考試科目	細胞與分子生物學	系所別	神經科學研究所	考試時間	2 月 7 日(五) 第 二 節

一、 選擇題(共 10 題， 每題 3 分)

1. Which base pair(s) typically occur(s) in double-stranded DNA?
a. C·C
b. C·T
c. C·A
d. C·G

2. Short micro RNAs (miRNAs)
a. are common in bacteria but not eukaryotes.
b. code for proteins.
c. are involved in regulation of gene expression.
d. have no known function.

3. Cholesterol in cell membranes:
a. decrease membrane thickness.
b. increase membrane thickness.
c. cause biomembranes to become curved.
d. allow hydrophilic molecules to diffuse across the lipid bilayer.

4. When computing the osmotic pressure that must be placed across the membrane to stop the flow of water, what is the glucose osmotic equivalent of 1 M NaCl?
a. 0.5 M
b. 3 M
c. 2 M
d. 1 M

5. Glycosylation, a post-translational modification to proteins, occurs in the
a. Golgi.
b. proteasome.
c. mitochondria.
d. none of the above

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6. Which of the following statements best describes the difference between low-affinity integrins and high-affinity integrins?
a. Many integrins can exist in two conformations a low-affinity (bent) conformation and a high-affinity (straight) conformation.
b. Dissociation of the heterodimer converts many integrins from the low-affinity to the high-affinity state.
c. Association of the heterodimer converts many integrins from the low-affinity to the high-affinity state.
d. Proteolytic cleavage of the C-terminal tails of the two subunits converts many integrins from the low-affinity to the high affinity state.

7. Vertebrate gap junctions are composed of
a. adherins.
b. collagens.
c. connexins.
d. integrins.

8. NCAMs, a group of cell-adhesion proteins belonging to the Ig superfamily
a. are less heavily sialylated in embryonic tissues than in adult tissues.
b. bind to proteoglycans.
c. mediate Ca2+-independent cell-to-cell binding.
d. none of the above

9. Which of the following genes encodes a caspase in C. elegans?
a. ced-9
b. ced-4
c. ced-3
d. b and c

10. During X inactivation in females, the XIST gene product is expressed
a. only by the paternally derived X chromosome.
b. only by the maternally derived X chromosome.
c. only by the active X chromosome in each female cell.
d. only by the inactivated X chromosome in each female cell.

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二、 問答題(共 10 題，每題 7 分)

1. A double-stranded piece of DNA containing the sequence GCATGGCCACTACCG has a higher Tm than one containing the sequence GAATGGTAACAACTG. Describe the properties of DNA that make this true.

2. Describe how lipid soluble hormones, glucocorticoid for example, regulate gene transcription acting through nuclear hormone receptors.

3. What are the primary functions of the plasma membrane in animal cells?

4. When examined by fluorescent recovery after photobleaching (FRAP), certain integral membrane proteins are significantly less mobile than others. What accounts for this reduced mobility?

5. In a classic experiment, H. V. Wilson studied aggregation of mechanically dissociated individual sponge cells from two different species. He found that the cells of each species would adhere to one another but not to cells of the other species. Describe the factors involved in this species-specific aggregation.

6. Define stem cells. Which of the following cells are stem cells: (a) fertilized egg, (b) intestinal crypt cell, (c) cancer cells? Please explain your answers.

7. Explain the role of mitochondria in apoptosis.

8. What is a dominant-negative mutation? Describe the mechanism by which this mutation causes the dominant-negative phenotype.

9. What are the roles of SNARE proteins in exocytosis? How do they bring about specific membrane fusion?

10. What happens to a microtubule that loses its GTP cap?

備註	一、作答於試題上者，不予計分。 二、試題請隨卷繳交。

考試科目	生理學	系所別	神經科學研究所 (8151)	考試時間	2 月 7 日(週五) 第 2 節

注意：請用藍色或黑色原子筆(勿用鉛筆)答卷.

I. 選擇題：每題2分，共30分

1. A friend with damaged Wernicke's area will
(A) be difficult to recognize your face
(B) be difficult to understand what you said
(C) be difficult to move coordinately
(D) be difficult to talk to you
(E) be difficult to remember who you are

2. Which of the following sign you may NOT find during REM sleep?
(A) dreaming
(B) beta wave of EEG
(C) penile erection
(D) body movement
(E) none of the above

3. "Euphoria" is most likely induced by activation of the ____ system.
(A) Norepinephrine
(B) Acetylcholine
(C) Dopamine
(D) GABA
(E) Glutamate

4. Which lobe of the brain mainly processes motor information?
(A) Frontal lobe
(B) Temporal lobe
(C) Occipital lobe
(D) Parietal lobe
(E) all of the above

5. What is the most related function that hypothalamic-pituitary-adrenal axis acts for?
(A) Circadian rhythm
(B) Stress
(C) Reproduction
(D) Insomnia
(E) Chronic pain

6. NMDA receptor is NOT a
(A) glutamate receptor
(B) cation channel
(C) metabotropic receptor
(D) magnesium-gated ionophore

考試科目	生理學	系所別	神經科學研究所 (8151)	考試時間	2 月 7 日(週五) 第 2 節

(E) none of the above

7. Which of the following statement about the properties of an "AXON" is correct?
(A) A neuron usually has many axons.
(B) The axon hillock contains many Golgi apparatus.
(C) Many voltage-gated sodium channels are located on the "node of Ranvier".
(D) The myelin sheath slows down the conducting velocity of nerve impulses on an axon.
(E) none of above

8. Which of the flowing neurotransmitters would be inactivated by peptidases?
(A) histamine, nitric oxide
(B) substance P, vasopressin
(C) acetylcholine, dopamine
(D) glutamate, GABA
(E) all of the above

9. Bilateral loss of hippocampal function may cause
(A) loss of remote memories.
(B) loss of working memory.
(C) emotional disturbances when recalling events of the recent past.
(D) loss of the ability to encode recent events into long-term memory.
(E) all of the above

10. Which of the following statement about "Alzheimer's disease (AD)" is NOT correct?
(A) AD only occurs in people older than 60 years of age.
(B) Most AD cases are sporadic.
(C) AD patients often show progressively declined cognitive function.
(D) Senile plaques can be detected in the brain of AD patients.
(E) none of the above

11. Which of the following statement about "long-term potentiation (LTP)" is NOT correct?
(A) It is important for learning and memory.
(B) It causes enlarged amplitude of action potential.
(C) It enhances synaptic transmission.
(D) It relies activation of glutamate receptors.
(E) none of the above

12. Drinking alcohol enhances the risks for cancers, especially in people with the deficiency of the following enzyme?
(A) alcohol dehydrogenase 2
(B) alcohol deacetylase 2
(C) aldehyde dehydrogenase 2
(D) aldehyde deacetylase 2

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(E) aldehyde decarboxylase 2

13. Which of the following brain regions may determine sexual orientation?
(A) corpus callosum
(B) superchiasmatic nucleus
(C) superior colliculus
(D) locus coeruleus
(E) anterior hypothalamus

14. The physiological responses to insulin may include
(A) enhancing amino acid uptake by skeletal muscle
(B) activating glucose reabsorption in the kidney
(C) promoting glucose transport in skeletal muscle, red blood cells and the brain
(D) blocking triglyceride synthesis in adipose tissue
(E) none of the above

15. Considering the main deregulated neurotransmission in brain disorders:
depression : seizure = _____ : _____
(A) GABA, serotonin
(B) serotonin, acetylcholine
(C) glutamate, serotonin
(D) serotonin, GABA
(E) none of above

II. 解釋名詞 (每題5分，共20分)
1. Blood-brain barrier
2. Gut-brain axis
3. Synaptic pruning
4. Parkinson's disease

III. 問答題 (50%)

1. Please draw an action potential and indicate:
(a) the voltage for the resting membrane potential
(b) the voltage for the threshold
(c) the phase of depolarization
(d) the phase of hyperpolarization
(e) the ionic flows and the channels/membrane proteins activated during different phases of action potential (10%)

2. Please provide an example to describe how a hormone affects physiological function by acting through its receptors. (10%)

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3. How does calcium modulate muscle contraction? Please compare the action of calcium in contraction of smooth muscles vs. skeletal muscles. (10%)

4. Please read the following abstract and answer questions (a) and (b).
(a) Please describe the aim and main results of this study in your own words. (10%)
(b) Based on the results and conclusion of this article, please speculate: what will be the next questions they may investigate? How can they answer the questions with experiments? (10%)

Title: HCN2 Channels in Cholinergic Interneurons of Nucleus Accumbens Shell Regulate Depressive Behaviors (Source: Cheng et al. 2019, Neuron 101, 662–672)

Abstract: Cholinergic interneurons (ChIs) in the nucleus accumbens (NAc) have been implicated in drug addiction, reward, and mood disorders. However, the physiological role of ChIs in depression has not been characterized. Here, we show that the tonic firing rate of ChIs in NAc shell is reduced in chronic stress mouse models and in a genetic mouse model of depression. Chemogenetic inhibition of NAc ChIs renders naive mice susceptible to stress, whereas enhancement of ChI activity reverses depressive phenotypes. As a component of the molecular mechanism, we found that the expression and function of the hyperpolarization-activated cyclic nucleotidegated channel 2 (HCN2) are decreased in ChIs of NAc shell in depressed mice. Overexpression of HCN2 channels in ChIs enhances cell activity and is sufficient to rescue depressive phenotypes. These data suggest that enhancement of HCN2 channel activity in NAc ChIs is a feasible approach for the development of a new class of antidepressants.

備註	一、作答於試題上者，不予計分。 二、試題請隨卷繳交。