# Neurons and Synapses

**1. Annotated diagram of a neuron**

**Diagram

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* **Nucleus:** biosynthetic center of the cell
* **Dendrites:** short, thick branched extensions of cytoplasm that are receptive sites
* **Axon:** Generates and conducts impulses, each neuron has one axon
* **Myelin Sheath:** fatty sheath that covers axon and increases speed of transmission of nerve impulses, made by Schwann cells
* **Nodes of Ranvier:** gaps in sheath that increase speed of transmission of nerve impulses

**2. What is meant by resting membrane potential?**

* Resting potential is the difference in charge across the membrane when a neuron is not firing.
* The inside of the neuron is more negative than the outside.
* Maintenance of a resting potential is an active process and is controlled by the sodium-potassium pump.
* Diagram, timeline

  Description automatically generated

**3. What is the role of the sodium potassium pump in maintaining the resting membrane potential?**

* Pump is a protein that exchanges sodium and potassium. Expels 3 Na+ for every 2K+ admitted. This creates a gradient in which there are more positively charged ions outside of the cell and more negatively charged ions outside. This required ATP hydrolysis and is energy-dependent.

**4. What is depolarization and how is it essential to creating an action potential?**

* Depolarization is a sudden change in the membrane potential, usually from negative to positive charge.
* In depolarization, the response to a signal initiated by a dendrite opens the sodium channels of the axon. Na+ ions are more concentrated outside of the neuron and the opening of sodium channels causes a passive influx of sodium.
* Influx of sodium causes the action potential to become more positive.

**Chart, bubble chart

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**5. What is acetylcholine? How does it work? How is it broken down? How do neonicotinoid pesticides interfere with acetylcholine?**

* Acetylcholine is a neurotransmitter used in many synapses such as neurons and muscle fibers.
* Once released into the synapse, it is broken down by **acetylcholinesterase** into choline and acetate. Choline is reabsorbed by presynaptic neuron where it is converted back to acetylcholine.
* Neonicotinoids bind to acetylcholine receptors but cannot break down. Binding is irreversible so it leads to paralysis and death.

# Hormones, Homeostasis, and Reproduction

**6. Draw an annotated diagram of spermatogenesis and oogenesis.**

**Diagram

Description automatically generatedDiagram

Description automatically generated**



* **Leydig Cells** (located between tubules) are responsible for testosterone production
* **Germinal epithelium** (outermost layers in tubules) is where sperm production begins
* These sperm cells grow and divide via **Mitosis** to create **primary spermatocytes**
* The primary spermatocyte divides via **Meiosis I** to produce 2 haploid **secondary spermatocytes**
* The secondary spermatocytes divides by **Meiosis II** to produce spermatids
* Spermatids become involved with a **Sertoli cell**, which helps them develop into spermatozoa (these have tails!)
* Sperm detach and are carried out by fluid in the lumen
* Timeline

  Description automatically generated
* Oocyte production begins with division of germ cells by **mitosis,** called oogonia
* 5th month of gestation: cells grown and begin **Meiosis I** but are stopped in **Prophase I**
* 7th month: cells are surrounded by granulosa cells and together called **primordial follicles**
* **Diagram, schematic

  Description automatically generated**
* **Follicular Phase:** primordial follicles are stimulated by FSH, causes granulosa cells to increase in number and secrete estrogen, now called **primary follicles**
* **Secondary follicles** are formed when fluid vesicles develop around oocyte and FSH levels rise
* **Mature follicle** forms when vesicles create 1 single vesicle
* Primary oocyte, with LH, completes **Meiosis I,** creates secondary oocyte and a polar body
* **Primary oocyte** completes Meiosis I with LH and creates a secondary oocyte and a polar body
* Ruptured follicle will develop in a corpeus luteum, which secretes key ovarian hormones
* Eventually corpus luteum will degenerate to form corpus albicans if no pregnancy is detected
* Diagram

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**7. Outline the roles of the 4 major hormones in the female reproductive system**

* **Follicle Stimulating Hormone (FSH):** stimulates ovarian follicle maturation and estrogen production
* **Luteinizing Hormone (LH):** triggers ovulation and stimulates progesterone production
* **Estrogen and Progesterone:** together they promote breast development and cyclic changes in endometrium
* **Estrogen** (alone) is responsible for maturation of reproductive organs and stimulates repair of uterus lining
* **Progesterone** (alone) causes thickening of the uterus lining and prepares uterine lining for implantation

# Movement

**8. Draw a labeled diagram of a sarcomere**

* **Diagram

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**9. Given a light micrograph of skeletal muscle be able to label the various structures Map

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Description automatically generated with medium confidence**

**10. Outline calcium’s role in muscle contraction**

* Action potential/nerve impulse/motor neuron triggers the release of acetylcholine into the motor end plate
* Acetylcholine initiates depolarization within the sarcolemma which causes the release of calcium from sarcoplasmic reticulum
* On actin, the binding sites for the myosin heads are covered by a blocking complex (troponin and tropomyosin)
* Ca2+ bind to troponin and refigure the complex, causing binding sites on actin to be exposed
* Myosin heads bind to binding sites/to actin and push actin inwards

**11. Outline the process of muscle contraction**

* Action potential arrives at the neuromuscular junction/depolarizes muscle cells
* Release of Ca2+ from the sarcoplasmic reticulum
* Ca2+ binding to troponin exposes actin to form cross-bridges with myosin heads
* Myosin heads push actin filament towards center of sarcomere so sarcomere becomes shorter
* Use of ATP to break cross-bridges/reset myosin heads

# The Kidney and Osmoregulation

**12. Describe the difference between osmoregulators and osmoconformers**

* Describe the difference between osmoregulators and osmoconformers
* **Osmoconformers** maintain internal conditions that are equal to the osmolarity of their environment
* By matching internal osmotic conditions to the environment, osmoconformers minimize water movement in and out of cells
* Less energy is used to maintain internal osmotic conditions within an osmoconformer
* **Osmoregulators** keep their body’s osmolarity constant, regardless of environmental conditions
* While osmoregulation is a more energy-intensive process, it ensures internal osmotic conditions are always tightly controlled
* Osmoregulators can maintain optimal internal conditions whereas osmoconformers are affected by environmental conditions

**13. Be able to draw an annotated diagram of a kidney**

Diagram

Description automatically generated

* **Renal artery**: branch of the aorta that brings blood into the kidney
* **Renal vein**: blood drains from the kidney and into the inferior vena cava
* **Renal medulla**: located deep to the cortex and contains the medullary pyramids
* **Renal cortex**: outermost layer containing the nephrons
* **Renal pelvis**: a continuation of the ureter
* The urine is transported from the kidneys via the **ureter**, where it is stored by the bladder prior to excretion

**14. Describe how the kidney regulates osmolarity**

* osmoregulation is maintenance of water balance of blood/tissues;
* loop of Henle creates hypertonic conditions in the medulla;
* water reabsorbed as filtrate passes through collecting duct;
* hypothalamus monitors/controls water balance/content of blood;
* controls secretion of ADH by (posterior) pituitary gland;
* ADH is released when blood too concentrated/too little water/hypertonic;
* ADH makes the collecting duct more permeable to water;
* due to more aquaporins;
* more water reabsorbed (in response to ADH);
* less water in urine/urine more concentrated/urine hypertonic;
* no/less ADH when blood too dilute/too much water/hypotonic;
* collecting duct less permeable/less water reabsorption/more water in urine;