Possible Clinical Application Questions for Exam II

1. A friend of yours returns from the doctor and says that they were diagnosed with Myasthenia Gravis. She isn’t sure what the condition is and asks you, a brilliant physiologist, to explain it to her.

Myasthenia gravis is an **autoimmune disease where antibodies attack the ACh receptors on the neuromuscular junctions.** It results in progressive weakening of the skeletal muscles. Treatment usually involves **anticholinesterases** such as neostigmine and physostigmine. These **decrease the activity of acteylcholinesterase** and help to restore muscle strength because **ACh is able to stimulate the muscle longer to achieve a contraction.**

2. Explain what the acronym SSRIs stand for and describe the mechanism of action of SSRIs such as Prozac, in the treatment of depression.

SSRIs stands for **selective serotonin reuptake inhibitors.** They are a class of medications that are used to treat depression, which is **characterized by a deficiency of serotonin.** These antidepressents work by **selectively blocking the reuptake of serotonin into the presynaptic axon terminals.** The neurotransmitter serotonin is allowed to stay longer in the synapse (since its “uptake” is inhibited), thereby **activating postsynaptic neurons that maintain a more positive mood.** Common SSRIs include Prozac, Paxil, and Zoloft.

3. List four adrenergic receptors found in the human body. List two cholinergic receptors found in the human body

**Adrenergic receptors:** alpha 1, alpha 2, beta 1, beta 2  
**Cholinergic receptors:** nicotinic and muscarinic

4. A friend of yours just found out she has diabetes insipidus. She is not sure what this diagnosis means or how it is caused. Explain the two main forms of diabetes insipidus and why she has the symptom of polyuria and excessive thirst.

**Two forms of diabetes insipidus include:**

1) **Neurogenic diabetes insipidus** results from hyposecretion of **antidiuretic hormone (ADH).** Results from either the hypothalamus not producing enough ADH or the posterior pituitary gland not releasing it. Usually caused by a brain tumor or head trauma.

2) **Nephrogenic diabetes insipidus** results from the receptors within the kidneys not responding to ADH. The ADH receptors may be nonfunctional to a genetic disorder or the kidneys may be damaged.

Since ADH stimulates the kidneys to retain water a common symptom of both forms is excretion of large volumes of urine (polyuria), which results in dehydration and excessive thirst. Because so much water is lost in the urine, a person may die of dehydration if deprived of water for only a day or so.
5. You return home to find your little sister crying about her dead hamster Sparky, who is very stiff. In an effort to cheer your sister up you decide to teach her about why Sparky is so stiff. What are the details of this condition that causes the stiffness.

The condition is known as rigor mortis and usually occurs several hours after death. It is caused by a lack of ATP in muscles to allow cross-bridges to release. Upon death, muscle cells are unable to prevent calcium entry from the sarcoplasmic reticulum. Calcium binds to troponin and causes the troponin tropomyosin complex to move out of the way and allow myosin to bind to actin. Since there is no ATP made postmortem, the myosin cannot unbind and the body remains in a state of muscular rigidity for a day or two.

6. Your grandmother wants to get rid of her facial wrinkles by using BOTOX. She doesn’t understand what it is and why it works. Give an explanation for the details about BOTOX.

BOTOX is a trade name that stands for botulinum toxin, which is produced by the bacterium Clostridium botulinum. The toxin inhibits acetylcholine release by motor neurons at the neuromuscular junctions resulting in flaccid muscle paralysis. Paralyzed muscles do not contract to wrinkle the skin and thus help to eliminate wrinkles – as well as certain facial expressions.

7. A patient has hypothyroidism and is confused about its classification. You are asked by the patient to explain the classification of hypothyroidism.

Thyroid gland disorders affect all major body systems and are among the most common endocrine disorders. Hyposecretion of thyroid hormone (hypothyroidism) is classified as primary, secondary or tertiary dependent upon the organ that is malfunctioning.

Primary hypothyroidism (most common type): the thyroid gland is malfunctioning and results in decreased production of thyroid hormones.

Secondary hypothyroidism: the pituitary gland is malfunctioning. The pituitary gland does not create enough thyroid stimulating hormone (TSH or Thyrotropin) to induce the thyroid gland to create a sufficient quantity of thyroid hormones.

Tertiary Hypothyroidism: the Hypothalamus is malfunctioning. This results in decreased production and/or reduced delivery of thyroid-releasing hormone (TRH) from the hypothalamus to the pituitary gland.
8. Organophosphates are the basis of many insecticides, herbicides, and nerve gas (such as sarin). They can be rapidly absorbed through skin and mucous membranes as well as by inhalation. Explain the following 1) What is the mechanism of action of organophosphates, 2) What are the symptoms of intoxication focusing on the overstimulation of nicotinic and muscarinic receptors, and 3) How is this condition treated?

1) **Mechanism of action:** Organophosphates reversible inhibit **acetylcholine esterase (AChE).** Acetylcholine esterase breaks down acetylcholine and thus the inhibition of AChE results in the accumulation of **acetylcholine (ACh) at the synapse** and continued stimulation of **ACh receptors.**

2) The symptoms result from the overstimulation of nicotinic and muscarinic ACh receptors.

**Nicotinic effects:** Skeletal muscle initially exhibits involuntary irregular, violent muscle contractions (fasciculation) followed by the inability to repolarize cell membranes resulting in weakness and flaccid paralysis. Severe reactions can lead to respiratory failure and death.

**Muscarinic effects:** The main concern is respiratory failure from excessive airway mucus secretions by submucosal glands that are innervated by the parasympathetic nervous system. Additional effects can be recalled using the mnemonic **SLUDGEM** (Salivation, Lacrimation, Defecation, Gastrointestinal motility, Emesis (vomiting), Miosis (excessive constriction of the pupil of the eye). Diaphoresis or excessive sweating will also be present due to effects of sympathetic cholinergic neurons on sweat glands.

3) **Treatment:**

**Atropine:** The main concern with organophosphate toxicity is respiratory failure from excessive airway secretions. Atropine is used primarily to reduce pulmonary secretions which will improve oxygenation. Tachycardia usually results due to atropine’s effect on the heart.

**Pralidoxime:** Agent that reactivates AChE by binding to the organophosphate molecule.