

一、選擇題(每題二分) ※ 注意：請於試卷內之「選擇題作答區」依序作答。

- Which of the following are produced by reactions that take place in the thylakoids and consumed by reactions in the stroma?
  - CO<sub>2</sub> and H<sub>2</sub>O
  - NADP<sup>+</sup> and ADP
  - ATP and NADPH
  - ATP, NADPH, and CO<sub>2</sub>
  - O<sub>2</sub> and ATP
- Whether an allele is dominant or recessive depends on
  - how common the allele is, relative to other alleles.
  - Whether it is inherited from the mother or the father.
  - Which chromosome it is on.
  - Whether or not it is linked to other genes.
  - Whether it or another allele determines the phenotype when both are present.
- Which of the following methods of gene regulation do eukaryotes and prokaryotes have in common?
  - activator and repressor proteins which attach to DNA
  - lac and trp operons
  - elaborate packing of DNA in chromosomes
  - the addition of a cap and tail to mRNA after transcription
  - the removal of noncoding portions of RNA
- A new plant species C, which formed from hybridization of species A (2n=16) with species B (2n=12), would probably produce gametes with a chromosome number of
  - 12
  - 14
  - 16
  - 28
  - 56
- Which of the following statements about translation is false?
  - Translation consists of initiation, elongation, and termination.
  - During polypeptide initiation, an mRNA, the first amino acid attached to its tRNA, and the two subunits of a ribosome are brought together.
  - An mRNA molecule transcribed from DNA is shorter than the genetic message it carries.
  - During the first step of initiation, an mRNA molecule binds to a small ribosomal subunit.
  - Translation stops when stop codons are recognized by release factor.
- Which of the following permits a single gene to code for more than one polypeptide?
  - retention of different introns in the final version of the different mRNA strands
  - alternative RNA splicing
  - genetic differentiation
  - addition of different types of caps and tails to the final version of the mRNA strands
  - mutation during transcription
- Which of the following statements regarding DNA packing is false?
  - A nucleosome consists of DNA wound around a protein core of eight histone molecules.
  - DNA packing tends to promote gene expression.
  - Highly compacted chromatin is generally not expressed at all.
  - Prokaryotes have proteins analogous to histones.
  - DNA packing could be dynamic and regulated by post-translational modification of histone molecules.

見背面

8. Oxygen crosses a plasma membrane by

- A) osmosis.
- B) active transport.
- C) pinocytosis.
- D) passive transport.
- E) receptor mediated endocytosis

二、解釋名詞 (每題三分)

- 1. Autophagy
- 2. Cytokinesis
- 3. Reverse transcription
- 4. CRISPR
- 5. Kinase
- 6. X chromosome inactivation

三、問答題 (配分每題不一，請斟酌作答)

Q1:

A key question about animal regeneration is the sources of the new tissues. There are two basic models for tissue contribution in regeneration. In one model, there is a single population of precursor cells that can give rise to multiple tissue types. These precursor cells are said to be "multipotent" or "pluripotent" because each of them has a potential to develop into multiple cell types. In the other model, there are several distinct populations of precursor cells, and each precursor cell can only give rise to a limited set of differentiated cell types. This pattern of tissue contribution is said to be "lineage-restricted".

Among vertebrates, urodeles have an exceptional regenerative capability. It can regrow the lost appendage and tail. To analyze the pattern of tissue contribution in urodele regeneration, a researcher study the tail regeneration in axolotl (an urodele species). This researcher first designed a DNA construct that can drive the expression of green fluorescent protein (GFP) with the promoter of axolotl GFAP, a gene that is normally expressed in radial glial cells of the spinal cord. This construct was injected into the lumen of the spinal cord central canal. An electroporation was then performed in the cerebrospinal fluid. 48 hours later, the GFP signal was readily detected in the spinal cord. The researcher then amputated the tail and allow tail regeneration to complete. In the newly regenerated tail, the researcher found that the GFP signal can be found not only in the spinal cord but also in other tissue types such as muscle and cartilage.

Based on the information given above, please answer the following questions.

1. What is the main conclusion of this experiment? (8 points)

(hint: tissue contribution by \_\_\_\_\_ is \_\_\_\_\_ in axolotl tail regeneration)

2. What is the purpose of electroporation after the injection of DNA construct into the cerebrospinal fluid? (4 points)

3. There are many promoters available for driving transgene expression. Please list at least two reasons why the researcher chose to use the GFAP promoter. (8 points)

4. Where can you expect to find GFP expression if the researcher cut off one of the hind legs instead of the tail? (2 points)

Please explain why you expect such a result. (4 points)

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Q2:

There are several endemic urodele species in Taiwan, all belonging to the genus *Hynobius*. These include *H. formosanus* (台灣山椒魚), *H. arisanensis* (阿里山山椒魚), *H. sonani* (楚南氏山椒魚), and the newly described *H. glacialis* (南湖山椒魚) & *H. fuca* (觀霧山椒魚). They can be found in high-altitude alpine habitats as they can only survive in a cool temperature. Furthermore, phylogenetic analysis suggests that the common ancestor of these species first arrived in Taiwan and then experienced multiple speciation events locally.

1. Please describe a possible ecological mechanism for the speciation of Taiwanese *Hynobius*. (4 points)
2. There are several dozens of surviving *Hynobius* species, and all the living species are distributed within the geographic zone including the Pacific coast of Russia, Japan, Korea, Taiwan and Mainland China. The ancestor of Taiwanese *Hynobius* species could migrate from the West to the East (Mainland China to Taiwan) or from the North to the South (Japan to Taiwan). If specimens of all the *Hynobius* species are made available to you, please design an analysis to determine the route of migration for the Taiwanese *Hynobius* lineage. Please describe how the expected results can distinguish the West-to-East and the North-to-South hypotheses. (4 points)

Q3:

Muscle contraction is initiated by the influx of which ion to the muscle cell? (2 points) Please describe how this ion initiates muscle contraction? (8 points)

Q4:

The primary mean of a neuron to convey information is through electrical signaling. When stimulated, neurons can fire action potential which usually travels from the cell body, axon to axon terminal but not in reverse direction. This is due to a special property of an ion channel. Please name that ion channel (2 points), and explain why action potential does not go from cell body to axon and then goes back to cell body again. (8 points)

Q5:

When an action potential reaches axon terminal, synaptic transmitter could be released which produces either excitatory postsynaptic potentials (EPSPs) or inhibitory postsynaptic potentials (IPSPs) on the post-synaptic neurons. Please briefly describe the shift of membrane potential of EPSPs and IPSPs, and why they can "excite" or "inhibit" post-synaptic neurons. (6 points)

Q6:

Diabetes mellitus is perhaps the best-known endocrine disorder. It is marked by elevated blood glucose levels. According to the cause, there are type I and type II diabetes. Please describe the different between 2 types of Diabetes mellitus. (6 points)

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