

## 單選題 (2% each)

- (1) Carbohydrates are stored in animals in the form of (A) cellulose (B) starch (C) glycogen (D) glucose
- (2) Synthesis of lipids occurs in which organelle? (A) Golgi body (B) mitochondria (C) smooth endoplasmic reticulum (D) endosomes
- (3) Osmosis is specifically about the movement of \_\_\_\_\_ cross cell membrane. (A) proton (B) proteins (C) water (D) oxygen
- (4) Under anaerobic conditions, the end-product of glycolysis is converted to (A) acetic acid (B) amino acids (C) lactic acid (D) ascorbic acid
- (5) A promoter is defined as (A) DNA repair enzymes (B) the active portion of a protease (C) an enzyme which turns on a gene to transcribe an RNA molecule (D) the site where RNA polymerase will bind
- (6) Programmed cell death is known as (A) mitosis (B) cytokinesis (C) necrosis (D) apoptosis
- (7) A primary spermatocyte with 46 chromosomes will undergo meiosis and yield (A) two spermatids with 46 chromosomes (B) four spermatids with 23 chromosomes (C) four spermatids with 46 chromosomes (D) two spermatids with 23 chromosomes
- (8) The appearance of both A and B types of glycoproteins on the red blood cells of the people with AB blood type is an example of (A) codominance (B) incomplete dominance (C) autosomal recessiveness (D) polygenic inheritance
- (9) In photosynthesis, CO<sub>2</sub> fixation occurs when CO<sub>2</sub> combines with (A) ribulose biphosphate (B) glyceraldehyde-3-phosphate (C) NADP (D) pyruvate
- (10) The diploid generation of plants is called (A) spore (B) sporophyte (C) gamete (D) gametophyte

## 國立中山大學99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】

- (11) An accumulation of \_\_\_\_\_ ions within guard cells causes the stomata to open. (A) calcium (B) sodium (C) potassium (D) magnesium
- (12) Which of the following is a germ layer that may be present during animal development? (A) hypoderm (B) epidermis (C) placoderm (D) endoderm
- (13) The ability of one embryonic tissue to influence the development of another tissue is called (A) differentiation (B) gastrulation (C) induction (D) morphogenesis
- (14) An endoskeleton is observed in (A) vertebrates (B) arthropods (C) annelids (D) mollusks
- (15) Fish classified as agnathans are \_\_\_\_\_ fish. (A) lobe-finned (B) jawless (C) cartilaginous (D) bony
- (16) Which of the following involves a positive feedback mechanism? (A) body temperature control (B) maintaining blood pressure (C) maintaining oxygen concentrations in blood (D) ovulation
- (17) Where does the blood go when it leaves the right atrium? (A) the body (B) the right ventricle (C) the left atrium (D) the lungs
- (18) The \_\_\_\_\_ are disabled by the HIV virus. (A) plasma B cells (B) memory B cells (C) helper T cells (D) NK cell
- (19) Chemical digestion begins in the (A) mouth (B) esophagus (C) stomach (D) small intestine
- (20) Which of the following is not filtered out of the blood during glomerular filtration? (A) red blood cells (B) urea (C) water (D) glucose
- (21) Which of the following is a postzygotic isolating mechanism? (A) hybrid sterility (B) temporal isolation (C) habitat isolation (D) mechanical isolation
- (22) If there is an absence of migration of breeding individuals among populations, \_\_\_\_\_ will not occur. (A) gene flow (B) random mating (C) genetic mutations (D) natural selection

- (23) The use of a reward to elicit a desired behavior is characteristic of (A) operant conditioning (B) altruism (C) imprinting (D) fixed action patterns
- (24) K-strategists (A) adapt easily when their normal way of life is destroyed (B) require large ranges (C) easily colonize new habitats (D) provide little or no care for their offspring
- (25) The abyssal plain is characterized by (A) a variety of seaweed (B) numerous phytoplankton (C) hydrothermal vents that support communities of organisms (D) an absence of living things

## 問答題 (10% each)

- (1) What is microRNA? What is the role of microRNA?
- (2) Describe the role of  $\text{Ca}^{2+}$  in intracellular messenger transduction.
- (3) In multicellular animals, how cells communicate?
- (4) In vertebrates, gas exchange can be carried out in the respiratory system as a counter current system, a flow through system or a sac system. Compare the efficiency of these three systems and take an example for each of them.
- (5) What are the "ultimate causes" and the "proximate causes" to control the annual reproductive rhythm in season breeders?

4 points for each question. Write all your answers in the designated area in the answering booklet, not in this question sheet. Choose the most appropriate answer only(單選).

Please answer questions following each abstract

### Historical baselines for large marine animals

Lotze K and Worm B Trends in Ecology & Evolution 2009 24(5):254-262

Current trends in marine ecosystems need to be interpreted against a solid understanding of the magnitude and drivers of past changes. Over the last decade, marine scientists from different disciplines have engaged in the emerging field of marine historical ecology to reconstruct past changes in the sea. Here we review the diversity of approaches used and resulting patterns of historical changes in large marine mammals, birds, reptiles and fish. Across 256 reviewed records, exploited populations declined 89% from historical abundance levels (range: 11-100%). In many cases, long-term fluctuations are related to climate variation, rapid declines to overexploitation and recent recoveries to conservation measures. These emerging historical patterns offer new insights into past ecosystems, and provide important context for contemporary ocean management.

1. This paper was published in a) Ecology b) Evolution c) Ecology & Evolution d) Lotze and Worm e) Trends in Ecology & Evolution
2. Which of the following organisms may not be included in this study a) whales b) sea turtles c) pelicans d) sharks e) elephants
3. The paper seems to suggest that a) marine mammals become larger in the last decade b) marine scientists started studying ocean management over the last decade c) human activities exert only negative effects on natural populations d) human activities can exert positive effects on natural populations e) most exploited populations are recovering or are recovered

### Predicting ecological consequences of marine top predator declines.

Heithaus MR, Frid A, Wirsing AJ and Worm B Trends in Ecology & Evolution 23(4):202-210

Recent studies document unprecedented declines in marine top predators that can initiate trophic cascades. Predicting the wider ecological consequences of these declines requires understanding how predators influence communities by inflicting mortality on prey and inducing behavioral modifications (risk effects). Both mechanisms are important in marine communities; and a sole focus on the effects of predator-inflicted mortality might severely underestimate the importance of predators. We outline direct and indirect consequences of marine predator declines and propose an integrated predictive framework that includes risk effects, which appear to be strongest for long-lived prey species and when resources are abundant. We conclude that marine predators should be managed for the maintenance of both density- and risk-driven ecological processes, and not demographic persistence alone.

4. There are a total of a) 23 b) 4 c) ~200 d) 9 e) unknown number of pages in this paper
5. The authors suggest that a) some predators live for a long time b) long-lived prey species may change their behaviors due to presence/absence of predators c) top predators may have behavioral modifications d) top predators may decline in population sizes e) none above are true

## Glaciers as a source of ancient and labile organic matter to the marine environment.

Nature 462:1044-U100, 2009

Hood E et al.

Riverine organic matter supports of the order of one-fifth of estuarine metabolism. Coastal ecosystems are therefore sensitive to alteration of both the quantity and lability of terrigenous dissolved organic matter (DOM) delivered by rivers. The lability of DOM is thought to vary with age, with younger, relatively unaltered organic matter being more easily metabolized by aquatic heterotrophs than older, heavily modified material. This view is developed exclusively from work in watersheds where terrestrial plant and soil sources dominate streamwater DOM. Here we characterize streamwater DOM from 11 coastal watersheds on the Gulf of Alaska that vary widely in glacier coverage (0-64 per cent). In contrast to non-glacial rivers, we find that the bioavailability of DOM to marine microorganisms is significantly correlated with increasing C-14 age. Moreover, the most heavily glaciated watersheds are the source of the oldest (similar to 4 kyr C-14 age) and most labile (66 per cent bioavailable) DOM. These glacial watersheds have extreme runoff rates, in part because they are subject to some of the highest rates of glacier volume loss on Earth. We estimate the cumulative flux of dissolved organic carbon derived from glaciers contributing runoff to the Gulf of Alaska at  $0.13 \pm 0.01$  Tg per yr (1 Tg =  $10^{12}$  g), of which similar to 0.10 Tg is highly labile. This indicates that glacial runoff is a quantitatively important source of labile reduced carbon to marine ecosystems. Moreover, because glaciers and ice sheets represent the second largest reservoir of water in the global hydrologic system, our findings indicate that climatically driven changes in glacier volume could alter the age, quantity and reactivity of DOM entering coastal oceans

6. How many authors wrote this essay? a) 1 b) 2 c) >2 d) this is written by the editor
7. This paper is most likely written by a) molecular biologists and ecologists b) physiologists and botanists c) chemists and microbiologists d) physicists and geologists e) zoologists and taxonomists
8. DOM is a) a mixture of organic compounds b) an energy source c) products of organisms d) metabolized by microorganisms e) all above
9. It was found in this investigation that the bioavailability of DOM is determined by a) C-14 contents b) its age and presence of glaciers c) its chemical structures d) the sizes of water reservoirs e) all above

## Genotypic sex determination enabled adaptive radiations of extinct marine reptiles

Organ CL, Jane DE, Meade A, Pagel M. Nature 461:389-392 2009

Adaptive radiations often follow the evolution of key traits, such as the origin of the amniotic egg and the subsequent radiation of terrestrial vertebrates. The mechanism by which a species determines the sex of its offspring has been linked to critical ecological and life-history traits but not to major adaptive radiations, in part because sex-determining mechanisms do not fossilize. Here we establish a previously unknown coevolutionary relationship in 94 amniote species between sex-determining mechanism and whether a species bears live young or lays eggs. We use that relationship to predict the sex-determining mechanism in three independent lineages of extinct Mesozoic marine reptiles (mosasaurs, sauropterygians and ichthyosaurs), each of which is known from fossils to have evolved live birth. Our results indicate that each lineage evolved genotypic sex determination before acquiring live birth. This enabled their pelagic radiations, where the relatively stable temperatures of the open ocean constrain temperature-dependent sex determination in amniote species. Freed from the need to move and nest on land, extreme physical adaptations to a pelagic lifestyle evolved in each group, such as the fluked tails, dorsal fins and wing-shaped limbs of ichthyosaurs. With the inclusion of ichthyosaurs, mosasaurs and sauropterygians, genotypic sex determination is present in all known fully pelagic amniote groups (sea snakes, sirenians and cetaceans), suggesting that this mode of sex determination and the subsequent

evolution of live birth are key traits required for marine adaptive radiations in amniote lineages.

10. Which of the following statements about mosasaurs, sauropterygians and ichthyosaurs are NOT necessarily correct? a) they gave birth to live youngs b) they had genotypic sex determination c) they are adapted to pelagic life d) they all radiated into many other species e) they are all extinct
11. According to this paper, pelagic reptiles cannot evolve unless they a) give birth to live-youngs b) lay amniotic eggs c) determine sex without relying on environmental cues d) become osmocomformers e) evolved extreme physical adaptations first
12. The reason that adaptive radiation follows the evolution of genetically-determined sex is because a) the reptiles do not need to nest on land b) live-birth is better than laying eggs c) the reptiles can swim d) amniotic eggs allows the reptiles to live on land e) genetically-determined sex can be transmitted to the offspring
13. What would happen if an amniotic reptile becomes pelagic with temperature-dependent sex determination? a) the offspring may drown in the water b) the swimming appendages cannot evolve c) they will have to give birth to floating eggs d) they won't be able to give live birth e) all offspring will have same sex
14. It is clear from the text above that amniotic groups include a) frogs b) whales c) sharks d) fishes e) land insects
15. The reason that the marine dinosaurs mentioned here become extinct is because a) they had not evolved genotypic sex in time b) they became pelagic c) they gave live birth d) they have amniotic eggs e) None above

## Photosystem I gene cassettes are present in marine virus genomes

Sharon I, et al Nature 461:258-262, 2009

Cyanobacteria of the *Synechococcus* and *Prochlorococcus* genera are important contributors to photosynthetic productivity in the open oceans. Recently, core photosystem II (PSII) genes were identified in cyanophages and proposed to function in photosynthesis and in increasing viral fitness by supplementing the host production of these proteins. Here we show evidence for the presence of photosystem I (PSI) genes in the genomes of viruses that infect these marine cyanobacteria, using pre-existing meta-genomic data from the global ocean sampling expedition(8) as well as from viral biomes(9). The seven cyanobacterial core PSI genes identified in this study, *psaA*, *B*, *C*, *D*, *E*, *K* and a unique *J* and *F* fusion, form a cluster in cyanophage genomes, suggestive of selection for a distinct function in the virus life cycle. The existence of this PSI cluster was confirmed with overlapping and long polymerase chain reaction on environmental DNA from the Northern Line Islands. Potentially, the seven proteins encoded by the viral genes are sufficient to form an intact monomeric PSI complex. Projection of viral predicted peptides on the cyanobacterial PSI crystal structure(10) suggested that the viral-PSI components might provide a unique way of funnelling reducing power from respiratory and other electron transfer chains to the PSI.

16. According to the study, the photosynthesis was carried out a) in the virus b) in the host cells with the virus c) in PSI d) in sea water e) in PSII
17. The authors discovered that a) *Synechococcus* are parasitized by cyanobacteria b) *Prochlorococcus* are parasitized by virus c) some viruses contain PSI genes d) Viruses containing PSI genes can utilize sunlight without host cells e) Viruses containing PSI genes can increase the fitness of host cells
18. It was suggested that the presence of the PSI genes are beneficial to the viruses carry them, since a) all genes serve some functions b) these genes are together in the virus genome c) the viruses carrying them was found to propagate faster than those without d) the host cells carrying the PSI genes-viruses

divide faster e) PSI cluster indeed exists in seawater

### Effect of Ocean Acidification on Iron Availability to Marine Phytoplankton

Shi DL, Xu Y, Hopkinson BM, Morel FMM, Science 327: 676-679, 2010

The acidification caused by the dissolution of anthropogenic carbon dioxide ( $\text{CO}_2$ ) in the ocean changes the chemistry and hence the bioavailability of iron (Fe), a limiting nutrient in large oceanic regions. Here, we show that the bioavailability of dissolved Fe may decline because of ocean acidification. Acidification of media containing various Fe compounds decreases the Fe uptake rate of diatoms and coccolithophores to an extent predicted by the changes in Fe chemistry. A slower Fe uptake by a model diatom with decreasing pH is also seen in experiments with Atlantic surface water. The Fe requirement of model phytoplankton remains unchanged with increasing  $\text{CO}_2$ . The ongoing acidification of seawater is likely to increase the Fe stress of phytoplankton populations in some areas of the ocean.

19. Using Fe as a fertilizer, one is most likely to see conspicuous effects in a) the open ocean b) coastal area c) estuaries d) deep sea e) all the same
20. It can be inferred from the essay above that the assimilation of Fe by diatoms and coccolithophores is influenced by a) temperature b) acidity of sea water c) water depths d) dissolution rate of  $\text{CO}_2$  e) solubility of Fe
21. "Fe stress" mentioned in the last line of the essay is referring to a) the harmful effects of Fe b) the high availability of Fe c) the lack of Fe d) the addition of Fe e) the excretion of Fe

### Contribution of Fish to the Marine Inorganic Carbon Cycle

Wilson RW et al. SCIENCE 323: 359-362 2009

Oceanic production of calcium carbonate is conventionally attributed to marine plankton (coccolithophores and foraminifera). Here we report that marine fish produce precipitated carbonates within their intestines and excrete these at high rates. When combined with estimates of global fish biomass, this suggests that marine fish contribute 3 to 15% of total oceanic carbonate production. Fish carbonates have a higher magnesium content and solubility than traditional sources, yielding faster dissolution with depth. This may explain up to a quarter of the increase in titratable alkalinity within 1000 meters of the ocean surface, a controversial phenomenon that has puzzled oceanographers for decades. We also predict that fish carbonate production may rise in response to future environmental changes in carbon dioxide, and thus become an increasingly important component of the inorganic carbon cycle.

22. The most important contributors of calcium carbonates in the sea are a) Coccolithophores and foraminifera b) fishes c) an inorganic process
23. According to this study, the calcium carbonate the marine fish excrete originates from a) scales b) guts c) blood d) coccolithophores e) flesh
24. The fish-excreted carbonates could be distinguished from that by others by a) higher Mg contents b) higher plankton contents c) lower organic contents d) ~3-15% of inorganic contents e) higher alkalinity
25. Where are you least likely to find the carbonates excreted by marine fishes a) coral reefs b) mangroves c) continental shelves d) ocean surface e) deep sea