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Autonomic Nervous System

I. Introduction to the Autonomic Nervous System

☞ *Concept:* The action of effectors (muscle tissue and glandular epithelium) is controlled to a large extent by motor neuron impulses. Skeletal muscles, which are the voluntary effectors, are regulated by somatic motor impulses. The involuntary effectors (smooth muscle tissue, cardiac muscle tissue, and glandular epithelium) are regulated by autonomic motor impulses through the autonomic nervous system.


A. Multiple Choice Questions

- ___ 1. Which effector(s) is (are) *not* under autonomic regulation?
(a) skeletal muscles (c) smooth (visceral) muscles
(b) glands (d) cardiac muscle
- ___ 2. The motor pathways of the autonomic nervous system
(a) contain one neuron from the CNS to each effector.
(b) are either excitatory or inhibitory.
(c) have specialized motor end plates at the neuromuscular junctions.
(d) are fast-conducting because of thick, myelinated neurons.
- ___ 3. In which location would autonomic ganglia *not* be found?
(a) head (d) abdomen
(b) axilla (e) parallel to the spinal cord
(c) neck
- ___ 4. What happens when a visceral organ is denervated?
(a) It ceases to function.
(b) It becomes less sensitive to subsequent stimulation by neurotransmitters.
(c) It becomes hypersensitive to subsequent stimulation.
(d) None of the above occur.
- ___ 5. Which of the following statements is *false* concerning cardiac muscle?
(a) The fibers are striated with actin and myosin.
(b) The fibers respond with all-or-none contraction.
(c) Intercalated discs are located between adjacent fibers.
(d) The fibers require external stimulation in order to produce an action potential.
(e) The fibers are short, branched, and interconnected.
- ___ 6. Which of the following functional types of smooth muscle is *incorrectly* described?
(a) single-unit—numerous gap junctions
(b) multiunit—requires nerve stimulation
(c) multiunit—displays spontaneous depolarization
(d) single-unit—displays intrinsic (myogenic) contraction

B. True–False Questions

- ___ 1. A preganglionic neuron of the autonomic nervous system is located between a receptor organ and a sensory ganglion.
- ___ 2. The origins of the preganglionic fibers and the locations of the autonomic ganglia help to differentiate the sympathetic and parasympathetic subdivisions of the autonomic nervous system.
- ___ 3. Damage to an autonomic nerve makes its target muscle less sensitive than normal to stimulating agents.
- ___ 4. Denervation to a muscle—be it skeletal, smooth, or cardiac—results in paralysis.
- ___ 5. Neurotransmitter chemicals always stimulate the effector organ.
- ___ 6. Smooth muscles do not contain actin and myosin because, unlike skeletal and cardiac muscles, they are nonstriated.

II. Structure of the Autonomic Nervous System

 *Concept:* The sympathetic and parasympathetic divisions of the autonomic nervous system both consist of preganglionic neurons with cell bodies located in the CNS and postganglionic neurons with cell bodies located outside of the CNS in ganglia. However, the specific origin of the preganglionic neurons and the location of the ganglia differ in the two subdivisions of the autonomic nervous system.

A. Multiple Choice Questions


- ___ 1. The preganglionic neurons of the sympathetic division of the autonomic nervous system originate in
 - (a) the midbrain and the medulla oblongata.
 - (b) the medulla oblongata and the cervical vertebrae.
 - (c) the entire spinal nerve complex.
 - (d) the first cervical (C1) to the first lumbar (L1) vertebrae.
 - (e) the first thoracic (T1) to the second lumbar (L2) vertebrae.
- ___ 2. Myelination in the autonomic nervous system
 - (a) forms the gray rami communicantes.
 - (b) occurs in the preganglionic sympathetic fibers.
 - (c) is important for the mass activation of nerve fibers.
 - (d) occurs only in the fibers that innervate the head and neck.
- ___ 3. The preganglionic neurons of the parasympathetic division of the autonomic nervous system originate in
 - (a) the entire spinal nerve complex.
 - (b) the midbrain and medulla oblongata of the brain and the second through the fourth sacral spinal nerves (S2 to S4).
 - (c) the medulla oblongata and spinal nerves to the level of the first thoracic (T1) vertebra.
 - (d) the first thoracic (T1) to the twelfth thoracic (T12) vertebrae.
- ___ 4. The arrector pili muscles have
 - (a) only sympathetic innervation.
 - (b) only parasympathetic innervation.
 - (c) both a and b.
 - (d) neither a nor b.

- _____ 5. The cranial nerves that contain preganglionic parasympathetic fibers are
- the oculomotor, trigeminal, trochlear, and facial nerves.
 - the facial, glossopharyngeal, vestibulocochlear, and vagus nerves.
 - the oculomotor, facial, glossopharyngeal, and vagus nerves.
 - the facial, trigeminal, vestibulocochlear, and vagus nerves.
- _____ 6. Which of the following is *not* a result of parasympathetic nerve stimulation?
- increased movement of the gastrointestinal tract (GI tract)
 - increased mucus secretion
 - constriction of the pupils
 - constriction of visceral blood vessels

B. True–False Questions

- _____ 1. The sympathetic division of the autonomic nervous system is also known as the craniosacral division.
- _____ 2. The gray rami communicantes travel distally within the spinal nerves to innervate their effector organs with sympathetic fibers.
- _____ 3. The celiac, superior mesenteric, and inferior mesenteric ganglia are peripheral ganglia.
- _____ 4. The adrenal medulla is a modified sympathetic ganglion whose cells are derived from postganglionic sympathetic neurons.
- _____ 5. The most extensive sympathetic innervation in the body is provided by the vagus nerves.
- _____ 6. The celiac plexus and plexuses of the abdominal portion of the aorta are composed of nerve fibers arising only from the spinal cord.

III. Functions of the Autonomic Nervous System

 *Concept:* The actions of the autonomic nervous system, together with the effects of hormones, help to maintain a state of dynamic constancy in the internal environment. The sympathetic division gears the body for action through adrenergic effects; the parasympathetic division conserves and restores the body's energy through cholinergic effects. Homeostasis thus depends, in large part, on the complementary and often antagonistic effects of sympathetic and parasympathetic innervation.

A. Multiple Choice Questions


- _____ 1. Which of the following statements is *true* concerning increased activity of the GI tract?
- It is the result of adrenergic transmission.
 - It results from the release of norepinephrine.
 - It is an example of a sympathetic response.
 - It is an example of a parasympathetic response.
 - Both a and d are true.
- _____ 2. The neurotransmitter that is released into the synapses by all preganglionic sympathetic and parasympathetic fibers is
- | | |
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| (a) acetylcholine. | (d) glycine. |
| (b) norepinephrine. | (e) none of the above. |
| (c) serotonin. | |

- ___ 3. Because it blocks the muscarinic effects of acetylcholine, the drug atropine
 (a) increases the heart rate. (c) inhibits movement of the GI tract.
 (b) decreases mucus secretion. (d) does all of the above.
- ___ 4. The effects of sympathetic and parasympathetic stimulation on the diameter of the pupil of the eye are
 (a) cooperative. (c) graded.
 (b) antagonistic. (d) complementary.
- ___ 5. The actions of sympathetic and parasympathetic nerves are cooperative in
 (a) the urinary bladder. (c) the salivary glands.
 (b) the heart. (d) the iris.
- ___ 6. Regulation of sweat gland activity involves
 (a) cooperative effects. (c) complementary effects.
 (b) antagonistic effects. (d) none of the above.

B. True–False Questions

- ___ 1. Although they have opposite effects, both the sympathetic and parasympathetic divisions are activated as a whole when they are autonomically stimulated.
- ___ 2. The neurotransmitter chemical released by most postganglionic sympathetic nerve fibers is acetylcholine.
- ___ 3. Parasympathetic stimulation through the vagus nerves results in slowing of the heart rate.
- ___ 4. Since the same heart cells are innervated by both sympathetic and parasympathetic fibers, the heart experiences the antagonistic effects of the two autonomic divisions.
- ___ 5. The dual innervation of sympathetic and parasympathetic fibers to the salivary glands results in antagonistic effects.
- ___ 6. Erection of the penis and ejaculation are caused by stimulation through parasympathetic nerves.
- ___ 7. Both the sympathetic and parasympathetic systems are directly involved in thermoregulatory responses to heat.
- ___ 8. Sympathetic stimulation to sweat glands causes the release of bradykinin, which stimulates dilation of the surface blood vessels.

IV. Control of the Autonomic Nervous System by Higher Brain Centers

 *Concept:* Visceral functions are largely regulated by autonomic reflexes. In most autonomic reflexes, sensory input is directed to brain centers, which in turn regulate the activity of descending pathways to preganglionic autonomic neurons. The neural centers that directly control the activity of autonomic nerves are influenced by higher brain areas, as well as by sensory input.

A. Multiple Choice Questions

- ___ 1. The structure of the brain that has autonomic influence over the respiratory and the reproductive systems is
 (a) the pituitary gland. (d) the limbic system.
 (b) the hypothalamus. (e) the medulla oblongata.
 (c) the pons.

- _____ 2. Which pair of terms relating a body organ to a receptor type is *incorrect*?
- (a) lungs and type J receptors
 - (b) aorta and chemoreceptors
 - (c) heart and baroreceptors
 - (d) stomach and stretch receptors
 - (e) lungs and stretch receptors
- _____ 3. Which of the following statements is *false* concerning the hypothalamus?
- (a) It can evoke the autonomic responses characteristic of aggression and sexual behavior.
 - (b) It elicits only visceral autonomic activities.
 - (c) It integrates its autonomic activities with those of the medulla oblongata.
 - (d) It regulates some of the autonomic functions of the pituitary gland.
- _____ 4. The limbic system
- (a) courses through the midbrain and brain stem.
 - (b) is the brain center for basic emotional drives.
 - (c) functions totally at the conscious level.
 - (d) monitors the blood hormone levels of the autonomic nervous system.

B. True–False Questions

- _____ 1. Stimulation of the stretch receptors in the lungs inhibits inhalation and increases cardiac rate and vasodilation.
- _____ 2. Stimulation of the aortic baroreceptors results in an increased heart rate.
- _____ 3. The autonomic activities of the hypothalamus function independently of the higher brain centers.
- _____ 4. Nerve impulses through the motor tracts of the cerebellum influence the autonomic responses of motion sickness.

V. Chapter Review

A. Completion Questions

1. The autonomic nervous system exerts its effect on _____ effectors.
2. The effectors that respond to autonomic regulation include cardiac muscle, smooth muscles, and _____.
3. Synapses within the autonomic nervous system occur within autonomic _____.
4. Adjacent myocardial cells are joined by gap junctions called _____.
5. Because all cells in the myocardium are joined, the heart muscle behaves as a single functional unit called a functional _____.
6. The alternate contraction of circular and longitudinal smooth muscle layers produces _____, which propel the contents of the GI tract in one direction.

7. Contractions of single-unit smooth muscles that do not require stimulation by autonomic nerves are said to be _____.
8. The sympathetic division of the autonomic nervous system is also called the _____ division because of its specific origin from the spinal cord.
9. Postganglionic fibers from the _____ ganglion innervate the stomach, spleen, liver, small intestine, and the kidneys.
10. The _____ nerve innervates the parotid salivary gland with parasympathetic fibers.
11. The _____ nerve provides _____ innervation to the “pacemaker” of the heart.
12. The “theme” of the sympathetic division of the autonomic nervous system is summarized as the _____ or _____ response.
13. _____ is the neurotransmitter of all sympathetic and parasympathetic preganglionic fibers.
14. _____ is a chemical secreted by the eccrine sweat glands that stimulates dilation of the cutaneous blood vessels, helping to radiate heat.
15. The _____ of the brain can evoke the autonomic responses characteristic of aggression, sexual behavior, eating, or satiety.

B. Matching Questions

Match the characteristic with the type(s) of muscle.

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| ___ 1. striated fibers | (a) skeletal muscle |
| ___ 2. contains actin and myosin | (b) cardiac muscle |
| ___ 3. contracts in peristaltic waves | (c) smooth muscle |
| ___ 4. gap junctions present as intercalated discs | |
| ___ 5. somatic motor innervation | |
| ___ 6. autonomic motor innervation | |