbon dioxide) when the inspiratory muscles relax; elastic recoil of the lungs creates a pressure greater than atmospheric and the resulting pressure gradient drives flow.	❑	❑	❑
16. O_2 diffuses from the air in the lungs into the blood, carbon dioxide diffuses from the blood into the air in the lungs, both gases move down their respective partial pressure gradients.	❑	❑	❑
17. The partial pressure of O_2 in the lungs is directly determined by alveolar ventilation and inversely determined by the rate of O_2 consumption. The partial pressure of carbon dioxide in the lungs is inversely determined by alveolar ventilation.	❑	❑	❑
18. O_2 is transported in the blood bound to the protein hemoglobin, which is present within red blood cells. Carbon dioxide is transported predominately as bicarbonate ions.	❑	❑	❑
19. The respiratory system is homeostatic. It regulates the partial pressure of O_2 and carbon dioxide in arterial blood.	❑	❑	❑
Gastrointestinal – 6 statements			
1. The GI system is NOT homeostatically regulated: it absorbs everything that it can digest that is presented to it .	❑	❑	❑

Gastrointestinal – continued			
2. Movement of material through the GI tract occurs because of the presence of pressure gradients created by the coordinated contraction of the smooth muscles that in the walls of the tract (stomach, small and large intestine).	❑	❑	❑
3. Digestion involves the enzymatic breakdown of food into monomers (amino acids, simple sugars, fatty acids).	❑	❑	❑
4. The products of digestion (monomers) are absorbed by passive diffusion (fats) or by active transport processes (carbohydrates, proteins, nucleic acids, minerals, vitamins).	❑	❑	❑
5. The enzymes required for digestion are produced in exocrine organs and released into the GI tract. They are not derived from the food itself.	❑	❑	❑
6. The motility and secretory activities of the GI tract organs is controlled by the intrinsic (enteric) and extrinsic (autonomic) nervous systems and by hormonal signals.	❑	❑	❑
Endocrine – 13 statements			
1. Hormones are chemical messengers, produced by gland (exocrine and endocrine) cells. Hormones can alter the metabolism of target cells.	❑	❑	❑
2. For a hormone to alter a cell's function, that cell must have (express) receptors for the hormone. Hormone receptors are proteins.	❑	❑	❑
3. Every cell has a subset of hormone receptors, and every cell responds to a number of different hormones.	❑	❑	❑
4. Hormones alter cell function by altering the activity of a specific sets of cellular enzymes. Hormones act through a number of different mechanisms. They can regulate protein activity or gene expression, or both.	❑	❑	❑
5. Hormones play major roles in sexual reproduction, energy metabolism, water and electrolyte balance, growth and development, and stress response and immune function.	❑	❑	❑
6. Hormones generally reach their target cells by transport in the blood and thus affect cells throughout the body.	❑	❑	❑

Endocrine – continued			
7. The storage and utilization of energy substrates – glucose, fatty acids, and amino acids – are controlled by hormones. Storage of energy substrates is controlled by insulin; by its actions promoting glucose storage, insulin is the primary regulator of blood glucose concentration. Utilization of energy is controlled by glucagons, epinephrine, cortisol and growth hormone.	❑	❑	❑
8. Reproductive functions – generation of gametes (eggs and sperm) and the production of the sex hormones (testosterone and estrogen) – is controlled by hormonal feedback between the hypothalamus (Define?), the anterior pituitary, and the gonads (ovaries and testes).	❑	❑	❑
9. Na+ and K+ balance is regulated by the rennin-angiotensin II-aldosterone system acting on the kidneys.	❑	❑	❑
10. Body fluid osmolarity is regulated by antidiuretic hormone, related from the posterior pituitary, acting to control water readsorption by the kidneys.	❑	❑	❑
11. Reproductive behavior is generated by the interaction of the nervous system (CNS, ANS and hypothalamus) and the endocrine system.	❑	❑	❑
12. Ca2+ balance is regulated by parathyroid hormone and calcitonin.	❑	❑	❑
13. Gametes (sperm and eggs are haploid cells produced in the gonads (testes and ovaries, respectively) under the control of the hypothalamic-pituitary-gonadal axis .	❑	❑	❑

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