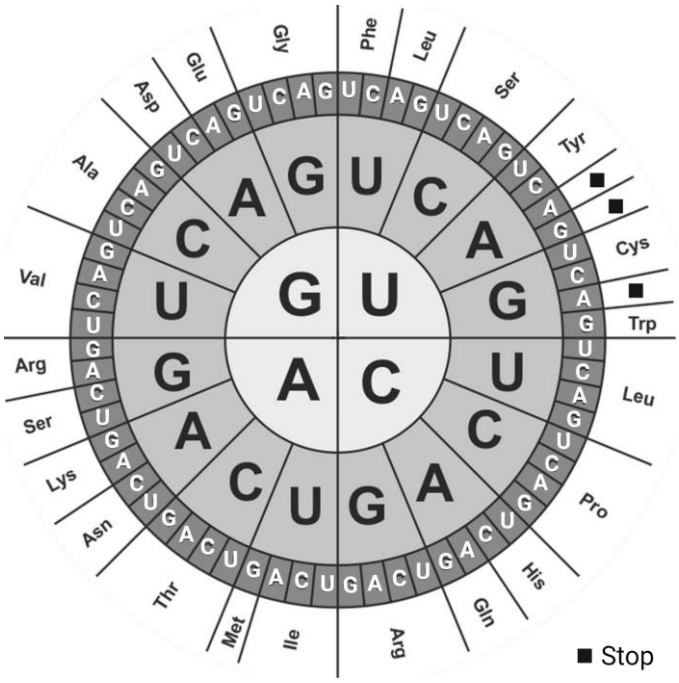
Name: _____

Student Number:_____

MIE205H W2024
Fundamentals of Biomedical Engineering

MIDTERM EXAMINATION
12-Mar-2024

Equations and Codon Chart



$$V_m = 61 \log \frac{P_{K^+}[K^+{}_{out}] + P_{Na^+}[Na^+{}_{out}] + P_{Cl^-}[Cl^-{}_{in}]}{P_{K^+}[K^+{}_{in}] + P_{Na^+}[Na^+{}_{in}] + P_{Cl^-}[Cl^-{}_{out}]}$$

Where: V_m is the membrane potential in mV; P_{K+}= 1; P_{Na+} = 0.04; P_{Cl-} = 0.3; and ions in [ ] are the respective concentrations

$$E_X = \frac{61}{Z} \log \frac{[X_{out}]}{[X_{in}]}$$

Where: E_x is the Nernst potential in mV; Z = ion valence; and [X] is concentration

$$\Delta G_{Chem} = RT \ln \frac{[X_{out}]}{[X_{in}]}$$

Where: ΔG_{Chem} is the free energy available from the chemical gradient, defined from inside the cell to outside; R = 8.314 J/mol K; T is taken to be 309.65 K; and [X] is the concentration

$$\Delta G_{Elec} = ZFV_m$$

Where: ΔG_{Elec} is the free energy available from an electrical potential inside a cell with respect to the outside; V_m is the membrane potential in V; Z = ion charge; and F = 96485 C/mol

Indicate the answer choice that best completes the statement or best answers the question.

1. What is the main energy source for the Na+-K+ pump in active transport?
   A) Glucose
   B) ATP
   C) ADP
   D) GTP
2. Resting membrane potential is approximately:
   A) +70 mV
   B) -70 mV
   C) 0 mV
   D) +35 mV
3. Which type of gated ion channel is crucial for the propagation of action potentials from the cell body into the axon of a neuron?
   A) Ligand-gated
   B) Mechanically gated
   C) Voltage-gated
   D) Temperature-gated
4. Which type of synapse directly allows ions to pass between neurons?
   A) Chemical synapse
   B) Electrical synapse
   C) Gap junction
   D) Neurotransmitter synapse
5. Which RNA nucleobase pairs with adenine in DNA?
   A) Cytosine
   B) Guanine
   C) Thymine
   D) Uracil
6. Which type of cell in the CNS creates myelin sheaths around axons?
   A) Neurons
   B) Astrocytes
   C) Oligodendrocytes
   D) Schwann Cells
7. Hyperpolarization of a neuron makes it:
   A) Less likely to fire an action potential
   B) More likely to fire an action potential
   C) Unaffected in its ability to fire an action potential
   D) Immediately fire an action potential
8. The autonomic nervous system is divided into which two primary systems?
   A) Somatic and Sympathetic
   B) Sympathetic and Parasympathetic
   C) Central and Peripheral
   D) Somatic and Autonomic

9. What neurotransmitter is always associated with muscle activation at the motor end-plate?
   A) Dopamine
   B) Serotonin
   C) GABA
   D) Acetylcholine
10. Ion channels that open and close in response to mechanical loading are associated with which type of receptors?
   A) Mechanoreceptors
   B) Photoreceptors
   C) Chemoreceptors
   D) Thermoreceptors
11. The autonomic nervous system typically has a chain of how many neurons from the CNS to the effector organ?
   A) One
   B) Two
   C) Three
   D) Four
12. The termination of protein synthesis occurs when the ribosome encounters:
   A) A start codon
   B) A stop codon
   C) A poly-A tail
   D) A 5' cap
13. Which process converts the genetic information in mRNA into a corresponding protein?
   A) Replication
   B) Transcription
   C) Translation
   D) Mitosis
14. What is the role of myelin sheath in neurons?
   A) Producing neurotransmitters
   B) Generating action potentials
   C) Speeding up signal transmission
   D) Degrading neurotransmitters
15. The brain and spinal cord are part of the:
   A) Peripheral Nervous System
   B) Central Nervous System
   C) Autonomic Nervous System
   D) Somatic Nervous System

16. The start codon AUG codes for which amino acid?
    A) Methionine
    B) Tyrosine
    C) Lysine
    D) Glycine
17. The neurotransmitter released at the neuromuscular junction is:
    A) Dopamine
    B) Serotonin
    C) Acetylcholine
    D) GABA
18. Which process generates the most ATP during cellular respiration?
    A) Glycolysis
    B) Oxidative phosphorylation
    C) Krebs cycle
    D) Fermentation
19. What type of receptors adapts rapidly to a sustained stimulus?
    A) Tonic receptors
    B) Mechanoreceptors
    C) Thermoreceptors
    D) Phasic receptors
20. Adrenergic receptors in the ANS are activated by:
    A) Norepinephrine
    B) Acetylcholine
    C) Epinephrine
    D) GABA
21. What happens when an action potential reaches the presynaptic terminal at a chemical synapse?
    A) It triggers the release of neurotransmitters.
    B) It immediately generates another action potential in the postsynaptic neuron.
    C) It stops all synaptic activity.
    D) It leads to the destruction of the synapse.
22. EPSP (Excitatory PostSynaptic Potential) increases the likelihood of:
    A) An action potential
    B) Hyperpolarization
    C) Inhibition
    D) Neuronal death
23. What does the Nernst equation calculate?
    A) The rate of diffusion
    B) The equilibrium potential for an ion
    C) The action potential threshold
    D) The speed of action potential propagation

24. The synaptic cleft is the gap between:
    A) Two Schwann cells
    B) A presynaptic neuron and a postsynaptic neuron in a chemical synapse
    C) The myelin sheath and the axon
    D) A presynaptic neuron and a postsynaptic neuron in an electrical synapse
25. Which type of bond is found between base pairs in the DNA structure?
    A) Covalent bond
    B) Ionic bond
    C) Hydrogen bond
    D) Metallic bond
26. The difference between the sympathetic and parasympathetic nervous systems lies in:
    A) Their neurotransmitters
    B) Their effects on target organs
    C) The types of neurons involved
    D) All of the above
27. What mechanism enhances the precision of sensory perception by reducing the activity of neighboring neurons?
    A) Positive feedback
    B) Negative feedback
    C) Lateral inhibition
    D) Direct inhibition stimulation
28. Phasic receptors are characterized by:
    A) Slow adaptation to a sustained stimulus
    B) Rapid adaptation to a sustained stimulus
    C) Continuous response without adaptation
    D) Activation only by strong stimuli
29. The larger the receptor potential, the:
    A) Lower the frequency of action potentials
    B) Higher the frequency of action potentials
    C) More irregular the action potentials
    D) Less likely an action potential will occur
30. What does a codon specify in the process of translation?
    A) A specific nucleotide
    B) A specific lipid
    C) A specific protein
    D) A specific amino acid

31. If the extracellular concentration of potassium ions is 5 mMol/L and the intracellular concentration is 150 mMol/L, what is the equilibrium potential of potassium ions (K+) across the cell membrane?
    A) +61 mV
    B) -90 mV
    C) 0 mV
    D) -70 mV
32. During depolarization occurring due to an action potential, which ion channels open first?
    A) Potassium channels
    B) Sodium channels
    C) Calcium channels
    D) Chloride channels
33. What is the basic distinguishing structural unit of DNA?
    A) Amino acid
    B) Nucleotide
    C) Nucleoside
    D) Phosphate group
34. What makes up a nucleotide?
    A) Only a sugar and a base
    B) Only a phosphate group and a nitrogen base
    C) A sugar, a phosphate group, and a nitrogen base
    D) Only a sugar and a phosphate group
35. What are synapses primarily responsible for?
    A) DNA replication
    B) Cellular respiration
    C) Neuronal communication
    D) Protein synthesis
36. Saltatory conduction occurs in:
    A) Unmyelinated axons
    B) Myelinated axons
    C) Dendrites
    D) The cell body
37. Presynaptic inhibition occurs when:
    A) An inhibitory neuron synapses directly with a postsynaptic neuron
    B) There is a higher the frequency of action potentials
    C) An inhibitory neuron laterally inhibits adjacent neurons
    D) An inhibitory neuron synapses directly with a presynaptic neuron

38. What is the role of the ganglion in the ANS?
    A) To interface between preganglionic and postganglionic neurons
    B) To produce neurotransmitters
    C) To serve as a barrier to pathogens
    D) To process sensory information
39. What is the primary function of inhibitory neurotransmitters?
    A) To indirectly or directly depolarize the postsynaptic neuron
    B) To indirectly or directly increase the likelihood of an action potential
    C) To indirectly or directly hyperpolarize the postsynaptic neuron
    D) To indirectly or directly increase synaptic strength
40. Which ion's influx is crucial for the release of neurotransmitters into the synaptic cleft?
    A) Sodium (Na+)
    B) Potassium (K+)
    C) Calcium (Ca2+)
    D) Chloride (Cl-)
41. Neurotransmitters are released into the synaptic cleft by:
    A) Dendrites
    B) Axon terminals
    C) Cell body
    D) Myelin sheath
42. Which type of ion channel opens or closes in response to a change in membrane potential?
    A) Ligand-gated channels
    B) Voltage-gated channels
    C) Mechanically-gated channels
    D) Temperature-gated channels
43. The primary function of mitochondria is:
    A) Protein synthesis
    B) DNA replication
    C) Cell division
    D) Cellular respiration
44. During transcription, DNA is copied into:
    A) mRNA
    B) tRNA
    C) rRNA
    D) DNA
45. Which type of receptors are associated with the parasympathetic nervous system?
    A) Adrenergic
    B) Thermal receptors
    C) Mechanoreceptors
    D) Cholinergic

46. Which part of the spinal cord contains motor neurons?
    A) Dorsal horn
    B) Dorsal root ganglion
    C) Ventral horn
    D) Dorsal root
47. The Grand Post-Synaptic Potential (GPSP) is can be effected by of:
    A) Temporal summation
    B) Local summation
    C) Inverse summation
    D) Primary summation
48. Reflex arcs do NOT include which of the following components?
    A) Receptor
    B) Sensory neuron
    C) Effector
    D) Hormone
49. Reflex arcs may be:
    A) Polysynaptic
    B) Monosynaptic
    C) Isosynaptic
    D) Both A and B
50. Which mnemonic helps remember the difference between afferent and efferent nerve fibers?
    A) SAME (Sensory Afferent Motor Efferent)
    B) CARE (Central Afferent Receptor Efferent)
    C) DAME (Dorsal Afferent Motor Efferent)
    D) SEAM (Sensory Efferent Afferent Motor)