注意：考試開始鈴響前，不得翻閱試題，
並不得書寫、畫記、作答。

國立清華大學 114 學年度碩士班考試入學試題

系所班組別：生命科學暨醫學院
甲組(生物與醫學科學組)

科目代碼：0402

考試科目：生物學

—作答注意事項—

1. 請核對答案卷（卡）上之准考證號、科目名稱是否正確。
2. 考試開始後，請於作答前先翻閱整份試題，是否有污損或試題印刷不清，得舉手請監試人員處理，但不得要求解釋題意。
3. 考生限在答案卷上標記「由此開始作答」區內作答，且不可書寫姓名、准考證號或與作答無關之其他文字或符號。
4. 答案卷用盡不得要求加頁。
5. 答案卷可用任何書寫工具作答，惟為方便閱卷辨識，請儘量使用藍色或黑色書寫；答案卡限用 2B 鉛筆畫記；如畫記不清（含未依範例畫記）致光學閱讀機無法辨識答案者，其後果一律由考生自行負責。
6. 其他應考規則、違規處理及扣分方式，請自行詳閱准考證明上「國立清華大學試場規則及違規處理辦法」，無法因本試題封面作答注意事項中未列明而稱未知悉。

國立清華大學 114 學年度碩士班考試入學試題

系所班組別：生命科學暨醫學院甲組、丁組

考試科目（代碼）：生物學(0402、0702)

 *請在【答案卡】作答

單選題 (共 50 題，每題 2 分)

1) A new organism was discovered in the forests of Costa Rica. Scientists determined that the new organism's hemoglobin polypeptide sequence differs by 72 amino acids from humans, 65 from a gibbon, 49 from a rat, and five from a frog. These data suggest that the new organism is more closely related to _____.

A) humans than to frogs

B) frogs than to humans

C) rats than to frogs

D) gibbons than to rats

2) An enzyme is composed of four identical subunits. Substrate binding to one subunit stimulates more rapid substrate binding to the other three subunits. Which of the following mechanisms is this enzyme most likely regulated?

A) noncompetitive inhibition

B) competitive activation

C) competitive inhibition

D) cooperativity

3) Which of the following statements provides the most plausible explanation for the results of this experiment?

A) The two sponge species had different enzymes that functioned in the reassembly process.

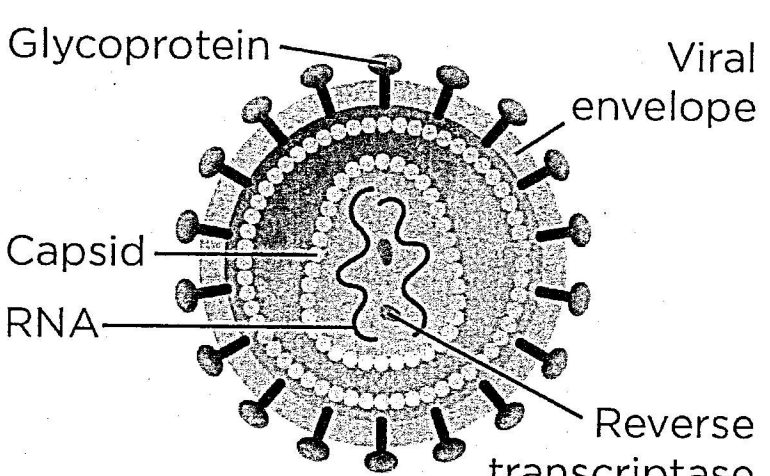
B) The molecules responsible for cell-cell adhesion (cell junctions) were irreversibly destroyed during the experiment.

C) The molecules responsible for cell-cell adhesion (cell junctions) differed between the two species of sponge.

D) One cell functioned as an organizer for each organism, attracting only cells of the same species.

4) Human immunodeficiency virus (HIV) infects cells with CD4 and CCR5 cell surface molecules. The viral nucleic acid molecules are enclosed in a protein capsid, and the protein capsid is contained inside an envelope consisting of a lipid bilayer membrane and viral glycoproteins. One hypothesis for viral entry into cells is that the binding of HIV membrane glycoproteins to CD4 and CCR5 initiates the fusion of the HIV membrane with the plasma membrane, releasing the viral capsid into the cytoplasm. An alternative hypothesis is that HIV gains entry into the cell via receptor-mediated endocytosis, and membrane fusion occurs in the endocytotic vesicle. To test these alternative hypotheses for HIV entry, researchers labeled the lipids on the HIV membrane with a red fluorescent dye.

Fig 1. **HIV virus structure**



What would be observed by live-cell fluorescence microscopy immediately after HIV entry if HIV enters the cell by endocytosis first and then later fuses with the endocytotic vesicle membrane?

A) The infected cell's plasma membrane will show a spot of red fluorescence, marking the site of membrane fusion and HIV entry.

B) The red fluorescent dye-labeled lipids will appear in the infected cell's interior.

C) A spot of red fluorescence will diffuse in the infected cell's cytoplasm.

D) A spot of red fluorescence will remain outside the cell after delivering the viral capsid.

5) Which of the following statements best describes why *C. elegans* is an excellent model organism for investigating apoptosis.

A) Cells in *C. elegans* do not naturally undergo apoptosis but can be induced to do so in the laboratory.

B) *C. elegans* undergoes a fixed and easy-to-visualize number of apoptotic events during normal development.

C) *C. elegans* has large cells wherein apoptosis is easily observed without a microscope.

D) Death in *C. elegans* through a well-defined sequence of apoptotic events.

6) When electrons flow along the electron transport chains of mitochondria, which of the following changes occurs?

A) The pH of the matrix increases.

B) ATP synthase pumps protons by active transport.

C) The electrons gain free energy.

D) NAD^+ is oxidized.

7) Which of the following statements best describes a characteristic of C_4 plants?

A) They can fix CO_2 at lower CO_2 concentrations and higher oxygen concentrations than C_3 plants.

B) They have higher rates of photorespiration than C_3 plants.

C) They use rubisco for carbon fixation, whereas C_3 plants do not.

D) They produce oxaloacetate, a four-carbon compound, which is then delivered to the citric acid cycle in mitochondria.

8) Cell A has half as much DNA as cells B, C, and D in a mitotically active tissue. Cell A is most likely in _____.

A) G_1

B) G_2

C) prophase

D) metaphase

9) Meiosis II is similar to mitosis in that _____.

A) sister chromatids separate during anaphase

B) DNA replicates before the division

C) the daughter cells are diploid

D) homologous chromosomes synapse

10) In cats, an X-linked locus is responsible for fur color. There are two known alleles at this locus—one in black fur color and the other in orange fur color. A heterozygote animal has patches of orange and black fur (tortoiseshell). Which coat color phenotypes are expected from the cross of a black female and an orange male?

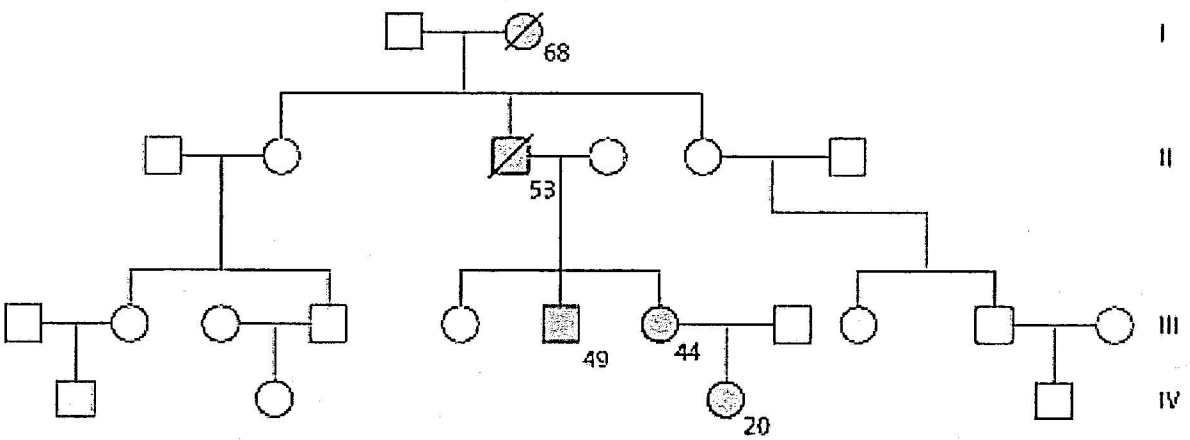
A) tortoiseshell females; tortoiseshell males

B) black females; orange males

C) tortoiseshell females; black males

D) orange females; black males

11) The figure shows a family's pedigree. Dark-shaded symbols represent individuals with one of the two significant types of colon cancer. Numbers under the symbols indicate the individual's age at diagnosis. Males are represented by squares and females by circles.



Based on this pedigree, this trait is most likely inherited _____.

A) by older individuals

B) as a recessive trait

C) because of epistasis

D) as a dominant trait

12) A phosphorescent red strain of bacteria is heat-killed and mixed with a living, colorless strain. Further observations of the mixture show that some living cells are now red. Which observations would provide the best evidence that red color is a heritable trait?

A) exceptionally bright red color in some members of the living strain

B) as the living cells divide, the number of red cells increases

C) when the heat-killed and living cells are mixed, there is a decrease in the overall amount of red color

D) after a few generations, there are no more colorless cells. All cells are red

13) RNA is single-stranded, can hydrogen bond with other nucleic acids, and has functional groups that can function in catalysis. These characteristics support the idea that RNA could have which of the following cellular roles?

A) tagging proteins for degradation by lysosomes

B) targeting proteins for secretion

C) forming scaffolds for ribosome attachment

D) forming peptide bonds

14) Within a cell, the amount of protein made using a given mRNA molecule in that cell depends partly on _____.

A) the degree of DNA methylation

B) the rate at which the mRNA is degraded

C) the number of introns present in the mRNA

D) the types of ribosomes present in the cytoplasm

15) Which of the following best explains the inability of bacteria to correctly express the protein products of a plasmid containing an unmodified mammalian gene?

A) prokaryotes use a different genetic code from that of eukaryotes

B) bacteria translate only mRNAs that have multiple messages

C) bacteria cannot remove eukaryotic introns

D) bacterial RNA polymerase cannot make RNA complementary to mammalian DNA

16) Which of the following describes an advantage of establishing and using a human reference genome in a bioinformatics investigation?

A) It represents the entire genome of one individual who acts as a standard for comparison.

B) It is continuously revised as new data are collected and represents current consensus.

C) Filling in the remaining gaps would be more work than worth, so the reference has been set.

D) "Next generation" sequencing efforts can be used to see if their output is correct.

17) Some beetles and flies have antler-like structures on their heads, much like male deer. The existence of antlers in beetle, fly, and deer species with intense male-male competition is an example of which of the following?

A) convergent evolution

B) similarity due to shared ancestry

C) homology

D) parsimony

18) Which of the following situations leads to microevolution?

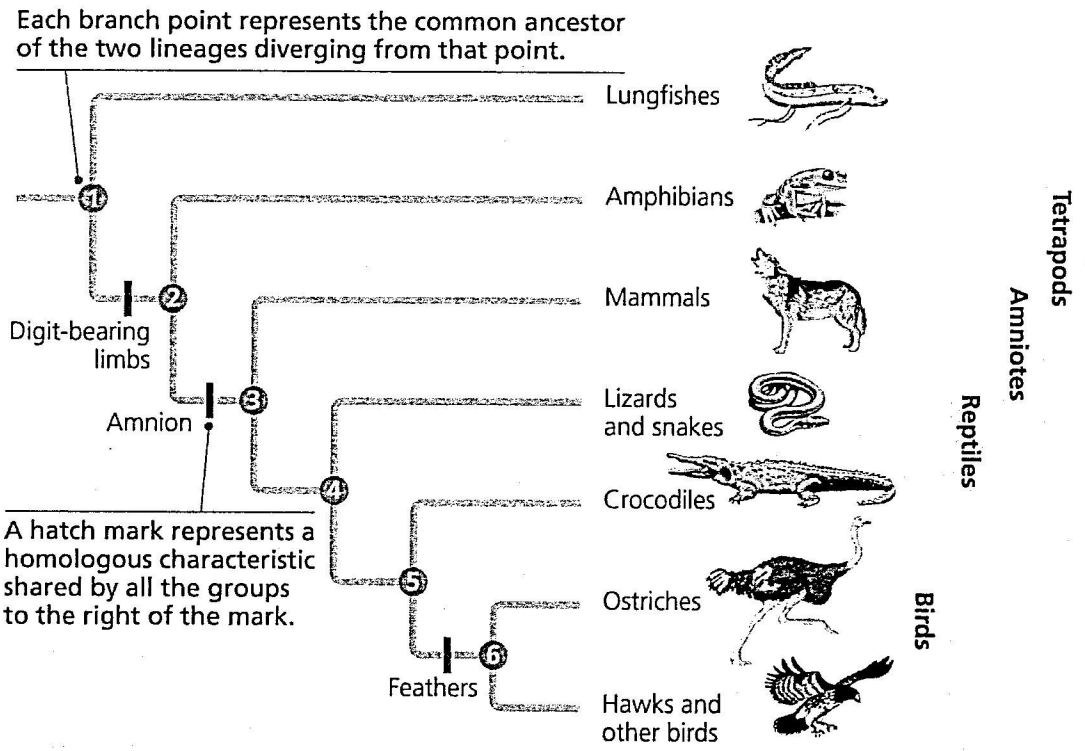
A) An individual bird has a beak of a particular size that grows larger during a drought.

B) Mutations in muscle cells are transferred to the next generation.

C) Alleles move between populations that differ in allele frequencies.

D) All individuals within a population have the same allele at a particular locus.

19) Use the diagram to answer the following question.



Which of the following conclusions is consistent with the information in the evolutionary tree?

A) The amnion occurs in mammals, birds, and lizards.

B) Amnion occurs in all organisms with digit-bearing limbs.

C) The amnion is a membrane that surrounds developing embryos.

D) Feathers contribute to temperature regulation in birds.

20) Bird guides once listed the myrtle and Audubon's warbler as distinct species. Recently, these birds have been classified as eastern and western forms of a single species, the yellow-rumped warbler. Which of the following pieces of evidence, if true, would be cause for this reclassification?

A) The two forms often interbreed in nature, and their offspring survive and reproduce well.

B) The two forms live in similar habitats and have similar food requirements.

C) The two forms have many genes in common.

D) The two forms are very similar in appearance.

21) In 2013, researchers constructed a vesicle that could copy a template strand of RNA. Which of the following best states the significance of this evidence concerning the abiotic origin of life?

A) On early Earth, such vesicles could increase in abundance more than vesicles that could not copy a template strand of RNA.

B) On early Earth, such vesicles were better able to acquire energy than vesicles that could not copy a template strand of RNA.

C) This experimental achievement demonstrated that RNA is a more chemically stable information repository than DNA.

D) This experimental achievement proved that such vesicles could produce daughter protocells.

22) Which of the following statements best supports the argument that viruses are nonliving?

A) They do not carry out metabolic processes.

B) Their DNA does not encode proteins.

C) They have RNA rather than DNA.

D) They do not evolve.

23) Jams, jellies, preserves, honey, and other foods with high sugar content hardly ever become contaminated by bacteria, even when the food containers are left open at room temperature. Which of the following statements best explains the inability of bacteria to survive in such an environment?

A) they undergo death as a result of water loss from the cell

B) they are unable to metabolize the glucose or fructose and thus starve to death

C) they are obligate anaerobes

D) they are unable to swim through these thick and viscous materials

24) According to the endosymbiotic theory, it was adaptive for the larger host cell to keep the engulfed cell alive rather than digesting it as food because _____.

A) the engulfed cell provided the host cell with adenosine triphosphate (ATP)

B) the engulfed cell provided the host cell with carbon dioxide

C) the engulfed cell allowed the host cell to metabolize glucose

D) the host cell was able to survive anaerobic conditions with the engulfed cell alive

25) Which description of the plant cell expansion is WRONG?

A) It is driven by the cell's ability to take up water by osmosis

B) It is regulated by the orientation of cellulose microfibrils in the cell wall

C) It is regulated by the mechanical properties of the cell wall

D) The plant hormone auxin regulates it.

E) It is inhibited by apoplastic acidification.

26) Which description of the plant vacuole is WRONG?

A) It participates in the generation of turgor pressure.

B) Vacuolar acidification requires the combined activity of vacuolar ATPase and vacuolar H+-PPase.

C) It occupies more than 70% of the cellular volume of plant cells.

D) It is a degradative site for secondary metabolites.

E) It allows plants to adapt to the fluctuating availability of essential nutrients.

27) Physcomitrella patens is a non-vascular plant commonly referred to as:

(A) mosses

(B) liverworts

(C) hornworts

(D) ferns

(E) gymnosperm

28) Which description of the plant hormone auxin is WRONG?

A) Polar auxin transport requires energy and contributes to many critical auxin-dependent responses.

B) Polarly localized proteins are required for polar auxin transport.

C) Auxin entry into plant cells is mediated by diffusion or active uptake via an uptake carrier.

D) Auxin modulated initiation of lateral roots.

E) Auxin works synergistically with jasmonic acid to promote xylem differentiation.

29) Genetic diversity within plant species can be decreased due to

A) artificial selection by humans based on phenotypic traits

B) natural selection

C) transgenic technologies or chemical/physical mutagens

D) CRISPR technologies

E) propagation of plants with self-incompatibility

30) Which of the following is the cell of connective tissue?

A) neurons

B) fibroblasts

C) epithelial cells

D) astrocytes

31) Which of the following is an example of negative feedback control?

A) During birthing contractions, oxytocin (a hormone) is released and acts to stimulate further contractions.

B) When a baby is nursing, suckling produces more milk and a subsequent increase in the secretion of prolactin (a hormone that stimulates lactation).

C) After a blood vessel is damaged, signals are released by the damaged tissues that activate platelets in the blood. These activated platelets release chemicals that activate more platelets.

D) When the glucose level in the blood increases, the pancreas produces and releases the hormone insulin. Insulin acts to decrease blood glucose. As blood glucose decreases, insulin production and release rate decreases.

32) The temperature-regulating center of vertebrate animals is located in the _____.

A) hippocampus

B) hypothalamus

C) anterior pituitary gland

D) posterior pituitary gland

33) Stomach cells are well adapted to the acidity environment and protein-digesting activities by having _____.

A) a sufficient colony of *H. pylori*

B) a thick, mucous secretion covering the stomach wall

C) a high level of secretion of enzymes by chief cells

D) a cell wall impermeable to acid

34) Which of the following develops the most significant pressure on the blood in the mammalian aorta?

A) systole of the left atrium

B) diastole of the right ventricle

C) systole of the left ventricle

D) diastole of the right atrium

35) Which of the following is NOT a role of antibody in immunity?

A) neutralizes virus by blocking its ability to bind to a host cell

B) increases phagocytosis by macrophages through binding to the bacterial surface

C) activates the complement system

D) promotes the formation of immune memory cells

36) Which of the following mechanisms are used to prevent backflow of venous blood?

I) changing the force of heart contraction

II) contraction of smooth and skeletal muscles

III) one-way valves in the vein

IV) change in pressure within the chest cavity during inhalation

A) I, II, and III

B) II, III, and IV

C) I, III, and IV

D) only I and IV

37) Treating an oocyte with a chemical that binds calcium and magnesium ions will block _____.

A) the acrosomal reaction

B) fusion of sperm and egg nuclei

C) the fast block to polyspermy

D) formation of the fertilization envelope

38) Which statement about human reproduction is false?

A) Fertilization occurs in the oviduct.

B) Spermatogenesis and oogenesis require different temperatures.

C) An oocyte completes meiosis after a sperm penetrates it.

D) The earliest stages of spermatogenesis occur closest to the lumen of the seminiferous tubules.

39) Which of the following species should natural selection favor the highest proportion of juxtamedullary nephrons?

A) a river otter

B) a mouse species living in a temperate broadleaf forest

C) a mouse species living in a desert

D) a beaver

40) Which of the following is the most likely explanation for hypothyroidism in a patient whose iodine level is normal?

A) more excellent production of T_3 than of T_4

B) hyposecretion of TSH

C) hypersecretion of MSH

D) a decrease in the thyroid secretion of calcitonin

41) Which of the following describes a similarity between fungi and arthropods?

A) The haploid state is dominant in both groups.

B) Both groups are predominantly autotrophs that produce their food.

C) Both groups use chitin for support.

D) Both groups have cell walls.

42) As you are walking along a beach, you find an animal and believe that it belongs to the class Asteroidea. Which characteristics would support your hypothesis that the animal is a sea star, not another type of echinoderm?

A) It is radially symmetric.

B) It feeds on other animals.

C) It has a hydrostatic skeleton formed from its water vascular system.

D) it has five or more appendages.

43) Use the table to answer the following question.

Organism	Appearance	Habitat/Activity	Nutrient Acquisition	Reproduction
A	Microscopic, unicellular, with a flagellum	Swims around in freshwater pools	Envelops and consumes other microscopic organisms	Mates with others; young bud off
B	Shaped like a basketball, covered with purple filaments, multicellular	Rolls slowly across grassy fields	Thrives with access to only freshwater and sunlight	Mates with others; young emerge from hardened spherical structures
C	Hard and branched, multicellular, covered in a sticky coating	Attached to rocky surfaces	Traps insects in sticky coating and ingests them	No mating; releases winged young that fly off and affix to bare rocks
D	Multicellular with cell walls	Mostly sessile	Absorption from the environment	Disperses spores ballistically

A researcher studies animals on a previously undiscovered island, home to many unfamiliar organisms, and decides to survey them using the research equipment. The researcher observes them in detail and makes the notations shown in the table.

Which organism would you classify as an animal?

A) organism A
B) organism B
C) organism C
D) organism D

44) Which of the following could be considered the most recent common ancestor of living tetrapods?

A) a sturdy-finned, shallow-water lobe-fin whose appendages had skeletal supports similar to those of terrestrial vertebrates

B) an armored, jawed placoderm with two pairs of appendages

C) an early ray-finned fish that developed bony skeletal supports in its paired fins

D) a salamander that had legs supported by a bony skeleton but moved with the side-to-side bending typical of fishes

45) Stem cell transplants may someday be used to treat Parkinson's disease. How could stem cell transplants alleviate the symptoms of Parkinson's disease?

A) by preventing temporal lobe seizures

B) by repairing sites of traumatic brain injury

C) by replenishing missing ion channels

D) by secreting the neurotransmitter dopamine

46) Which sensory distinction is *not* encoded by a difference in neuron identity?

A) white and red

B) red and green

C) loud and faint

D) salty and sweet

47) Which of the following types of sensory signals is brief and can work at night amongst physical obstructions?

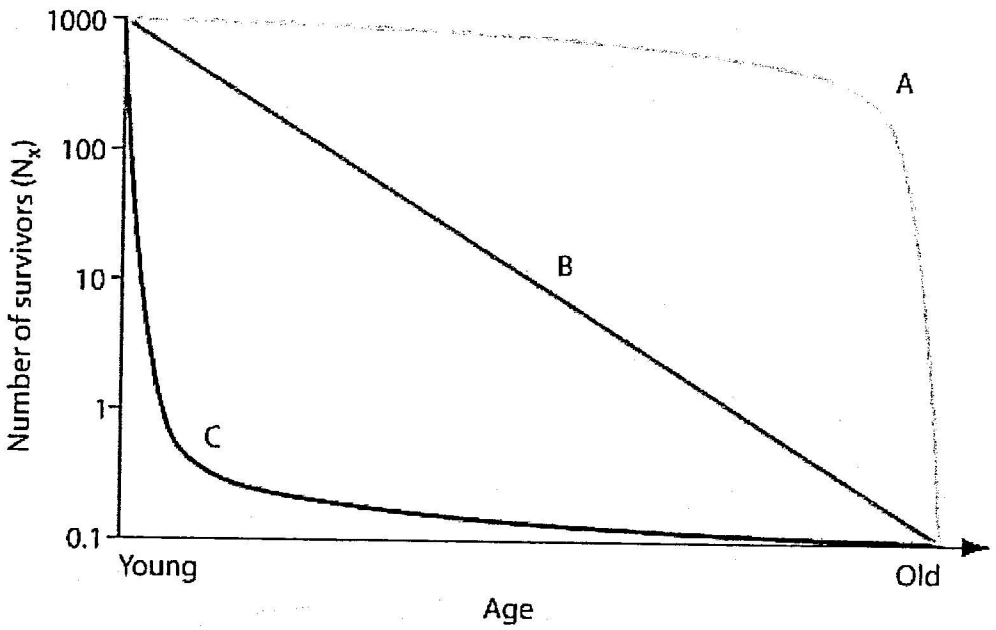
A) olfactory

B) visual

C) auditory

D) magnetic

48) Use the graph to answer the following question.



Which survivorship curve most closely models a population of mice in which females consistently give birth to a large number of offspring, and the mortality rate of the offspring is fairly regular during each year of their lives, regardless of their age?

A) curve A

B) curve B

C) curve C

D) curves A or C

49) The number of bird species is determined mainly by the number of vertical strata in the environment. If so, which biomes would you find the most significant number of bird species?

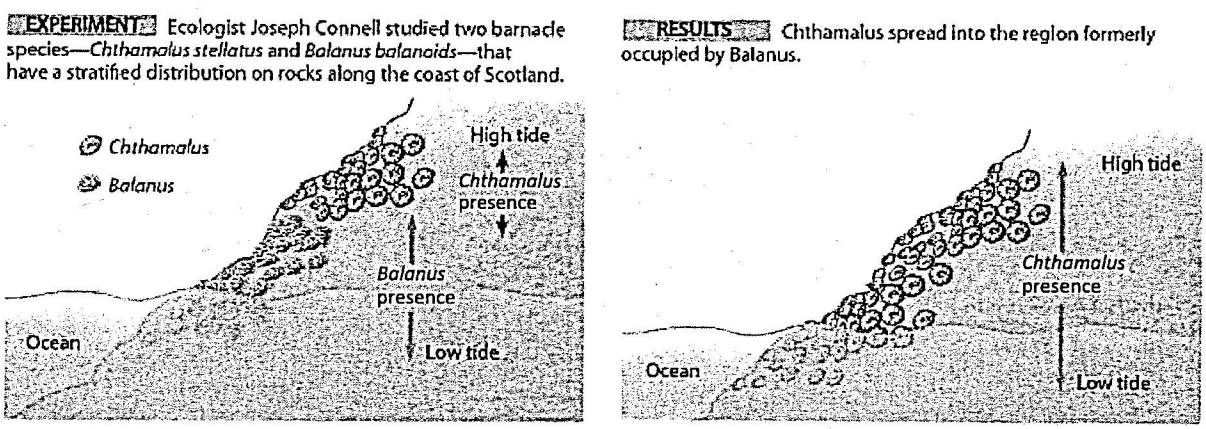
A) tropical rainforest

B) savanna

C) desert

D) temperate broadleaf forest

50) Use the figures to answer the following question.



This experiment removed *Balanus balanoides* (a barnacle species) from the habitat shown on the left. Which of the following statements is consistent with the experimental results (see the diagram on the right)?

A) The fundamental and realized niches of *B. balanoides* and *C. stellatus* are identical.

B) The fundamental and realized niches of *B. balanoides* and *C. stellatus* differ.

C) The fundamental and realized niches of *B. balanoides* are different, but the fundamental and realized niches of *C. stellatus* are identical.

D) The fundamental and realized niches of *C. stellatus* are different.