**Animal Physiology**

**Chapter 7: Animal Nervous System:**

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**General Organization of Nervous System**

The two primary nervous system components are the peripheral nervous system (PNS) and the central nervous system (CNS). Nerves and ganglia outside the central nervous system (CNS) comprise the PNS, whereas the brain and spinal cord make up the CNS.

Central Nervous System (CNS)

* Brain: The brain is the primary control centre of the nervous system. It receives in, processes, and interprets data from the body and the external environment. Many functions, including motor control, emotions, sensory perception, and cognitive processes, are attributed to distinct brain areas.
* Spinal Cord: Extending from the brainstem down the vertebral column, the spinal cord is a long, cylindrical bundle of nerve fibres. It acts as a channel of communication between the peripheral nervous system and the brain. In addition to controlling reflexes, the spinal cord facilitates nerve messages that go to and from the brain.

Peripheral Nervous System (PNS):

* Nerves: The PNS is comprised of up of nerves that connect the CNS to different areas of the body. Nerves are collections of nerve fibres, or axons, that allow the central nervous system (CNS) to communicate with peripheral organs, muscles, and tissues electrically. Afferent sensory nerves transmit messages from sensory receptors to the central nervous system (CNS), while efferent motor neurons transmit signals from the CNS to muscles and glands.
* Ganglia: Found outside the central nervous system, ganglia are groups of nerve cell bodies. They function in the integration and processing of nerve signals and are a component of the PNS. Reflex actions and certain parts of sensory processing are mediated by ganglia.

The general organization can be visualized as a hierarchy, with the brain and spinal cord at the top (CNS) and nerves and ganglia branching out to connect with various parts of the body (PNS). The CNS processes and integrates information, while the PNS serves as a communication network, facilitating the transmission of signals between the CNS and the rest of the body.

This division allows for the specialization of functions: the CNS handles complex processes like decision-making and information processing, while the PNS ensures communication and coordination with the peripheral tissues and organs. Together, the CNS and PNS work in concert to regulate and control the body's physiological functions and responses to the environment.

**Neuron Structure and Function**

The fundamental cells that make up the nervous system's structure are called neurons. They are essential for information transmission throughout the body, facilitating various physiological processes as well as communication between different nervous system components. A neuron's structure is highly specialised to support its role in signal transmission. They are made up of an axon that sends signals, dendrites that receive signals, and a cell body. Chemical messages and electrical impulses are two ways that neurons can interact.

* Cell Body (Soma): It is the central part of the neuron. It comprises the nucleus and other organelles essential for the cell's metabolic activities. The cell body selects whether to create and send an electrical signal down the axon after integrating signals coming in from the dendrites.
* Dendrites: They are branched extensions that project from the cell body. Their foremost function is to receive signals from other neurons or sensory receptors. Dendrites have numerous synaptic connections, where they receive chemical signals (neurotransmitters) from adjacent neurons. These signals have the ability to stimulate or inhibit the neuron, which affects the possibility that the neuron will produce an electrical signal.
* Axon: It is a long, slender projection that extends from the cell body. It serves as the main route via which electrical impulses are transmitted out from the cell body. Myelin, a fatty material that covers the axon, functions as an insulator and quickens the passage of electrical information. Axon terminals, also known as synaptic terminals, are the sites where axons terminate.
* Synaptic Terminals: The axon terminals are specialized structures at the end of the axon. When an electrical impulse reaches the axon terminals, it triggers the release of neurotransmitters. Neurotransmitters are chemical messengers that bridge the gap (synapse) between the axon terminal of one neuron and the dendrites of the next neuron or the target cell (such as a muscle or gland cell).
* Communication: Neurons communicate through a combination of electrical impulses and chemical signals. An electrical signal, travels along the axon when a neuron is activated is also known as an action potential. At the junction between neurons known as the synapse, neurotransmitters are discharged and attach to receptors located on the dendrites of adjacent neurons. This attachment has the potential to either stimulate or suppress activity in the receiving neuron, determining whether it will initiate its own electrical impulse.

In summary we can say that the structure of a neuron is specialized to receive, integrate, and transmit signals. Dendrites receive signals, the cell body integrates them, and the axon transmits the resulting electrical impulse to communicate with target cells. This process of communication is fundamental to the basic functions of the nervous system and underlies various physiological processes, including sensation, movement, and cognition.

**Excitability and Transmission of Impulse in Neuron and Muscle**

The concept of excitability and the transmission of impulses in neurons and muscle cells is a fundamental aspect of the nervous and muscular systems in all animals. Excitability refers to the ability of cells to respond to stimuli, and in the context of neurons and muscle cells, this involves the generation as well as transmission of the electrical impulses.

Neurons: They are excitable cells that play a key role in transmitting information throughout the nervous system. The transmission of impulses in neurons involves a series of events:

* Resting Membrane Potential: Neurons uphold a resting membrane potential, denoting an electrical charge across the cell membrane. This resting state is characterized by a negative charge within the cell relative to its exterior.
* Stimulus: When a neuron is exposed to a stimulus (such as a sensory input or chemical signal), it can lead to a change in the membrane potential.
* Depolarization: If the stimulus is strong enough, it can cause depolarization, where the membrane potential becomes less negative. This change in voltage triggers the opening of voltage-gated ion channels in the cell membrane.
* Action Potential: Ion channels opening facilitate ion movement, leading to an action potential—an electrical signal that propagates along the neuron's axon.
* Propagation: The action potential travels down the length of the axon, reaching the axon terminals. At the synapses, neurotransmitters are released, transmitting the signal to the next neuron or target cell.

Muscle Cells: The contraction of muscles involves the transmission of electrical impulses that lead to muscle contraction. The key steps in muscle excitation-contraction coupling are as follows:

* Neuromuscular Junction: The signal for muscle contraction begins at the neuromuscular junction, where a motor neuron releases acetylcholine, a neurotransmitter, onto the muscle fiber.
* Depolarization: Acetylcholine binding to receptors on the muscle cell membrane (sarcolemma) leads to depolarization. This electrical signal is transmitted along the sarcolemma and into the muscle fiber through structures called transverse tubules.
* Calcium Release: The depolarization triggers the calcium ions release from the sarcoplasmic reticulum (an intracellular calcium storage structure) into the muscle cell.
* Muscle Contraction: Calcium binds to proteins in the muscle cell, initiating the contraction process by allowing the interaction of actin and myosin, the two major proteins in muscle fibers.
* Relaxation: When the stimulation ceases, calcium is actively pumped back into the sarcoplasmic reticulum, and the muscle relaxes.

This process of excitation-contraction coupling allows animals to move, maintain posture, and perform various motor functions. In short, excitability in neurons and muscle cells involves the generation and transmission of electrical impulses in response to stimuli. This fundamental process underlies the functioning of the nervous and muscular systems in ruminants and other organisms.

**Junctional Transmission**

The synapse is a specialized junction where neurons communicate. It is the point where the axon terminals of one neuron come into close proximity to the dendrites of another neuron or the target cell (such as a muscle cell). The process of junctional transmission involves the release of neurotransmitters into the synapse. When an action potential reaches the axon terminals, it initiates the release of neurotransmitters from synaptic vesicles. These neurotransmitters traverse the synapse and bind to receptors present on the membrane of the receiving neuron or target cell. This type of binding can either excite or inhibit the receiving cell, influencing whether an action potential will be generated.

"Synaptic Transmission

The synapse serves as a specialized connection point facilitating communication between neurons. It's where the axon terminals of one neuron closely interact with the dendrites of another neuron or the target cell, such as a muscle cell. The process of synaptic transmission entails the discharge of neurotransmitters into the synapse. When an action potential reaches the axon terminals, it prompts the release of neurotransmitters stored in synaptic vesicles. These neurotransmitters travel across the synapse and attach to receptors located on the membrane of the receiving neuron or target cell. This attachment can either stimulate or inhibit the receiving cell, thereby influencing whether an action potential will occur."

**Neurotransmitters**

Theye are chemical messengers that play a crucial role in transmitting signals between neurons or from neurons to muscles. These signalling molecules facilitate the transmission of information across synapses, which are the junctions where two nerve cells or a nerve cell and a target cell (such as a muscle cell) communicate. Examples of neurotransmitters include dopamine, serotonin, acetylcholine, and many others. Each neurotransmitter has specific functions and effects on the target cells. For example, **acetylcholine** is involved in transmitting signals at the **neuromuscular junction**, while **dopamine and serotonin** are neurotransmitters associated with **mood regulation and other brain functions**.

Function of Neurotransmitters:

Interneuronal Communication: Neurotransmitters enable communication between neurons. When an action potential (electrical signal) reaches the end of the axon (axon terminal) of one neuron, it triggers the release of neurotransmitters into the synapse (the small gap between neurons). The neurotransmitters then bind to receptors on the membrane of the receiving neuron, transmitting the signal to the next neuron.

Neuromuscular Junction: In the context of muscles, neurotransmitters are released at the neuromuscular junction. This is the point where a motor neuron connects with a muscle fiber. Neurotransmitters released into the synapse between the motor neuron and muscle fiber stimulate the muscle to contract. Following are some examples,

**Dopamine:** Dopamine is a neurotransmitter associated with various functions, including movement, motivation, reward, and pleasure. It plays a role in mood regulation and is implicated in conditions such as Parkinson's disease and schizophrenia.

**Serotonin:** Its is involved in regulating mood, sleep, appetite, and various physiological processes. Imbalances in serotonin levels are associated with mood disorders such as depression and anxiety.

**Acetylcholine:** Acetylcholine is a neurotransmitter that plays a key role in the neuromuscular junction. It is involved in transmitting signals from motor neurons to muscle fibers, leading to muscle contraction. Acetylcholine is also present in other parts of the nervous system, where it functions in processes such as learning and memory.

Neurotransmitter Receptors: Neurotransmitters binds to specific receptors on the membrane of the target cell. Each neurotransmitter has its own set of receptors, and the binding of the neurotransmitter to its receptor can have excitatory or inhibitory effects on the target cell.

Reuptake and Degradation: After neurotransmitters transmit their signals, they can be removed from the synapse through reuptake or degraded by enzymes. Reuptake is the process by which neurotransmitters are reabsorbed by the neuron that released them, terminating their action. Enzymes in the synapse may also break down neurotransmitters.

Understanding the role of neurotransmitters is crucial for gaining insights into various physiological and behavioral processes in animals. Imbalances or dysregulation of neurotransmitters can contribute to a variety of neurological and psychiatric disorders. Therefore, the study of neurotransmitters and their functions is central to both basic neuroscience research and the development of treatments for neurological and psychiatric conditions in animals, including humans.

**Reflex Action**

It is an automatic and involuntary response to a stimulus. Reflex arcs are neural pathways that mediate reflex actions. They typically involve three main components: sensory neurons, interneurons in the spinal cord, and motor neurons. When a sensory receptor senses a stimulus (e.g., touching a hot surface), it sends a signal to the spinal cord through a sensory neuron. In the spinal cord, interneurons process the information and rapidly send a signal to motor neurons. The motor neurons then convey the response signal to effectors (muscles or glands), leading to a quick and automatic reaction (e.g., pulling the hand away from the hot surface).

**Initiation of Impulses from Sense Organs/Receptors**

Sensory receptors are specialized structures that detect stimuli from the external environment or within the body. These stimuli can be various forms of energy, such as light, sound, pressure, or chemicals. When a sensory receptor is stimulated, it generates electrical signals in the form of action potentials. These electrical signals are then transmitted along sensory neurons to the central nervous system (CNS), where the information is processed. The CNS interprets these signals, leading to appropriate responses or actions.

The junctional transmission, neurotransmitters, reflex actions, and the initiation of impulses from sense organs are integral components of the nervous system in animals. These processes allow for rapid and coordinated responses to the environment, ensuring the survival and well-being of the organism.

Functions:

The spinal cord, brain stem, and cerebellum are integral parts of the central nervous system in animals, each serving distinct functions in regulating various physiological processes. The brain stem regulates basic functions like breathing and heart rate, while the cerebellum coordinates movement and balance. The functions of these structures are as follows:

Spinal Cord

* Signal Relay: It acts as a vital relay center, transmitting signals between the brain and the rest of the body. It serves as a conduit for both sensory signals from the periphery to the brain and motor signals from the brain to muscles and glands.
* Reflex Actions: The spinal cord is capable of generating reflex actions. Reflex arcs, which involve sensory neurons, interneurons in the spinal cord, and motor neurons, allow for rapid, involuntary responses to stimuli. For example, the withdrawal reflex is initiated when a pain stimulus is detected, leading to the quick withdrawal of a body part from the source of harm.

Brain Stem:

* Regulation of Basic Functions: The brain stem, located at the base of the brain, is responsible for regulating essential and involuntary functions necessary for survival.
* Autonomic Functions: It controls autonomic functions such as breathing, heart rate, blood pressure, and digestion. The medulla oblongata, a part of the brain stem, is particularly crucial for these autonomic functions.
* Cranial Nerve Nuclei: The brain stem houses nuclei associated with several cranial nerves, which are responsible for various sensory and motor functions related to the head and neck.

Cerebellum:

* Coordination of Movement: The cerebellum, situated at the back of the brain, is primarily involved in the coordination and fine-tuning of voluntary movements. It ensures smooth and precise execution of motor tasks.
* Balance and Posture: Along with coordinating movement, the cerebellum plays a crucial role in maintaining balance and posture. It receives sensory input regarding the body's position and adjusts muscle activity to keep the body stable.
* Motor Learning: The cerebellum is also implicated in motor learning and the adaptation of movements based on experience. It contributes to the refinement of motor skills through practice and repetition.

These structures collaborate to facilitate communication between the brain and the body, regulate essential autonomic functions, and ensure coordinated and balanced movement. The spinal cord relays signal and generates reflex actions, the brain stem oversees basic physiological processes, and the cerebellum fine-tunes voluntary movements and contributes to motor learning. The integrated functions of these central nervous system components are essential for an animal's ability to respond to its environment, move effectively, and maintain vital bodily functions.

**Limbic system and Cerebral cortex**

These two are interconnected components of the brain, each playing distinct roles in the cognitive and emotional processes of animals.

**Limbic System**

Emotions: The limbic system is heavily involved in the processing and regulation of emotions. Structures within the limbic system, such as the amygdala and hippocampus, play key roles in emotional experiences and responses.

Memory Formation: The hippocampus, in particular, is crucial for remembrances and the merging of information from short-term to long-term memory. It plays a role in spatial memory and navigation as well.

Amygdala and Emotional Responses: The amygdala is associated with the processing of emotions, particularly fear and pleasure. It plays a central role in the emotional aspects of memory and decision-making.

**Cerebral Cortex**

Higher Cognitive Functions: The cerebral cortex is the outer layer of the brain and is responsible for higher cognitive functions. It is highly developed in mammals, especially in humans.

Thinking and Reasoning: Regions of the cerebral cortex, such as the prefrontal cortex, are involved in complex thinking processes, reasoning, and decision-making. This area is particularly well-developed in primates.

Perception: Different areas of the cerebral cortex are dedicated to processing sensory information from the environment, including visual, auditory, somatosensory, and olfactory information. These areas contribute to the perception of the world around the animal.

Voluntary Movement: The motor cortex, located in the frontal lobe, is responsible for the initiation and coordination of voluntary movements. It sends signals to the muscles, allowing for purposeful and controlled actions.

Language Processing: In species capable of language, specific areas in the left hemisphere of the cerebral cortex are involved in language processing and production.

Interconnected Functionality: The limbic system and cerebral cortex are not isolated entities but are interconnected. Emotional experiences can influence cognitive processes, and cognitive processes, in turn, can impact emotional responses. For example, the prefrontal cortex, a part of the cerebral cortex, is involved in regulating emotions and making decisions based on social and environmental cues. It interacts with the amygdala and other limbic structures to modulate emotional responses.

In animals, the specific functions and complexity of the limbic system and cerebral cortex can vary among species. However, the general principles of emotional processing, memory, and higher cognitive functions are conserved across many vertebrates. These structures contribute to an animal's ability to navigate its environment, interact socially, and respond adaptively to various challenges.

**Hypothalamus and Its Autonomic Functions in Endocrine and Visceral Regulation**

The hypothalamus is a crucial region in the brain that plays a pivotal role in regulating various physiological processes in animals. The hypothalamus regulates autonomic functions, body temperature, hunger, thirst, and links the nervous and endocrine systems. Here are the important points regarding the hypothalamus and its autonomic functions in endocrine and visceral regulation:

Location and Structure

The hypothalamus is a small, almond-sized region located at the base of the brain, below the thalamus. It forms a link between the nervous system and the endocrine system, serving as a key integrative center.

Autonomic Functions

Regulation of ANS: The hypothalamus controls the ANS, which includes the sympathetic and parasympathetic branches. These branches regulate involuntary bodily functions for example heart rate, digestion, and respiratory rate.

SNS: Activation of the SNS prepares the body for **"fight or flight"** responses, increasing heart rate, dilating pupils, and redirecting blood flow to muscles.

PNS: Activation of the PNS promotes a **"rest and digest"** state, slowing heart rate, constricting pupils, and enhancing digestive processes.

Endocrine Regulation

Control of Pituitary Gland: The hypothalamus regulates the pituitary gland, often referred to as the master gland, through the release of hormones. This control influences the secretion of various hormones that, in turn, regulate other endocrine glands throughout the body.

Hormones Released: Hypothalamic hormones, such as thyrotropin-releasing hormone (TRH), gonadotropin-releasing hormone (GnRH), and corticotropin-releasing hormone (CRH), influence the release of hormones from the pituitary gland.

Body Temperature Regulation:

The hypothalamus is integral to maintaining core body temperature within a narrow range. It acts as a thermostat, responding to changes in temperature by initiating responses such as sweating, shivering, or adjusting blood flow to the skin to regulate heat loss or retention.

Hunger and Thirst Regulation

The hypothalamus is involved in the regulation of appetite and thirst. It responds to signals related to nutrient levels, blood glucose, and hydration status, influencing feelings of hunger and thirst accordingly.

Links Between Nervous and Endocrine Systems

The hypothalamus serves as a crucial interface between the nervous and endocrine systems. It integrates signals from the nervous system and translates them into hormonal responses, coordinating various physiological functions.

In summary, the hypothalamus is a central regulatory hub in the brain that orchestrates autonomic functions, endocrine responses, body temperature, hunger, and thirst. Its intricate control over the autonomic nervous system and its ability to link the nervous and endocrine systems contribute significantly to the overall homeostasis and adaptive responses in animals.

Ascending and Descending Tracts: Nerve tracts in the spinal cord that carry sensory information to the brain (ascending) and motor commands from the brain to the body (descending).

**Physiology of Learning and Memory**

Changes in Synaptic Connections: Learning and memory involve alterations in synaptic connections between neurons. Synapses, the junctions between neurons, can undergo structural and functional changes, impacting the strength of communication.

Long-Term Potentiation (LTP): LTP is a cellular process associated with memory formation. It involves the strengthening of synaptic connections, leading to increased responsiveness between neurons. LTP is often considered a cellular model for learning and memory.

Neurotransmitters and Memory: Neurotransmitters, such as glutamate, play a key role in synaptic plasticity and memory. The release of neurotransmitters during learning events contributes to the modification of synaptic connections.

Structures Involved: Brain structures like the hippocampus and certain regions of the cerebral cortex are crucial for the formation and consolidation of memories. The hippocampus, in particular, is associated with the conversion of short-term memory to long-term memory.

**Physiology of Pain**

Detection and Interpretation of Noxious Stimuli: Pain is a complex sensory and emotional experience. It involves the detection and interpretation of noxious stimuli by specialized receptors called **nociceptors.**

Nociceptors: Nociceptors are sensory neurons that respond to potentially damaging stimuli, such as tissue injury or inflammation. These receptors transmit signals to the spinal cord and brain, signaling the presence of harmful stimuli.

Neurotransmitters in Pain Pathways: Pain perception involves the release of neurotransmitters such as substance P. These neurotransmitters transmit pain signals along nerve pathways to the brain, contributing to the perception of pain.

Gate Control Theory: The gate control theory of pain suggests that the perception of pain can be modulated by inhibitory signals in the spinal cord. Non-painful stimuli or signals can close the "gate," reducing the sensation of pain.

Chronic Pain and Plasticity: Chronic pain involves long-term changes in the nervous system, including synaptic plasticity. Maladaptive plasticity can lead to persistent pain even after the initial injury has healed.

**Special Senses (Hearing, Vision, Taste, Smell, etc.)**

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| --- | --- | --- | --- | --- |
| Sense | Description | Receptors and Detection | Pathway to the Brain | Processing Center |
| Hearing | Involves the detection of sound waves by specialized receptors in the inner ear (hair cells). | Hair cells in the cochlea detect vibrations in response to sound waves. | Auditory nerve transmits signals to the auditory cortex in the brain. | Auditory cortex in the temporal lobe |
| Vision | Photoreceptor cells in the retina detect light and transmit visual information to the brain. | Rods and cones in the retina detect light, transmitting signals to the optic nerve. | Optic nerve transmits visual information to the visual cortex in the occipital lobe. | Visual cortex in the occipital lobe |
| Taste | Taste buds on the tongue detect chemicals in food | Taste buds contain receptors for sweet, salty, sour, bitter, and umami tastes. | Taste signals are transmitted to the gustatory cortex in the brain. | Gustatory cortex in the frontal lobe. |
| Smell | Olfactory receptors in the nasal epithelium detect odor molecules. | Olfactory receptors bind to odor molecules, transmitting signals to the olfactory nerve. | Olfactory nerve transmits information to the olfactory bulb in the brain. | Olfactory bulb in the brain |
| Touch | Touch receptors in the skin respond to mechanical stimuli. | Mechanoreceptors in the skin detect pressure, vibration, and temperature changes. | Somatosensory pathway transmits touch signals to the somatosensory cortex. | Somatosensory cortex in the parietal lobe |
| Balance (Vestibular Sense) | Involves sensors in the inner ear detecting head position and movement. | Hair cells in the vestibular system detect changes in head position and movement. | Vestibular nerve transmits signals to the brainstem and cerebellum. | Brainstem and cerebellum |

Multiple Choice Questions

1. Which part of the nervous system is responsible for voluntary muscle control and sensory perception?
	* 1. Autonomic nervous system
		2. Central nervous system
		3. Peripheral nervous system
		4. Enteric nervous system
2. What is the primary function of dendrites in a neuron?
	* 1. Transmission of signals to other neurons
		2. Integration of incoming signals
		3. Production of neurotransmitters
		4. Conduction of electrical impulses
3. The movement of an action potential along the axon is facilitated by the influx of which ion?
	* 1. Sodium
		2. Potassium
		3. Calcium
		4. Chloride
4. In a withdrawal reflex, which type of neuron directly stimulates the effector organ (e.g., muscle)?
	* 1. Sensory neuron
		2. Interneuron
		3. Motor neuron
		4. Association neuron
5. The coordination of voluntary movements, balance, and posture is primarily associated with which part of the brain?
	* 1. Cerebellum
		2. Medulla oblongata
		3. Pons
		4. Thalamus
6. Which brain structure is crucial for the consolidation of long-term memories?
	* 1. Hippocampus
		2. Amygdala
		3. Hypothalamus
		4. Basal ganglia
7. Pain signals are transmitted to the brain through which type of nerve fibers?
	* 1. Afferent fibers
		2. Efferent fibers
		3. Motor fibers
		4. Autonomic fibers
8. The photoreceptor cells responsible for color vision in the retina are called:
	* 1. Rod cells
		2. Cone cells
		3. Bipolar cells
		4. Ganglion cells
9. The communication between two neurons occurs at the:
	* 1. Synapse
		2. Axon hillock
		3. Nodes of Ranvier
		4. Myelin sheath
10. Which neurotransmitter is associated with mood regulation and is often targeted by antidepressant medications?
	* 1. Dopamine
		2. Serotonin
		3. Acetylcholine
		4. GABA
11. Photoreceptors in the retina are responsible for detecting:
	* 1. Sound waves
		2. Light stimuli
		3. Chemical stimuli
		4. Pressure stimuli
12. The hypothalamus plays a key role in:
	* 1. Motor coordination
		2. Temperature regulation
		3. Memory formation
		4. Visual perception
13. Ascending tracts in the spinal cord primarily carry:
	* 1. Motor information to the brain
		2. Sensory information to the brain
		3. Motor information to the muscles
		4. Sensory information to the muscles
14. The frontal lobe of the cerebral cortex is associated with:
	* 1. Vision processing
		2. Auditory processing
		3. Motor function and decision making
		4. Memory consolidation
15. The amygdala, a part of the limbic system, is primarily involved in the processing of:
	* 1. Taste
		2. Smell
		3. Emotions and memory
		4. Hearing
16. Which neurotransmitter is often associated with the modulation of pain signals?
	* 1. Endorphins
		2. Serotonin
		3. Dopamine
		4. Acetylcholine
17. The parasympathetic nervous system is known for its role in:
	* 1. "Fight or flight" responses
		2. Rest and digest responses
		3. Increased heart rate
		4. Dilation of pupils
18. The hypothalamus controls the release of hormones from the:
	* 1. Pituitary gland
		2. Thyroid gland
		3. Adrenal gland
		4. Pancreas
19. The auditory ossicles, including the malleus, incus, and stapes, are found in which part of the ear?
	* 1. Outer ear
		2. Middle ear
		3. Inner ear
		4. Eustachian tube
20. In addition to relaying sensory information to the brain, the spinal cord is involved in:
	* 1. Digestion
		2. Respiration
		3. Reflex actions
		4. Vision
21. The primary somatosensory cortex is responsible for processing sensations related to:
	* 1. Vision
		2. Hearing
		3. Touch and body position
		4. Taste
22. The neurotransmitter released at the neuromuscular junction (NMJ) for muscle contraction is:
	* 1. Dopamine
		2. Acetylcholine
		3. Serotonin
		4. GABA
23. The medulla oblongata is crucial for the regulation of:
	* 1. Heart rate and respiration
		2. Motor coordination
		3. Visual processing
		4. Memory consolidation
24. Long-term potentiation (LTP) is a cellular mechanism associated with:
	* 1. Short-term memory
		2. Long-term memory
		3. Immediate memory
		4. Procedural memory
25. Which division of the autonomic nervous system is responsible for "rest and digest" activities?
	* 1. Sympathetic division
		2. Parasympathetic division
		3. Enteric division
		4. Somatic division
26. In a reflex arc, the sensory neuron communicates directly with the:
	* 1. Motor neuron
		2. Interneuron
		3. Effector organ
		4. Synapse
27. The cochlea in the inner ear is responsible for detecting:
	* 1. Odors
		2. Sound waves
		3. Taste stimuli
		4. Light stimuli
28. Endorphins act as natural painkillers by binding to:
	* 1. Opioid receptors
		2. Dopamine receptors
		3. Serotonin receptors
		4. Acetylcholine receptors
29. The optic nerve carries visual information from the retina to the:
	* 1. Thalamus
		2. Hypothalamus
		3. Occipital lobe
		4. Parietal lobe
30. The primary motor cortex is responsible for the voluntary control of:
	* 1. Vision
		2. Hearing
		3. Muscle movements
		4. Taste perception
31. Dopamine is often associated with the brain's reward system and is involved in:
	* 1. Muscle contraction
		2. Memory consolidation
		3. Emotional regulation
		4. Motor coordination
32. The cranial nerves are a part of the:
	* 1. Central nervous system
		2. Peripheral nervous system
		3. Autonomic nervous system
		4. Somatic nervous system
33. The hypothalamus regulates hunger and satiety through the release of:
	* 1. Insulin
		2. Ghrelin
		3. Leptin
		4. Cortisol
34. Olfactory receptors responsible for the sense of smell are located in the:
	* 1. Tongue
		2. Nose
		3. Eyes
		4. Ears
35. Motor commands for voluntary muscle movements are initiated in the:
	* 1. Dorsal horn of the spinal cord
		2. Ventral horn of the spinal cord
		3. White matter of the spinal cord
		4. Grey matter of the spinal cord
36. GABA (gamma-aminobutyric acid) is a neurotransmitter that plays a role in the regulation of:
	* 1. Anxiety
		2. Mood
		3. Motor control
		4. Memory
37. Taste buds sensitive to salty flavors are primarily located on the:
	* 1. Tip of the tongue
		2. Sides of the tongue
		3. Back of the tongue
		4. Center of the tongue
38. The limbic system, particularly the amygdala, is involved in the processing of:
	* 1. Logical reasoning
		2. Emotional responses
		3. Motor coordination
		4. Vision
39. The withdrawal reflex, such as pulling your hand away from a hot object, is an example of
	* 1. Monosynaptic reflex
		2. Polysynaptic reflex
		3. Autonomic reflex
		4. Somatic reflex
40. The neurotransmitter melatonin, involved in sleep-wake cycles, is produced by the:
	* 1. Pineal gland
		2. Pituitary gland
		3. Thyroid gland
		4. Adrenal gland
41. The lens of the eye adjusts its shape to focus on near or distant objects through a process known as:
	* 1. Accommodation
		2. Conduction
		3. Refraction
		4. Reflection
42. Broca's area, located in the frontal lobe, is associated with:
	* 1. Speech production
		2. Speech comprehension
		3. Visual processing
		4. Motor coordination
43. Amyotrophic lateral sclerosis (ALS) primarily affects:
	* 1. Sensory neurons
		2. Motor neurons
		3. Interneurons
		4. Autonomic neurons
44. Association areas of the cerebral cortex are involved in:
	* 1. Primary sensory and motor functions
		2. Higher cognitive functions and integration of information
		3. Reflex actions and autonomic regulation
		4. Emotional processing
45. The process of memory consolidation involves the transfer of information from short-term memory to:
	* 1. Immediate memory
		2. Procedural memory
		3. Long-term memory
		4. Semantic memory
46. Imbalances in which neurotransmitter are often associated with mood disorders such as depression?
	* 1. Dopamine
		2. Serotonin
		3. Acetylcholine
		4. GABA
47. The prefrontal cortex is responsible for:
	* 1. Motor coordination
		2. Executive functions, decision making, and social behavior
		3. Visual processing
		4. Memory consolidation
48. Which neurotransmitter is predominantly released by the sympathetic nervous system during "fight or flight" responses?
	* 1. Acetylcholine
		2. Norepinephrine
		3. Dopamine
		4. Serotonin
49. The white matter of the spinal cord contains mainly:
	* 1. Neuronal cell bodies
		2. Axons
		3. Synapses
		4. Glial cells
50. Memory retrieval involves the activation of information stored in:
	* 1. Short-term memory
		2. Immediate memory
		3. Long-term memory
		4. Working memory
51. What is the primary neurotransmitter involved in transmitting signals from motor neurons to skeletal muscles?
	* 1. Dopamine
		2. Serotonin
		3. Acetylcholine
		4. GABA
52. Which part of the nervous system is responsible for voluntary muscle control and sensory perception?
	* 1. Autonomic nervous system
		2. Central nervous system
		3. Peripheral nervous system
		4. Enteric nervous system
53. What is the primary function of dendrites in a neuron?
	* 1. Transmission of signals to other neurons
		2. Integration of incoming signals
		3. Production of neurotransmitters
		4. Conduction of electrical impulses
54. The movement of an action potential along the axon is facilitated by the influx of which ion?
	* 1. Sodium
		2. Potassium
		3. Calcium
		4. Chloride
55. In a withdrawal reflex, which type of neuron directly stimulates the effector organ (e.g., muscle)?
	* 1. Sensory neuron
		2. Interneuron
		3. Motor neuron
		4. Association neuron
56. The coordination of voluntary movements, balance, and posture is primarily associated with which part of the brain?
	* 1. Cerebellum
		2. Medulla oblongata
		3. Pons
		4. Thalamus
57. Which brain structure is crucial for the consolidation of long-term memories?
	* 1. Hippocampus
		2. Amygdala
		3. Hypothalamus
		4. Basal ganglia
58. Pain signals are transmitted to the brain through which type of nerve fibers?
	* 1. Afferent fibers
		2. Efferent fibers
		3. Motor fibers
		4. Autonomic fibers
59. The photoreceptor cells responsible for color vision in the retina are called:
	* 1. Rod cells
		2. Cone cells
		3. Bipolar cells
		4. Ganglion cells
60. The communication between two neurons occurs at the:
	* 1. Synapse
		2. Axon hillock
		3. Nodes of Ranvier
		4. Myelin sheath
61. Which neurotransmitter is associated with mood regulation and is often targeted by antidepressant medications?
	* 1. Dopamine
		2. Serotonin
		3. Acetylcholine
		4. GABA
62. Photoreceptors in the retina are responsible for detecting:
	* 1. Sound waves
		2. Light stimuli
		3. Chemical stimuli
		4. Pressure stimuli
63. The hypothalamus plays a key role in:
	* 1. Motor coordination
		2. Temperature regulation
		3. Memory formation
		4. Visual perception
64. Ascending tracts in the spinal cord primarily carry:
	* 1. Motor information to the brain
		2. Sensory information to the brain
		3. Motor information to the muscles
		4. Sensory information to the muscles
65. The frontal lobe of the cerebral cortex is associated with:
	* 1. Vision processing
		2. Auditory processing
		3. Motor function and decision making
		4. Memory consolidation
66. The amygdala, a part of the limbic system, is primarily involved in the processing of:
	* 1. Taste
		2. Smell
		3. Emotions and memory
		4. Hearing
67. Which neurotransmitter is often associated with the modulation of pain signals?
	* 1. Endorphins
		2. Serotonin
		3. Dopamine
		4. Acetylcholine
68. The parasympathetic nervous system is known for its role in:
	* 1. "Fight or flight" responses
		2. Rest and digest responses
		3. Increased heart rate
		4. Dilation of pupils
69. The hypothalamus controls the release of hormones from the:
	* 1. Pituitary gland
		2. Thyroid gland
		3. Adrenal gland
		4. Pancreas
70. The auditory ossicles, including the malleus, incus, and stapes, are found in which part of the ear?
	* 1. Outer ear
		2. Middle ear
		3. Inner ear
		4. Eustachian tube
71. In addition to relaying sensory information to the brain, the spinal cord is involved in:
	* 1. Digestion
		2. Respiration
		3. Reflex actions
		4. Vision
72. The primary somatosensory cortex is responsible for processing sensations related to:
	* 1. Vision
		2. Hearing
		3. Touch and body position
		4. Taste
73. The neurotransmitter released at the neuromuscular junction (NMJ) for muscle contraction is:
	* 1. Dopamine
		2. Acetylcholine
		3. Serotonin
		4. GABA
74. The medulla oblongata is crucial for the regulation of:
	* 1. Heart rate and respiration
		2. Motor coordination
		3. Visual processing
		4. Memory consolidation
75. Long-term potentiation (LTP) is a cellular mechanism associated with:
	* 1. Short-term memory
		2. Long-term memory
		3. Immediate memory
		4. Procedural memory
76. Which division of the autonomic nervous system is responsible for "rest and digest" activities?
	* 1. Sympathetic division
		2. Parasympathetic division
		3. Enteric division
		4. Somatic division
77. In a reflex arc, the sensory neuron communicates directly with the:
	* 1. Motor neuron
		2. Interneuron
		3. Effector organ
		4. Synapse
78. The cochlea in the inner ear is responsible for detecting:
	* 1. Odors
		2. Sound waves
		3. Taste stimuli
		4. Light stimuli
79. Endorphins act as natural painkillers by binding to:
	* 1. Opioid receptors
		2. Dopamine receptors
		3. Serotonin receptors
		4. Acetylcholine receptors
80. The optic nerve carries visual information from the retina to the:
	* 1. Thalamus
		2. Hypothalamus
		3. Occipital lobe
		4. Parietal lobe
81. The primary motor cortex is responsible for the voluntary control of:
	* 1. Vision
		2. Hearing
		3. Muscle movements
		4. Taste perception
82. Dopamine is often associated with the brain's reward system and is involved in:
	* 1. Muscle contraction
		2. Memory consolidation
		3. Emotional regulation
		4. Motor coordination
83. The cranial nerves are a part of the:
	* 1. Central nervous system
		2. Peripheral nervous system
		3. Autonomic nervous system
		4. Somatic nervous system
84. The hypothalamus regulates hunger and satiety through the release of:
	* 1. Insulin
		2. Ghrelin
		3. Leptin
		4. Cortisol
85. Olfactory receptors responsible for the sense of smell are located in the:
	* 1. Tongue
		2. Nose
		3. Eyes
		4. Ears
86. Motor commands for voluntary muscle movements are initiated in the:
	* 1. Dorsal horn of the spinal cord
		2. Ventral horn of the spinal cord
		3. White matter of the spinal cord
		4. Grey matter of the spinal cord
87. GABA (gamma-aminobutyric acid) is a neurotransmitter that plays a role in the regulation of:
	* 1. Anxiety
		2. Mood
		3. Motor control
		4. Memory
88. Taste buds sensitive to salty flavors are primarily located on the:
	* 1. Tip of the tongue
		2. Sides of the tongue
		3. Back of the tongue
		4. Center of the tongue
89. The limbic system, particularly the amygdala, is involved in the processing of:
	* 1. Logical reasoning
		2. Emotional responses
		3. Motor coordination
		4. Vision
90. The withdrawal reflex, such as pulling your hand away from a hot object, is an example of a:
	* 1. Monosynaptic reflex
		2. Polysynaptic reflex
		3. Autonomic reflex
		4. Somatic reflex
91. The neurotransmitter melatonin, involved in sleep-wake cycles, is produced by the:
	* 1. Pineal gland
		2. Pituitary gland
		3. Thyroid gland
		4. Adrenal gland
92. The lens of the eye adjusts its shape to focus on near or distant objects through a process known as:
	* 1. Accommodation
		2. Conduction
		3. Refraction
		4. Reflection
93. Broca's area, located in the frontal lobe, is associated with:
	* 1. Speech production
		2. Speech comprehension
		3. Visual processing
		4. Motor coordination
94. Amyotrophic lateral sclerosis (ALS) primarily affects:
	* 1. Sensory neurons
		2. Motor neurons
		3. Interneurons
		4. Autonomic neurons
95. Association areas of the cerebral cortex are involved in:
	* 1. Primary sensory and motor functions
		2. Higher cognitive functions and integration of information
		3. Reflex actions and autonomic regulation
		4. Emotional processing
96. The process of memory consolidation involves the transfer of information from short-term memory to:
	* 1. Immediate memory
		2. Procedural memory
		3. Long-term memory
		4. Semantic memory
97. Imbalances in which neurotransmitter are often associated with mood disorders such as depression?
	* 1. Dopamine
		2. Serotonin
		3. Acetylcholine
		4. GABA
98. The prefrontal cortex is responsible for:
	* 1. Motor coordination
		2. Executive functions, decision making, and social behavior
		3. Visual processing
		4. Memory consolidation
99. Which neurotransmitter is predominantly released by the sympathetic nervous system during "fight or flight" responses?
	* 1. Acetylcholine
		2. Norepinephrine
		3. Dopamine
		4. Serotonin
100. The white matter of the spinal cord contains mainly:
	* 1. Neuronal cell bodies
		2. Axons
		3. Synapses
		4. Glial cells
101. Memory retrieval involves the activation of information stored in:
	* 1. Short-term memory
		2. Immediate memory
		3. Long-term memory
		4. Working memory
102. Which part of the nervous system controls voluntary movements and is responsible for initiating muscle contractions?
	* 1. Sympathetic nervous system
		2. Parasympathetic nervous system
		3. Autonomic nervous system
		4. Somatic nervous system
103. What is the neuromuscular junction?
	* 1. The point where two muscles intersect
		2. The connection between two neurons
		3. The site where a motor neuron meets a muscle fiber
		4. A specialized type of muscle tissue
104. Which ion plays a crucial role in triggering muscle contraction by binding to troponin?
	* 1. Sodium (Na+)
		2. Potassium (K+)
		3. Calcium (Ca2+)
		4. Magnesium (Mg2+)
105. What is the role of acetylcholinesterase in neuromuscular physiology?
	* 1. Initiating muscle contractions
		2. Breaking down acetylcholine to terminate signal transmission
		3. Synthesizing acetylcholine for neurotransmission
		4. Promoting the release of calcium ions
106. Which term refers to the minimal stimulus required to elicit a muscle contraction?
	* 1. Threshold stimulus
		2. Maximum stimulus
		3. Subthreshold stimulus
		4. Suprathreshold stimulus
107. What is the role of the sarcoplasmic reticulum in muscle contraction?
	* 1. Synthesizing ATP for energy
		2. Storing and releasing calcium ions
		3. Transmitting nerve impulses to muscles
		4. Facilitating oxygen exchange in muscle cells
108. Which protein, found in skeletal muscle, is responsible for binding with calcium ions and initiating muscle contraction?
	* 1. Actin
		2. Myosin
		3. Troponin
		4. Tropomyosin
109. What is the name of the process where ATP is used to detach myosin heads from actin during muscle relaxation?
	* 1. Cross-bridge cycling
		2. Power stroke
		3. Rigor mortis
		4. Hydrolysis
110. What does the term "motor unit" refer to?
	* 1. A group of muscles working together
		2. A motor neuron and the muscle fibers it innervates
		3. The point of contact between two muscle fibers
		4. A bundle of muscle cells
111. Which enzyme is responsible for the breakdown of ATP into ADP and inorganic phosphate, providing energy for muscle contraction?
	* 1. Creatine kinase
		2. Myosin ATPase
		3. Acetylcholinesterase
		4. Phosphofructokinase
112. During muscle contraction, what happens to the sarcomere length?
	* 1. It remains constant
		2. It shortens
		3. It lengthens
		4. It oscillates
113. Which component of the muscle fiber acts as a reservoir for calcium ions?
	* 1. Sarcomere
		2. Myofibril
		3. Sarcoplasmic reticulum
		4. T-tubule
114. What is the name of the phenomenon where a muscle responds to a stimulus with a quick contraction followed by a delayed relaxation?
	* 1. Tetanus
		2. Twitch
		3. Summation
		4. Muscle fatigue
115. Which of the following is NOT a type of muscle contraction?
	* 1. Isometric
		2. Isotonic
		3. Eccentric
		4. Elastic
116. What role does the neurotransmitter dopamine play in neuromuscular physiology?
	* 1. Initiating muscle contraction
		2. Inhibiting muscle relaxation
		3. Enhancing nerve impulse transmission
		4. Regulating mood and motivation
117. Which of the following statements about muscle fibers is true?
	* 1. Fast-twitch fibers have a high resistance to fatigue.
		2. Slow-twitch fibers are anaerobic and rely on glycolysis for energy.
		3. Intermediate fibers are specialized for rapid, sustained contractions.
		4. Fast-twitch fibers are rich in myoglobin.
118. What is the primary function of myoglobin in muscle cells?
	* 1. Facilitating calcium ion storage
		2. Providing energy for muscle contraction
		3. Oxygen storage and transport
		4. Breaking down acetylcholine
119. Which of the following factors contributes to muscle fatigue?
	* 1. Increased ATP levels
		2. Elevated calcium ion concentration
		3. Accumulation of lactic acid
		4. Enhanced acetylcholine release
120. What is the primary role of troponin in muscle contraction?
	* 1. Binding with myosin
		2. Regulating the availability of calcium ions
		3. Transmitting action potentials
		4. Storing energy for muscle contractions
121. During muscle contraction, what is the role of the cross-bridge formed between actin and myosin?
	* 1. Initiating nerve impulses
		2. Synthesizing ATP
		3. Generating force for muscle contraction
		4. Stabilizing the sarcomere
122. Which type of muscle fiber is primarily responsible for prolonged, sustained contractions and is rich in mitochondria?
	* 1. Type I (slow-twitch) fibers
		2. Type IIa (fast-twitch oxidative) fibers
		3. Type IIb (fast-twitch glycolytic) fibers
		4. Type III (intermediate) fibers
123. What is the main function of the motor end plate in neuromuscular physiology?
	* 1. Synthesizing neurotransmitters
		2. Transmitting action potentials
		3. Storing calcium ions
		4. Facilitating communication between motor neurons
124. Which of the following statements is true regarding isometric muscle contractions?
	* 1. The muscle shortens during contraction.
		2. The muscle lengthens during contraction.
		3. The muscle generates force without changing length.
		4. The muscle contracts without the involvement of ATP.
125. What is the primary factor that determines the force of muscle contraction?
	* 1. Sarcomere length
		2. Calcium ion concentration
		3. ATP synthesis
		4. Myoglobin content
126. Which regulatory protein covers the active sites on actin, preventing myosin from binding during muscle relaxation?
	* 1. Troponin
		2. Tropomyosin
		3. Myosin kinase
		4. Myoglobin
127. What is the term for the period of time during which a muscle is unresponsive to stimulation, following a previous contraction?
	* 1. Refractory period
		2. Resting phase
		3. Relaxation period
		4. Recovery interval
128. Which of the following statements is true regarding summation in muscle physiology?
	* 1. It refers to the relaxation phase of muscle contraction.
		2. It involves a single, brief contraction of muscle fibers.
		3. It results from multiple stimuli arriving at a muscle in rapid succession.
		4. It occurs only in fast-twitch muscle fibers.
129. What is the role of the neuromuscular spindle in muscle physiology?
	* 1. Producing ATP for muscle contractions
		2. Facilitating the stretch reflex
		3. Storing calcium ions in muscle cells
		4. Regulating neurotransmitter release
130. What is the primary function of creatine phosphate in muscle cells?
	* 1. Synthesizing ATP
		2. Storing energy for muscle contractions
		3. Transporting calcium ions
		4. Breaking down lactic acid
131. Which of the following events occurs during the power stroke of muscle contraction?
	* 1. Myosin heads detach from actin.
		2. ATP is hydrolyzed into ADP and inorganic phosphate.
		3. Cross-bridges form between actin and myosin.
		4. Calcium ions bind to troponin.
132. What is the primary role of the myelin sheath in the nervous system?
	* 1. Transmitting nerve impulses
		2. Providing mechanical support to neurons
		3. Enhancing neurotransmitter release
		4. Storing energy for neuronal activities
133. Which type of muscle contraction involves the muscle generating force while lengthening?
	* 1. Concentric
		2. Isotonic
		3. Eccentric
		4. Isometric
134. What is the term for the phenomenon where a sustained, maximal contraction is maintained in a muscle with no relaxation?
	* 1. Tetanus
		2. Twitch
		3. Summation
		4. Fatigue
135. Which ion is actively pumped back into the sarcoplasmic reticulum during muscle relaxation?
	* 1. Sodium (Na+)
		2. Calcium (Ca2+)
		3. Potassium (K+)
		4. Chloride (Cl-)
136. What is the term for the point at which a muscle is unable to respond to further stimulation, even with increased intensity?
	* 1. Fatigue
		2. Threshold
		3. Saturation
		4. Tetanus
137. Which of the following factors contributes to the increase in muscle force during recruitment?
	* 1. Increased muscle fiber diameter
		2. Decreased calcium ion concentration
		3. Reduced motor unit activation
		4. Lowered ATP levels
138. What is the primary function of the motor unit in neuromuscular physiology?
	* 1. Synthesizing neurotransmitters
		2. Storing calcium ions in muscle cells
		3. Transmitting action potentials to muscle fibers
		4. Facilitating communication between motor neurons
139. What is the role of the H-zone in the sarcomere during muscle contraction?
	* 1. It shortens
		2. It lengthens
		3. It remains unchanged
		4. It disappears
140. Which of the following statements about motor neurons is true?
	* 1. Motor neurons carry sensory information to the central nervous system.
		2. Motor neurons are also known as afferent neurons.
		3. Motor neurons control the contraction of skeletal muscles.
		4. Motor neurons transmit signals between neurons.
141. What is the primary function of the basal lamina in the neuromuscular junction?
	* 1. Storing neurotransmitters
		2. Transmitting action potentials
		3. Synthesizing acetylcholine
		4. Providing structural support for the synapse
142. Which of the following is a characteristic of fast-twitch (Type II) muscle fibers?
	* 1. High resistance to fatigue
		2. Rich in myoglobin
		3. Aerobic metabolism
		4. Rapid force generation
143. What is the primary function of the Golgi tendon organ in muscle physiology?
	* 1. Detecting changes in muscle length
		2. Initiating muscle contractions
		3. Storing energy for muscle activities
		4. Facilitating neuromuscular transmission
144. In muscle physiology, what is the significance of the all-or-none principle?
	* 1. All muscles contract simultaneously.
		2. All muscle fibers within a motor unit contract completely or not at all.
		3. All muscle fibers have the same contraction force.
		4. All muscle contractions are equally strong.
145. What is the primary role of acetylcholine receptors in the muscle membrane?
	* 1. Initiating muscle contraction
		2. Storing calcium ions
		3. Transmitting action potentials
		4. Breaking down acetylcholine
146. What is the term for the phenomenon where repeated stimulation of a muscle leads to an increased force of contraction?
	* 1. Tetanus
		2. Summation
		3. Twitch
		4. Fatigue
147. What role does the enzyme acetylcholinesterase play in the neuromuscular junction?
	* 1. Initiating muscle contractions
		2. Breaking down acetylcholine to terminate signal transmission
		3. Facilitating calcium ion release
		4. Inhibiting neurotransmitter synthesis
148. What is the primary function of the motor cortex in the brain?
	* 1. Controlling involuntary movements
		2. Initiating voluntary muscle contractions
		3. Storing motor memories
		4. Regulating heart rate
149. During muscle contraction, which molecule directly binds to the active sites on actin, allowing myosin to form cross-bridges?
	* 1. ATP
		2. Calcium ions
		3. Troponin
		4. Tropomyosin
150. What is the function of the stretch reflex in muscle physiology?
	* 1. Initiating muscle contractions
		2. Preventing overstretching of muscles
		3. Transmitting action potentials
		4. Enhancing muscle relaxation
151. Which part of the brain is responsible for coordinating complex muscle movements and maintaining equilibrium?
	* 1. Cerebellum
		2. Medulla oblongata
		3. Thalamus
		4. Hypothalamus
152. What is the primary role of the neurotransmitter gamma-aminobutyric acid (GABA) in the neuromuscular junction?
	* 1. Initiating muscle contractions
		2. Inhibiting nerve impulses
		3. Enhancing neurotransmitter release
		4. Storing calcium ions
153. Which of the following events occurs during the repolarization phase of an action potential?
	* 1. Sodium ions enter the cell
		2. Potassium ions exit the cell
		3. Calcium ions bind to troponin
		4. Acetylcholine is released
154. In muscle physiology, what is the purpose of the neuromuscular spindle?
	* 1. Initiating muscle contractions
		2. Facilitating the stretch reflex
		3. Storing calcium ions
		4. Inhibiting neurotransmitter release
155. What is the term for the specialized region of a muscle fiber that contains the nucleus and other organelles?
	* 1. Sarcomere
		2. Myofibril
		3. Sarcoplasm
		4. Endomysium
156. Which type of muscle contraction involves the muscle maintaining a constant length while generating force?
	* 1. Isotonic
		2. Isometric
		3. Eccentric
		4. Concentric
157. What is the primary function of the transverse tubules (T-tubules) in muscle cells?
	* 1. Transmitting action potentials into the muscle fiber
		2. Storing calcium ions
		3. Initiating muscle contractions
		4. Facilitating oxygen exchange
158. In muscle physiology, what role does ATP play in the cross-bridge cycle?
	* 1. It binds to troponin, initiating muscle contraction.
		2. It hydrolyzes to provide energy for myosin-actin interactions.
		3. It stabilizes the sarcomere during muscle relaxation.
		4. It activates acetylcholine receptors on the muscle membrane.
159. Which of the following statements about myosin is correct?
	* 1. Myosin is a regulatory protein that covers the active sites on actin.
		2. Myosin is responsible for binding with calcium ions in muscle cells.
		3. Myosin is a thin filament found in the sarcomere.
		4. Myosin is a thick filament that forms cross-bridges with actin.
160. What is the role of calcium ions in the initiation of muscle contraction?
	* 1. They bind to troponin, exposing active sites on actin.
		2. They inhibit the breakdown of acetylcholine.
		3. They stimulate the production of ATP.
		4. They trigger the repolarization of muscle fibers.
161. During muscle contraction, what is the function of the sarcoplasmic reticulum?
	* 1. Synthesizing ATP
		2. Storing and releasing calcium ions
		3. Transmitting nerve impulses
		4. Facilitating oxygen exchange
162. What is the primary energy source for muscle contractions during prolonged, low-intensity activities?
	* 1. Glycogen
		2. Creatine phosphate
		3. Fatty acids
		4. Glucose
163. What term describes the phenomenon where a muscle remains partially contracted even in a relaxed state?
	* 1. Tetanus
		2. Spasm
		3. Atrophy
		4. Tone
164. Which factor contributes to the increased force of muscle contraction during the recruitment of motor units?
	* 1. Increased muscle fiber diameter
		2. Reduced calcium ion concentration
		3. Lowered ATP levels
		4. Enhanced acetylcholine breakdown
165. Which type of muscle fiber is characterized by high resistance to fatigue and is involved in activities requiring endurance?
	* 1. Type I (slow-twitch) fibers
		2. Type IIa (fast-twitch oxidative) fibers
		3. Type IIb (fast-twitch glycolytic) fibers
		4. Type III (intermediate) fibers
166. What is the term for the phenomenon where a muscle responds to a series of stimuli with overlapping contractions, leading to a sustained force of contraction?
	* 1. Tetanus
		2. Twitch
		3. Summation
		4. Fatigue
167. What is the primary function of the muscle spindle in muscle physiology?
	* 1. Transmitting action potentials to muscle fibers
		2. Facilitating the stretch reflex
		3. Storing calcium ions
		4. Initiating muscle contractions
168. Which of the following statements about muscle fatigue is true?
	* 1. It is caused by an increased concentration of ATP.
		2. It results from a buildup of lactic acid.
		3. It occurs when acetylcholine release is enhanced.
		4. It is more common in fast-twitch muscle fibers.
169. What is the role of the A-band in the sarcomere?
	* 1. It contains only thick filaments (myosin).
		2. It shortens during muscle contraction.
		3. It corresponds to the region where actin and myosin overlap.
		4. It is the region where the H-zone is located.
170. Which neurotransmitter is responsible for inhibiting muscle contraction and promoting muscle relaxation?
	* 1. Acetylcholine
		2. Norepinephrine
		3. Dopamine
		4. Gamma-aminobutyric acid (GABA)
171. What is the term for the involuntary, rhythmic contractions of skeletal muscles that help maintain posture?
	* 1. Tetanus
		2. Twitch
		3. Spasm
		4. Tonus
172. Which of the following events occurs during the depolarization phase of an action potential in a muscle fiber?
	* 1. Potassium ions exit the cell.
		2. Sodium ions enter the cell.
		3. Calcium ions bind to troponin.
		4. Acetylcholine is broken down.
173. What is the primary role of the sodium-potassium pump in muscle cells?
	* 1. Initiating muscle contractions
		2. Storing calcium ions
		3. Maintaining the resting membrane potential
		4. Facilitating the release of neurotransmitters
174. During muscle contraction, what is the role of the Z-line (Z-disc)?
	* 1. Storing calcium ions
		2. Facilitating the stretch reflex
		3. Anchoring thin filaments (actin)
		4. Initiating muscle contractions
175. Which of the following is a characteristic of slow-twitch (Type I) muscle fibers?
	* 1. Rapid force generation
		2. Low resistance to fatigue
		3. Anaerobic metabolism
		4. Rich in myoglobin
176. What is the term for the brief delay between the stimulation of a muscle and the onset of contraction?
	* 1. Refractory period
		2. Latent period
		3. Tetanus period
		4. Relaxation period
177. The amino acids which act as neurotransmitters
	* 1. GABA
		2. Glutamate
		3. Glycine
		4. all the above
178. Tyrosine acts as a initial substrate for the production of which of the neurotransmitter
	* 1. Epinephrine
		2. Norepinephrine
		3. Dopamine
		4. all the above
179. …… is the amino acid necessary for the synthesis of Serotonin
	* 1. Choline
		2. Tyrosine
		3. Tryptophan
		4. Glycine
180. ……. Enzyme plays an important role in catabolism of catecholamines
	* 1. Monoamine oxidase (MAO)
		2. Catechol-o-methyltransferase (COMT)
		3. None of the above
		4. Both a and b
181. Depolarization of cochlear and vestibular hair cells, in response to the appropriate stimulus, is accomplished by opening of …….
	* 1. Mechanically gated potassium channels
		2. Mechanically gated sodium channels
		3. Voltage-gated potassium channels
		4. Voltage-gated sodium channels
182. Kinocilia are present on …….
	* 1. Vestibular hair cells
		2. Cochlear hair cells
		3. Both
		4. None
183. Match the following

|  |  |  |  |
| --- | --- | --- | --- |
| 1 | Telencephalon | a) | Midbrain |
| 2 | Diencephalon | b) | Cerebral cortex |
| 3 | Mesencephalon | c) | Medulla oblangata |
| 4 | Metencephalon | d) | Hypothalamus |
| 5 | Myelencephalon | e) | Cerebellum |

1. Match the following

|  |  |  |  |
| --- | --- | --- | --- |
| 1 | Dorsal root ganglia | a) | Sensory neuron |
| 2 | Olfactory system | b) | Multipolar neurons |
| 3 | CNS | c) | Motor neuron |
| 4 | Afferent | d) | Bipolar neurons |
| 5 | Efferent | e) | Pseudounipolar neurons |

1. Match the following

|  |  |  |  |
| --- | --- | --- | --- |
| 1 | Microglia | a) | Ependymal cells |
| 2 | Ventricles | b) | Pure reflex |
| 3 | Wallerian degeneration | c) | Paresthesias |
| 4 | Phantom pain | d) | Macrophages |
| 5 | Involuntary response | e) | Distal segment |

1. Match the following

|  |  |  |  |
| --- | --- | --- | --- |
| 1 | Lateral ventricles | a) | CSF |
| 2 | Fourth ventricle | b) | Diencephalon |
| 3 | Third ventricle | c) | Cerebral hemisphere |
| 4 | Arachnoid villi | d) | Medulla |
| 5 | Cisterna magna | e) | One-way valves |

1. Match the following

|  |  |  |  |
| --- | --- | --- | --- |
| 1 | Black widow spider venom | a) | Act as proteases |
| 2 | Clostridial neurotoxins | b) | Vesicle recycling |
| 3 | Lambert-Eaton myasthenic syndrome | c) | Vesicle-associated membrane protein |
| 4 | Synaptotagmin | d) | attack calcium voltage-gated channels |
| 5 | Synaptobrevin | e) | Formation of leakage channels |

1. Match the following

|  |  |  |  |
| --- | --- | --- | --- |
| 1 | Actin | a) | Calcium |
| 2 | Troponin T | b) | One polypeptide chain |
| 3 | Troponin I  | c) | Six polypeptide chains |
| 4 | Myosin | d) | Tropomyosin |
| 5 | Troponin C | e) | Myosin ATPase |

Fill in the blanks

1. Axons in the peripheral nervous system are wrapped by ……..
2. Axons in the central nervous system are wrapped by ……..
3. Myelin sheaths are interrupted at regular intervals called as …….. where rapid ionic exchange takes place.
4. ……. cells participate in blood-brain barrier and CSF production
5. ……. serves as a selective barrier between the brain and CSF
6. Abnormal skin sensation associated with the presence of neuromas is called as…….
7. ……. cells give rise to Schwann cells, melanocytes, chromaffin cells and meninges
8. …….. is divided into telencephalon and diencephalon
9. …….. is divided into metencephalon and myelencephalon
10. Every …….. nerve is a mixed nerve and has both sensory and motor components
11. Nerves that emerge from cranium are called as …..
12. Voltage across the neural membrane at rest is called as ……..
13. Action potential is often referred as ……..
14. The two phases of refractory period are …….. and ……..
15. Hyperkalemic periodic paralysis of horses is caused by prolonged inward leakage of ……... ions
16. Long QT syndrome in heart muscles due to mutation of ……. Channels
17. Leaping of action potential from node to node as it moves along the axon is called as ……..
18. Coonhound paralysis is a disease of hunting dogs that attacks ……
19. Conduction velocity of action potential can be increased through ……..
20. In resting neurons, the synaptic vesicles are bound to cytoskeletal elements or each other by …….
21. …….. influx triggers the release of neurotransmitter
22. Calcium binds to the …….. cytosolic protein
23. …….. is a major organ of receptor for pheromones
24. Individual muscle cells are called as ……..
25. Skeletal muscle fibers are held together in bundles is called as ……..
26. Fascicles held together by a connective sheath called as ……..
27. Fascicles in turn are wrapped in another larger connective tissue sheath called as…….. to form a whole skeletal muscle
28. Skeletal muscle fibers individually wrapped in their own connective tissue called as
29. Slow-twitch or type 1 muscle fibers are known as ……..
30. Fast-twitch or type 2 muscle fibers are known as …….
31. Type IIa fibers have greater …….
32. ……. fibers have highest amount of force
33. ……. % of total body weight is contributed by skeletal muscles
34. Ratio of actin and myosin in smooth muscle is…..
35. Smooth muscles contribute …… % of the total body weight
36. …… muscles exist as multi unit and single unit muscle fibres
37. …… muscles are absent in canines
38. ……. Protein is present in smooth muscles instead of troponin
39. …. T-tubule and …... lateral cisternae forms a triad
40. The whole action potential lasts for ……
41. The electrical potential difference across the cell membrane is called as ….
42. Interstitial fluid is characterized by higher concentrations of …… and lower concentrations of ……
43. Net resting membrane potential is ……
44. Glycolysis/anaerobic type of metabolism liberates ..…. molecules of ATP
45. …… muscle fibres are adapted for prolonged, continued muscle activity
46. All the muscle fibres in a muscle are innervated by a single motor neuron called as
47. …… contraction occurs when muscle contracts without shortening in length
48. …… contraction occurs between one fixed and one moveable joints
49. The presynaptic membrane is formed by …….. and …….
50. The synaptic vesicles contain ……. Neurotransmitter
51. ……… is a neuromuscular disorder where autoantibodies are produced against acetylcholine receptors
52. Walk-along theory of contraction explains ………
53. ……. is a period where muscle undergoing contraction for a first stimulus is unable to respond to the second stimulus
54. …… is a response, when a stimulus of constant strength and duration is repeated once or twice
55. ……. is the added effect of individual muscle twitches to get strong and powerful muscle contraction
56. …… occurs by increasing the number of motor units to control simultaneously
57. ……. occurs by increasing the rapidity of contraction of individual motor unit of a contracting muscle
58. …….. is the decrease in the working capacity of a muscle or tiredness of the muscle when it is continuously stimulated.
59. ……. kcal/mol produced by hydrolysis of ATP
60. Resting membrane potential of cardiac muscles is ……

Answers

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 1 | ii | 2 | ii | 3 | i | 4 | iii | 5 | i | 6 | i | 7 | i | 8 | ii | 9 | i | 10 | ii |
| 11 | ii | 12 | ii | 13 | ii | 14 | iii | 15 | iii | 16 | i | 17 | ii | 18 | i | 19 | ii | 20 | iii |
| 21 | iii | 22 | ii | 23 | i | 24 | ii | 25 | ii | 26 | ii | 27 | ii | 28 | i | 29 | iii | 30 | iii |
| 31 | ii | 32 | ii | 33 | iii | 34 | ii | 35 | ii | 36 | i | 37 | i | 38 | ii | 39 | ii | 40 | i |
| 41 | i | 42 | i | 43 | ii | 44 | ii | 45 | iii | 46 | ii | 47 | ii | 48 | ii | 49 | ii | 50 | iii |
| 51 | iii | 52 | ii | 53 | ii | 54 | i | 55 | iii | 56 | i | 57 | i | 58 | i | 59 | ii | 60 | i |
| 61 | ii | 62 | ii | 63 | ii | 64 | ii | 65 | iii | 66 | iii | 67 | i | 68 | ii | 69 | i | 70 | ii |
| 71 | iii | 72 | iii | 73 | ii | 74 | i | 75 | ii | 76 | ii | 77 | ii | 78 | ii | 79 | i | 80 | iii |
| 81 | iii | 82 | iii | 83 | ii | 84 | iii | 85 | ii | 86 | ii | 87 | i | 88 | i | 89 | ii | 90 | ii |
| 91 | i | 92 | i | 93 | i | 94 | ii | 95 | ii | 96 | iii | 97 | ii | 98 | ii | 99 | ii | 100 | ii |
| 101 | iii | 102 | iv | 103 | iii | 104 | iii | 105 | ii | 106 | i | 107 | ii | 108 | iii | 109 | i | 110 | ii |
| 111 | ii | 112 | ii | 113 | iii | 114 | ii | 115 | iv | 116 | iv | 117 | i | 118 | iii | 119 | iii | 120 | ii |
| 121 | iii | 122 | i | 123 | ii | 124 | iii | 125 | ii | 126 | ii | 127 | i | 128 | iii | 129 | ii | 130 | ii |
| 131 | iii | 132 | i | 133 | iii | 134 | i | 135 | ii | 136 | i | 137 | i | 138 | iii | 139 | iv | 140 | iii |
| 141 | iv | 142 | iv | 143 | i | 144 | ii | 145 | i | 146 | ii | 147 | ii | 148 | ii | 149 | iii | 150 | ii |
| 151 | i | 152 | ii | 153 | ii | 154 | ii | 155 | iii | 156 | ii | 157 | i | 158 | ii | 159 | iv | 160 | i |
| 161 | ii | 162 | iii | 163 | iv | 164 | i | 165 | i | 166 | i | 167 | ii | 168 | ii | 169 | i | 170 | iv |
| 171 | iv | 172 | ii | 173 | iii | 174 | iii | 175 | iv | 176 | ii | 177 | iv | 178 | iv | 179 | iii | 180 | iv |
| 181 | i | 182 | i |

Match the following

1. 1 b, 2. d, 3. a, 4. e, 5. c
2. 1. e, 2. d, 3. b, 4. a, 5. c
3. 1. d, 2. a, 3. e, 4. c, 5. b
4. 1. c, 2. d, 3. b, 4. e, 5. a
5. 1. e, 2. a, 3. d, 4. b, 5. c
6. 1. b, 2. d, 3. e, 4. c, 5. a

Fill in the blanks

1. Oligodendrocytes
2. Schwann cells
3. nodes of Ranvier
4. Glial cells
5. Choroid plexus
6. Paresthesias
7. Neural crest cells
8. Proencephalon
9. Rhombencephalon
10. Spinal
11. Cranial nerves
12. Resting potential
13. All-or-none phenomenon
14. Inactivation and Absolute refractory period
15. Sodium
16. Sodium
17. Saltatory conduction
18. Myelin
19. Myelination
20. Synapsin I
21. Calcium
22. Calmodulin
23. Vomeronasal organ
24. Myocytes
25. Fascicles
26. Perimysium
27. Epimysium
28. Endomysium
29. Red muscle fibers
30. White muscle fibers
31. Oxidative capacity
32. Type IIb
33. 40
34. 15:1
35. 10%
36. Smooth muscles
37. Fast twitch glycolytic/white
38. Calmodulin
39. one and two
40. 1-2 milliseconds
41. membrane potential
42. Sodium and potassium
43. -90mV
44. Two
45. slow muscle fibres
46. motor unit
47. isometric
48. isotonic
49. synaptic cleft and a post synaptic membrane
50. acetylcholine
51. Myasthenia gravis
52. sliding action of actin over myosin
53. Refractory period
54. Treppe
55. Summation
56. Spatial summation
57. Temporal summation
58. Fatigue
59. 7.3
60. -50 to -55 mV

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