國立中山大學100學年度碩士班招生考試試題

科目：普通生物學【海生所碩士班】

單選題 (choose the best answer among the 4 choices in each question. Three points each question.)

1. The major component in plasma membrane is (A) triacylglycerol (B) phospholipids (C) proteins (D) carbohydreates.

2. What kind of protein in the following is not associated with plasma membrane? (A) protein kinases (B) protein phosphatases (C) histones (D) aquaporins.

3. What provides the force to hold DNA double helix from breaking into two single strands? (A) hydrogen bonds (B) hydrophobic interactions (C) ionic interactions (D) disulfide bonds.

4. What kind of DNA sequence exists in telomeres? (A) introns (B) repetitive sequences (C) transposons (D) genes.

5. What provides the force to form alpha-helix domain in proteins? (A) hydrogen bonds (B) hydrophobic interactions (C) ionic interactions (D) disulfide bonds.

6. In a mutant plant that over-produces organic acids, what organelle is the most possible storage site for the organic acids? (A) cytosol (B) chloroplasts (C) mitochondria (D) vacuoles.

7. To amplify a piece of DNA using PCR, what in the following you don't need? (A) ATP (B) primers (C) Taq (D) DNA template

8. What is the best way to remove starch granules from bovine serum albumin (BSA) in the following? (A) electrophoresis (B) centrifugation (C) gel filtration (D) spectrophotometry

9. Which of the following is not required for protein synthesis *in vivo*? (A) ribosome (B) RNA polymerase (C) mRNA (D) tRNA.

10. You want to separate a mixture of proteins based their sizes, which of the following techniques will do that? (A) gel filtration chromatography (B) ion exchange chromatography (C) affinity chromatography (D) isoelectric focusing.

11. Which in the following is an unbound electron carrier that moves freely in chloroplasts? (A) PSII (B) cytochrome b_6f (C) plastocyanin (D) PSI

12. The reasons for the presence of gene alleles do not include (A) natural selection (B) gene mutation (C) acclimation (D) adaptation.

13. Which of the following about circadian rhythms is correct? (A) They are regulated by proteins (B) humans do not have circadian rhythms (C) phototropism is regulated by circadian rhythms (D) They occur during cell division.

14. Which DNA sequence(s) in the following is the best among the 4 choices for constructing species tree of fish? (A) mitochondrial cytochrome C oxidase gene (B) hemoglobin genes (C) myosin genes (D) ATP synthase genes.

15. Which in the following is not produced in Citric Acid Cycle? (A) NADPH (B) NADH (C) ATP (D) $FADH_2$.

16. Which in the following is not produced in glycolysis? (A) Fructose 1,6-bisphosphate (B) 3-phosphoglycerate (C) phosphoenolpyruvate (D) malate

17. The first product in C4 carbon fixation in plants is (A) phosphoenolpyruvate (B) oxaloacetate (C) malate (D) ribulose 1,5-bisphosphate.

18. During gametogenesis, the spindle fibers that pull chromosomes apart are actually (A) actinfilaments (B) intermediate filaments (C) microtubules (D) cellulose.

19. Which molecule in the following cannot diffuse through plasma membrane freely, thus needs assistance from channels (A) H_2O (B) CO_2 (C) O_2 (D) C_2H_5OH.

20. Which of the following is true about flagella of prokaryotes and eukaryotes? (A) The movement of eukaryotic flagella is the result of one microtubule pair sliding along a neighboring microtubule pair. (B) Prokaryotes use ATP as energy source to move flagella. (C) Eukaryotes use proton gradient to power flagellum movement. (D) The monomers of prokaryotic flagella are actins.

21. Which of the following is not likely to happen if the atmosphere carbon dioxide concentration reaches 1000 ppm? (A) The average global temperature will be higher than what it is right now. (B) Coral reefs may disappear. (C) Seawater pH will drop below 7. (D) Photosynthesis efficiency will be higher.

22. What is most likely to happen among the following if you insert a gene into centromere? (A) This gene will be silenced. (B) This gene will jump out and insert into other location. (C) This gene will be over-expressed. (D) This gene will duplicate on site.

23. In a genetic experiment, AaBbCcDd is self-crossed. What is the proportion of the progenies that are AaB-C-dd? (A)9/64 (B) 27/128 (C) 9/128 (D) 27/64

24. Which in the following is false about retrotransposons? (A) They are descendents of transposons. (B) They use DNA as intermediates for propagation. (C) The number of retrotransposons is much more than that of transposons in human genome. (D) RNA polymerase is required for their propagation.

25. The so-called chromosomes (dumb-bell shape chromosomes) can be observed when eukaryotic cells are in (A) prophase (B) metaphase (C) anaphase (D) telophase. ˙

簡答題

1. List 5 methods (or chemicals) that are used in labs to generate mutations (5 points)。

2. List 10 hormones you know in either animals or plants (5 points)。

3. Translate the mRNA sequence below into amino acid sequence using the codon table in the next page (5 points).

GAUCCUAUUGAUGCUGCCCGUUAGUUCCAAAGGGCUCGUGAAAUAAGGCUUUUCCAAAA

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4. Lab skills (2 points each)

I.   What is the molarity (M) concentration if you dissolve 20g of NaCl into 500 mL of water? (assume NaCl molecular weight is 40.00).

II. Assume the NaCl concentration in seawater is 3%. What is its molarity concentration?

III. You have a bottle of 1 M NaCl stock, and you want to make a NaCl solution that is 50 mM in the final volume 50 mL. What are the volumes of 1 M NaCl and water you need to mix together in order to make such a solution?

IV. You cloned a gene in which the coding region is 1 kb. Estimate the molecular weight of the protein it encodes.

V.   You need to make a solution of 50 mL that contains 0.1 mM of glucose (M.W. 180). What will you do to make this solution?

Second letter

	U	C	A	G	
U	UUU ⎤ Phe UUC ⎦ UUA ⎤ Leu UUG ⎦	UCU ⎤ UCC ⎥ Ser UCA ⎥ UCG ⎦	UAU ⎤ Tyr UAC ⎦ UAA Stop UAG Stop	UGU ⎤ Cys UGC ⎦ UGA Stop UGG Trp	U C A G
C	CUU ⎤ CUC ⎥ Leu CUA ⎥ CUG ⎦	CCU ⎤ CCC ⎥ Pro CCA ⎥ CCG ⎦	CAU ⎤ His CAC ⎦ CAA ⎤ Gln CAG ⎦	CGU ⎤ CGC ⎥ Arg CGA ⎥ CGG ⎦	U C A G
A	AUU ⎤ AUC ⎥ Ile AUA ⎦ AUG Met	ACU ⎤ ACC ⎥ Thr ACA ⎥ ACG ⎦	AAU ⎤ Asn AAC ⎦ AAA ⎤ Lys AAG ⎦	AGU ⎤ Ser AGC ⎦ AGA ⎤ Arg AGG ⎦	U C A G
G	GUU ⎤ GUC ⎥ Val GUA ⎥ GUG ⎦	GCU ⎤ GCC ⎥ Ala GCA ⎥ GCG ⎦	GAU ⎤ Asp GAC ⎦ GAA ⎤ Glu GAG ⎦	GGU ⎤ GGC ⎥ Gly GGA ⎥ GGG ⎦	U C A G

First letter (left side) — Third letter (right side)

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Choose the most appropriate answer. Five points for each question.

Genomic Signatures Predict Migration and Spawning Failure in Wild Canadian Salmon

Miller *et al.*, 2011, Science 331: 214-217

Long-term population viability of Fraser River sockeye salmon (*Oncorhynchus nerka*) is threatened by unusually high levels of mortality as they swim to their spawning areas before they spawn. Functional genomic studies on biopsied gill tissue from tagged wild adults that were tracked through ocean and river environments revealed physiological profiles predictive of successful migration and spawning. We identified a common genomic profile that was correlated with survival in each study. In ocean-tagged fish, a mortality-related genomic signature was associated with a 13.5-fold greater chance of dying en route. In river-tagged fish, the same genomic signature was associated with a 50% increase in mortality before reaching the spawning grounds in one of three stocks tested. At the spawning grounds, the same signature was associated with 3.7-fold greater odds of dying without spawning. Functional analysis raises the possibility that the mortality-related signature reflects a viral infection.

(1) The main objective of this study was to (a) trace the salmon migratory route (b) compare the genomic signature between different salmon population (c) correlate the genomic signature with salmon mortality (d) increase the success rate of salmon spawners

(2) How many groups of salmon were sampled to compare their mortality? (a)2 (b)3 (c)4 (d)5

(3) A genomic signature identified in this study may associate with (a) population variation (b) acclimation to salinity (c) reproductive maturation (d) infectious disease

Electrical Synapses Control Hippocampal Contributions to Fear Learning and Memory

Bissiere *et al.* 2011, Science 331:87-91

The role of electrical synapses in synchronizing neuronal assemblies in the adult mammalian brain is well documented. However, their role in learning and memory processes remains unclear. By combining Pavlovian fear conditioning, activity-dependent immediate early gene expression, and in vivo electrophysiology, we discovered that blocking neuronal gap junctions within the dorsal hippocampus impaired context-dependent fear learning, memory, and extinction. Theta rhythms in freely moving rats were also disrupted. Our results show that gap junction–mediated neuronal transmission is a prominent feature underlying emotional memories.

(4) Normal learning and memory processes depend on (a) blocking gap junction (b) impaired hippocampus (c) electrical synapse synchronization (d) all of the above

(5) Gap junction (a) is a synapse (b) is a neuron (c) transmits chemical signals (d) is found in the dorsal hippocampus only

Has the Microbiota Played a Critical Role in the Evolution of the Adaptive Immune System?

Lee and Mazmanian 2010, Science 330:1768-1773

Although microbes have been classically viewed as pathogens, it is now well established that the majority of host-bacterial interactions are symbiotic. During development and into adulthood, gut bacteria shape the tissues, cells, and molecular profile of our gastrointestinal immune system. This partnership, forged over many millennia of coevolution, is based on a molecular exchange involving bacterial signals that are recognized by host receptors to mediate beneficial outcomes for both microbes and humans. We explore how specific aspects of the adaptive immune system are influenced by intestinal commensal bacteria. Understanding the molecular mechanisms that mediate symbiosis between commensal bacteria and humans may redefine how we view the evolution of adaptive immunity and consequently how we approach the treatment of numerous immunologic disorders

(6) Symbiotic bacteria (a) are pathogenic (b) coevolve with host (c) send receptor to host as a signal (d) belong to the gastrointestinal immune system

(7) Which of the following supports the concept that adaptive immune system is influenced by intestinal commensal bacteria? (a) immunologic disorder (b) bacteria secret protein into gut (c) specific intestinal receptor bind to bacteria protein (d) all of the above

Fruit and vegetables and cancer risk

Key 2011, British Journal of Cancer 104: 6–11.

The possibility that fruit and vegetables may help to reduce the risk of cancer has been studied for over 30 years, but no protective effects have been firmly established. For cancers of the upper gastrointestinal tract, epidemiological studies have generally observed that people with a relatively high intake of fruit and vegetables have a moderately reduced risk, but these observations must be interpreted cautiously because of potential confounding by smoking and alcohol. For lung cancer, recent large prospective analyses with detailed adjustment for smoking have not shown a convincing association between fruit and vegetable intake and reduced risk. For other common cancers, including colorectal, breast and prostate cancer, epidemiological studies suggest little or no association between total fruit and vegetable consumption and risk. It is still possible that there are benefits to be identified: there could be benefits in populations with low average intakes of fruit and vegetables, such that those eating moderate amounts have a lower cancer risk than those eating very low amounts, and there could also be effects of particular nutrients in certain fruits and vegetables, as fruit and vegetables have very varied composition. Nutritional principles indicate that healthy diets should include at least moderate amounts of fruit and vegetables, but the available data suggest that general increases in fruit and vegetable intake would not have much effect on cancer rates, at least in well-nourished populations. Current advice in relation to diet and cancer should include the recommendation to consume adequate amounts of fruit and vegetables, but should put most emphasis on the well-established adverse effects of obesity and high alcohol intakes.

(8)In well-nourished populations, high intake of fruit and vegetables may reduce the risk of (a) colorectal cancer (b) breast cancer (c) lung cancer (d) none of the above

(9)It is possible that there are some benefits from fruit and vegetable to reduce the risk of cancer due to the (a) effects of particular nutrients (b) effects of alcohol (c) effects of smoking (d) all of the above

Global patterns and predictors of marine biodiversity across taxa

Tittensor *et al.* 2010, Nature 466:1098–1101

Global patterns of species richness and their structuring forces have fascinated biologists since Darwin and provide critical context for contemporary studies in ecology, evolution and conservation. Anthropogenic impacts and the need for systematic conservation planning have further motivated the analysis of diversity patterns and processes at regional to global scales. Whereas land diversity patterns and their predictors are known for numerous taxa, our understanding of global marine diversity has been more limited, with recent findings revealing some striking contrasts to widely held terrestrial paradigms. Here we examine global patterns and predictors of species richness across 13 major species groups ranging from zooplankton to marine mammals. Two major patterns emerged: coastal species showed maximum diversity in the Western Pacific, whereas oceanic groups consistently peaked across broad mid-latitudinal bands in all oceans. Spatial regression analyses revealed sea surface temperature as the only environmental predictor highly related to diversity across all 13 taxa. Habitat availability and historical factors were also important for coastal species, whereas other predictors had less significance. Areas of high species richness were disproportionately concentrated in regions with medium or higher human impacts. Our findings indicate a fundamental role of temperature or kinetic energy in structuring cross-taxon marine biodiversity, and indicate that changes in ocean temperature, in conjunction with other human impacts, may ultimately rearrange the global distribution of life in the ocean.

(10)Which of the following areas may have higher species diversity? (a) West Africa coast (b) Atlantic Ocean (c) South China Sea (d) Southern Ocean
(11)Which of the following factors may affect global species pattern? (a) overfishing (b) carbon dioxide emissions (c) global worming (d) all of the above
(12) How many different species were examined in this study (a) 2 (b) 10 (c) 13 (d) more than 13

Global phytoplankton decline over the past century
Boyce *et al.* 2010, Nature 466:591–596

In the oceans, ubiquitous microscopic phototrophs (phytoplankton) account for approximately half the production of organic matter on Earth. Analyses of satellite-derived phytoplankton concentration (available since 1979) have suggested decadal-scale fluctuations linked to climate forcing, but the length of this record is insufficient to resolve

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longer-term trends. Here we combine available ocean transparency measurements and *in situ* chlorophyll observations to estimate the time dependence of phytoplankton biomass at local, regional and global scales since 1899. We observe declines in eight out of ten ocean regions, and estimate a global rate of decline of ~1% of the global median per year. Our analyses further reveal interannual to decadal phytoplankton fluctuations superimposed on long-term trends. These fluctuations are strongly correlated with basin-scale climate indices, whereas long-term declining trends are related to increasing sea surface temperatures. We conclude that global phytoplankton concentration has declined over the past century; this decline will need to be considered in future studies of marine ecosystems, geochemical cycling, ocean circulation and fisheries.

(13) How many years of the records were combined to resolve the longer-term trends of phytoplankton concentration? (a) 1899 to 1979 (b) three decade (c) since 1899 (d) 1979 to 2010

(14) The author estimate a global rate of decline of ~1% of the global median per year which is related to (a) interannual phytoplankton fluctuations (b) decadal phytoplankton fluctuations (c) basin-scale climate indices (d) sea surface temperature

Reliability of flipper-banded penguins as indicators of climate change

Saraux *et al.* 2011, Nature 469:203–206

In 2007, the Intergovernmental Panel on Climate Change highlighted an urgent need to assess the responses of marine ecosystems to climate change[1]. Because they lie in a high-latitude region, the Southern Ocean ecosystems are expected to be strongly affected by global warming. Using top predators of this highly productive ocean[2] (such as penguins) as integrative indicators may help us assess the impacts of climate change on marine ecosystems[3,4]. Yet most available information on penguin population dynamics is based on the controversial use of flipper banding. Although some reports have found the effects of flipper bands to be deleterious[5,6,7,8], some short-term (one-year) studies have concluded otherwise[9,10,11], resulting in the continuation of extensive banding schemes and the use of data sets thus collected to predict climate impact on natural populations[12,13]. Here we show that banding of free-ranging king penguins (*Aptenodytes patagonicus*) impairs both survival and reproduction, ultimately affecting population growth rate. Over the course of a 10-year longitudinal study, banded birds produced 39% fewer chicks and had a survival rate 16% lower than non-banded birds, demonstrating a massive long-term impact of banding and thus refuting the assumption that birds will ultimately adapt to being banded[6,12]. Indeed, banded birds still arrived later for breeding at the study site and had longer foraging trips even after 10 years. One of our major findings is that responses of flipper-banded penguins to climate variability (that is, changes in sea surface temperature and in the Southern Oscillation index) differ from those of non-banded birds. We show that only long-term investigations may allow an evaluation of the impact of flipper bands and that every major life-history trait can be affected, calling into question the banding schemes still going on. In addition, our understanding of the effects of climate change on marine ecosystems based on flipper-band data should be reconsidered.

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(15)Which of the following is **not** the reason why we study penguin population dynamics as an index of the effects of climate change on marine ecosystems? (a) penguin lie in Southern Ocean ecosystem (b) penguin are the top predators (c) Southern Ocean ecosystems are strongly affected by global warming (d) there is no deleterious tagging effect on penguin

(16)Why do the effects of climate change on marine ecosystems based on flipper-band data should be reconsidered? (a) banded penguins had higher reproductive rate (b) banded penguins had higher mortality (c) banded penguins arrived earier for breeding (d) banded penguins had shorter foraging trips

(17) Which reference agrees with the point "flipper banding affect penguins" (a)1(b)4(c)7(d)10

Loss of fish actinotrichia proteins and the fin-to-limb transition

Zhang *et al.* 2010, Nature 466, 234–237

The early development of teleost paired fins is strikingly similar to that of tetrapod limb buds and is controlled by similar mechanisms. One early morphological divergence between pectoral fins and limbs is in the fate of the apical ectodermal ridge (AER), the distal epidermis that rims the bud. Whereas the AER of tetrapods regresses after specification of the skeletal progenitors, the AER of teleost fishes forms a fold that elongates. Formation of the fin fold is accompanied by the synthesis of two rows of rigid, unmineralized fibrils called actinotrichia, which keep the fold straight and guide the migration of mesenchymal cells within the fold. The actinotrichia are made of elastoidin, the components of which, apart from collagen, are unknown. Here we show that two zebrafish proteins, which we name actinodin 1 and 2 (And1 and And2), are essential structural components of elastoidin. The presence of *actinodin* sequences in several teleost fishes and in the elephant shark (*Callorhinchus milii*, which occupies a basal phylogenetic position), but not in tetrapods, suggests that these genes have been lost during tetrapod species evolution. Double gene knockdown of *and1* and *and2* in zebrafish embryos results in the absence of actinotrichia and impaired fin folds. Gene expression profiles in embryos lacking *and1* and *and2* function are consistent with pectoral fin truncation and may offer a potential explanation for the polydactyly observed in early tetrapod fossils. We propose that the loss of both *actinodins* and actinotrichia during evolution may have led to the loss of lepidotrichia and may have contributed to the fin-to-limb transition.

(18)In tetrapod (a) AER forms limb buds (b) AER form fin fold (c) AER regresses (d) AER synthesis actinotrichia

(19)Double gene knockdown of *and1* and *and2* in zebrafish embryos results in (a) lack of actinodin 1 and 2 (b) formation of fin folds (c) formation of actinotrichia (d) development of pectoral fin

(20)The *actinodin* sequence is present in (a) zebra (b) lizard (c) sting ray (d) elephant