

17th INTERNATIONAL BIOLOGY OLYMPIAD
9 -16 JULY 2006
Río Cuarto – República Argentina



THEORETICAL TEST

PART B

Student Code:	
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GENERAL INSTRUCTIONS

- Please check that you have the appropriate examination and answer sheets, a calculator, a black pencil, and two pens: a green one and a red one.
- Use the answer sheet provided to record your answers.
- Remember to write down your personal code number on top of the answer sheet.
- **There are different kinds of questions:** in some of them you will have to choose one answer, in this case, you must fill in the corresponding box; in other questions you will have to complete diagrams or in blank spaces.
- In the examination sheets you will find the instructions to complete the answer sheet according to each question.
- Use the pencils provided to complete the answer sheet.
- You have **2 hrs 30 min (150 minutes)** to answer the questions.
- The maximum score is approximately 79 points. The points assigned to each individual question depends on its complexity.

**PLEASE, REMEMBER: THE ACADEMIC COMMITTEE WILL CONTROL ONLY THE
ANSWER SHEET!**

GOOD LUCK IBO COMPETITORS!

17^o INTERNATIONAL BIOLOGY OLYMPIAD
THEORETICAL TEST
PART B

CELLULAR BIOLOGY (13 questions, 15 points)

1- In a laboratory of Molecular Biology, the amino acids sequence of an armadillo intestine protein has been partially determined. The tRNA molecules used in the synthesis have the following anticodons:

3' UAC 5' 3' CGA 5' 3' GGA 5' 3' GCU 5' 3' UUU 5' 3' GGA 5'

Mark the DNA nucleotide sequence of the complementary chain to the DNA chain that encodes for the armadillo intestine protein:

A) 5'-ATG-GCT-GGT-CGA - AAA-CCT-3'.

B) 5'-ATG-GCT-CCT-CGA - AAA-CCT-3'.

C) 5'-ATG-GCT-GCT-CGA - AAA-GCT-3'.

D) 5'-ATG-GGT-CCT-CGA - AAA-CGT-3'.

2- In the eukaryotic cell, the ribosomes that are located in the: cytosol, endoplasmic reticulum, mitochondria and chloroplast carry out the synthesis of specific proteins.

Using the answer code, mark the location of the ribosomes that carry out the synthesis of the detailed proteins:

Answer code:

01. Cytosol.

02. Endoplasmic reticulum.

03. Mitochondria.

04. Chloroplast.

PROTEINS	CODE
A) Fibronectin.	02
B) Lactate deshidrogenase.	01
C) Complex of the cytochrome b ₆ -f.	04
D) Amilase.	02

E) Ribulose biphosphate carboxylase.	04
F) Cytochrome C oxidase.	03
G) Keratin.	01
H) NADH deshydrogenase.	03

3- The nuclear protein DNA polymerase synthesized in the cytoplasmic ribosomes of the cell enters to the nucleus through the nuclear pores by:

- A) passive diffusion through hydrophilic channels.
- B) specific signal sequence of the protein using energy from the ATP hydrolysis.**
- C) receptor -mediated endocytosis.
- D) specific signal sequence of the protein without energy.

4- Using the answer code, specify the characteristics of RNA synthesis, mRNA processing and protein synthesis corresponding.

Answer code:

- 01.** prokaryote.
- 02.** eukaryote.
- 03.** both.

CHARACTERISTIC	CODE
A) A single RNA polymerase catalyzes the synthesis of the three types of RNA.	01
B) The assembly of RNA polymerase at the promoter requires a set of proteins called general transcription factors which must be assembled at the promoter before transcription can begin.	02
C) The structural genes are not contained in operons.	02
D) In the mRNA processing, a methylguanine cap is added to the 5'-end and a poly-A tail to the 3'-end.	02

E) Most of the structural genes contain introns that are separated before the translation.	02
F) The protein synthesis starts even before the transcription has been completed.	01
G) The protein synthesis always starts in free ribosomes in the cytoplasm.	03
H) The degradation rate of the mRNA is regulated by extracellular signs.	02
I) The Shine-Dalgarno sequence in the 5'-end of mRNA recognizes the ribosome and the translation starts.	01

5- In order to investigate protein location either in the cytoplasm or in organelles such as endoplasmic reticula and Golgi bodies, analyses that combine proteinases and surfactants are frequently carried out. As a result of the target protein contacting the proteinase, the former is decomposed and can no longer be detected. Although the proteinase does not act across the biomembrane, this is destroyed by the surfactant.

A fraction containing vesicles enclosed in a biomembrane was obtained by homogenizing and fractionating liver cells. In order to investigate the respective locations of protein A (40 kDa), protein B (50kDa) and protein C (80kDa) contained in this fraction, the following proceedings were performed followed by Western analysis to respectively detect and investigate the molecular weights of proteins A, B and C. (Note: kDa indicates a unit to express the molecular weight of proteins).

Procedure 1: Proteinase K was added followed by warming.

Procedure 2: Surfactant Triton X-100 was added followed by warming.

Procedure 3: Both proteinase K and surfactant Triton X-100 were added followed by warming.

Procedure 4: Only the vesicles were separated by precipitating with ultra-high-speed centrifugation followed by removal of cytoplasm components.

The experiment results are as shown below.

	Procedure 1	Procedure 2	Procedure 3	Procedure 4
Protein A	40 kDa	40 kDa	Not detected	40 kDa
Protein B	Not detected	50 kDa	Not detected	Not detected
Protein C	40 kDa	80 kDa	Not detected	80 kDa

Fill in the blanks using answer code corresponding to the location of each protein:

Answer code:

- 01. Suspended in the cytoplasm.
- 02. Attached to the outside of the vesicle.
- 03. Entrapped inside the vesicle.
- 04. Penetrating the vesicle membrane with one half being exposed on the outside and the other half entrapped inside.
- 05. Cannot be determined from this experiment only.

The protein is present:

	CODE
Protein A	03
Protein B	01
Protein C	04

6- Which of the following combinations among elements of the cytoskeleton and their characteristics is correct:

ELEMENTS OF THE CYTOSKELETON

- I. Microfilaments.
- II. Microtubules.
- III. Intermediate Filaments.

STRUCTURAL AND FUNCTIONAL CHARACTERISTICS

- 01. Polymer of the protein actin.
- 02. Participate in animal cytokinesis.
- 03. Participate in the formation of cilia and flagella.
- 04. Polymer of the protein tubulin.
- 05. Provide mechanical stability to the cell.
- 06. Participate in cellular locomotion.
- 07. Polymer of more than 50 different proteins.
- 08. Form the nuclear lamina.
- 09. Form the mitotic spindle.

	I	II	III
A)	01, 03, 05	02, 04, 08	02, 03, 07
B)	01, 02, 06	03, 04, 09	05, 07, 08
C)	01, 03, 08	03, 04, 05	02, 06, 09
D)	01, 06, 09	02, 04, 07	03, 05, 07

7- Using the answer code, answer which of the following statements about the transport through the plasmatic membrane of the animal cell is correct or incorrect.

Answer code:

01. Correct.

02. Incorrect.

STATEMENT	CODE
A) Steroid hormones are incorporated into the cell by endocytosis.	02
B) Amino acids are incorporated into the cell by simple diffusion.	02
C) Bacteria are incorporated into the cell by phagocytosis.	01
D) Metabolic wastes are incorporated into the cell by endocytosis.	02
E) Ions pass through channel proteins by passive transport.	01
F) Cholesterol is incorporated into the cell as a low-density lipoprotein (LDL) by receptor-mediated endocytosis.	01

G) In the epithelial cells of the intestine, the macromolecules transport from the apical side to the basolateral side is by transcytosis.	01
H) The Na ⁺ / K ⁺ pump transports 3 Na ⁺ into the cell and 2 K ⁺ out of the cell.	02

8- In the following table, some components, processes and structures of mitochondria are presented. Match both columns and identify the correct combination.

<p>01. Porin. 02. Enzymes of mitochondrial RNA synthesis. 03. ATP synthase. 04. Monoamine oxidase. 05. Enzymes of fatty acid oxidation. 06. Coenzyme Q. 07. Enzymes of citric acid cycle.</p>	<p>I. Outer mitochondrial membrane. II. Inner mitochondrial membrane. III. Mitochondrial matrix.</p>
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	I	II	III
A)	02, 06, 07	01, 04, 07	01, 05
B)	01, 05, 06	02, 03	02, 04, 07
C)	01, 04	03, 06	02, 05, 07
D)	02, 05	01, 03, 07	06, 07

9- Statements about prokaryotic and eukaryotic flagellae are:

01. prokaryotic flagellae are covered with membrane.
02. eucaryotic flagellae are rotating.
03. both prokaryotic and eukaryotic flagellae use proton gradient as a direct source of the energy for the movement.
04. prokaryotic flagellae are formed from actin, eukaryotic ones from the tubulin.
05. procaryotic flagellae consist of three parts: the basal body, the hook and the filament.
06. all prokaryotic cells have at least one flagellum.
07. all eukaryotic flagellae are covered with plasma membrane.
08. all functional eucaryotic flagellae contain motor-proteins (dyneins).

09. procaryotic flagellae can rotate only in one direction.

The correct statements are:

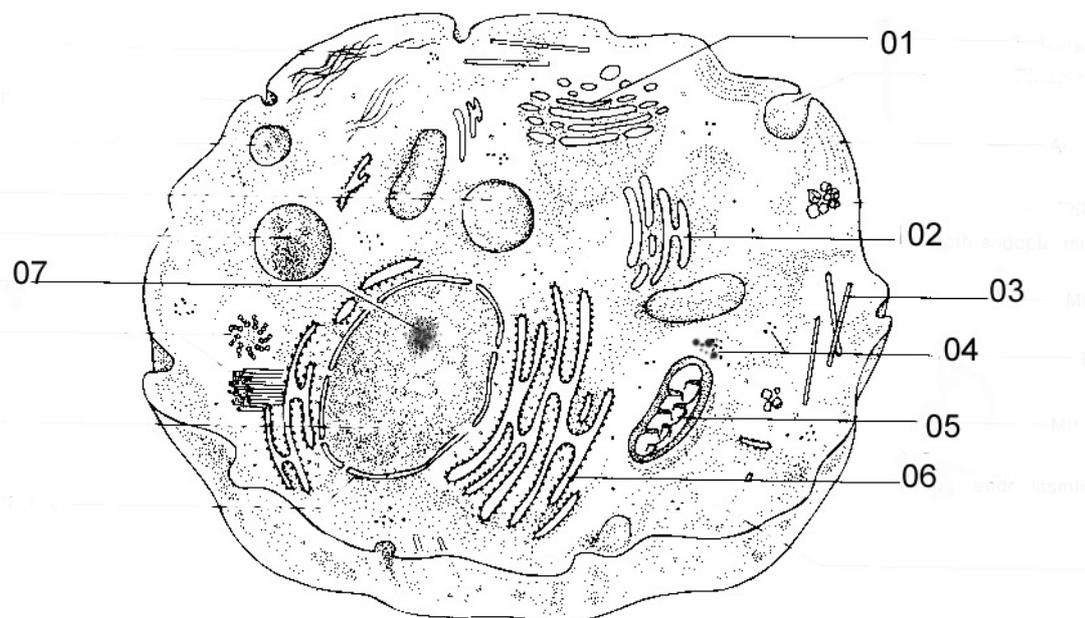
A) 01, 04, 07.

B) 03, 07, 08.

C) 02, 05, 09.

D) 05, 07, 08.

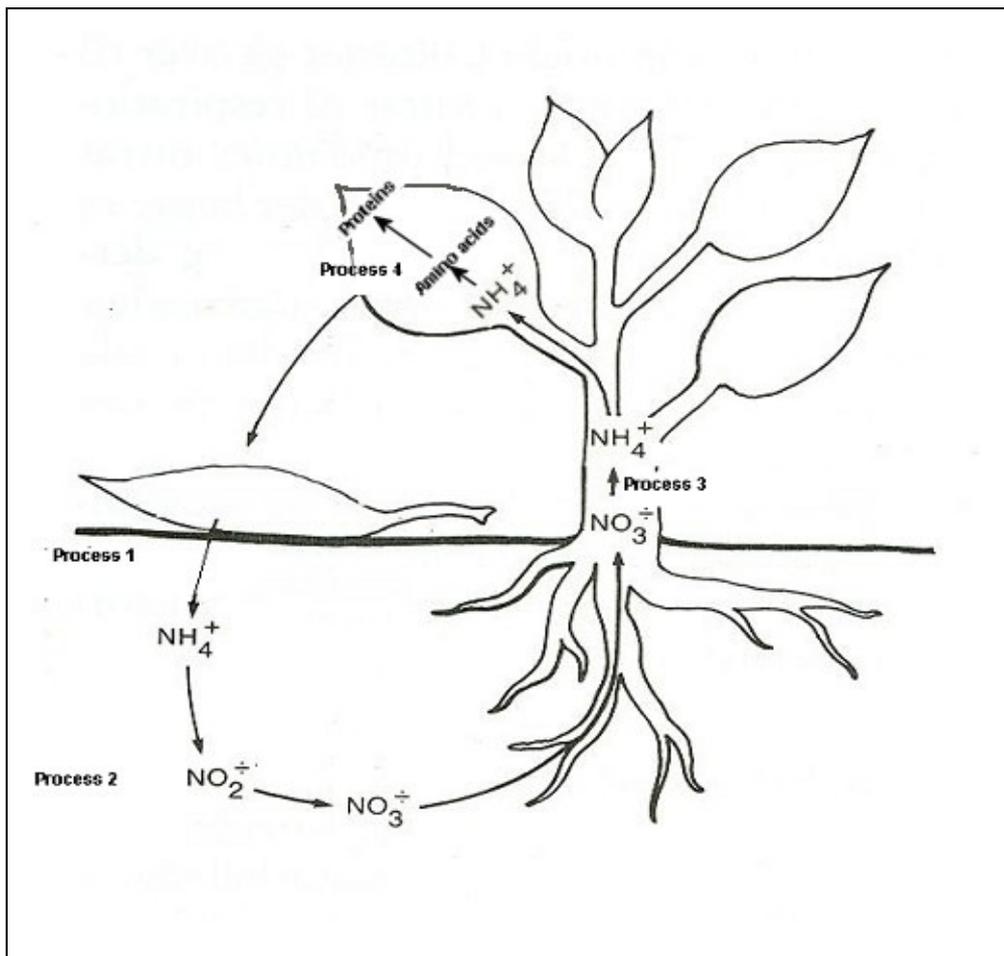
10- Look at the following picture and write down the correct answer code.



view of an animal cell as seen under an

Which of the structures:	CODE
A) is the place where the structures labelled "04" are formed?	07
B) is the place where the glycosylation of proteins and lipids are carried out?	01
C) can form protein not encoded by the nuclear DNA?	05
D) is the structure that maintains the structural integrity of an axon?	03
E) is the most abundant structure in the cytoplasm of the pancreatic acinar cells?	06
F) is the most abundant structure in an insect flight muscle?	05
G) is the place of lipid synthesis?	02

11- The following figure corresponds to the nitrogen cycle. Match the processes numbered 1 to 4 in the figure with the following answer code.



Answer code:

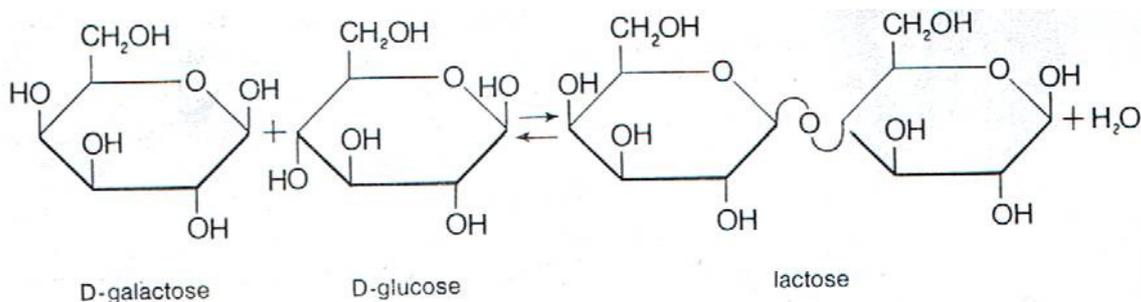
- 01. Ammonifying bacteria.
- 02. Denitrifying bacteria.
- 03. Nitrate reduction.
- 04. Nitrifying bacteria.
- 05. Protein synthesis.

	CODE
Process 1	01
Process 2	04
Process 3	03
Process 4	05

12- Using the answer code, select which of the following statements about carbohydrates and human body are correct or incorrect.

Answer code:

- 01. Correct.
- 02. Incorrect.



STATEMENT	CODE
A) D-Galactose and D-glucose are pentose sugars.	02
B) D-Galactose and D-glucose are optical isomers.	01
C) D-Galactose and D-glucose are aldoses.	01
D) In the human body the reaction from left to right takes place in the duodenum.	02

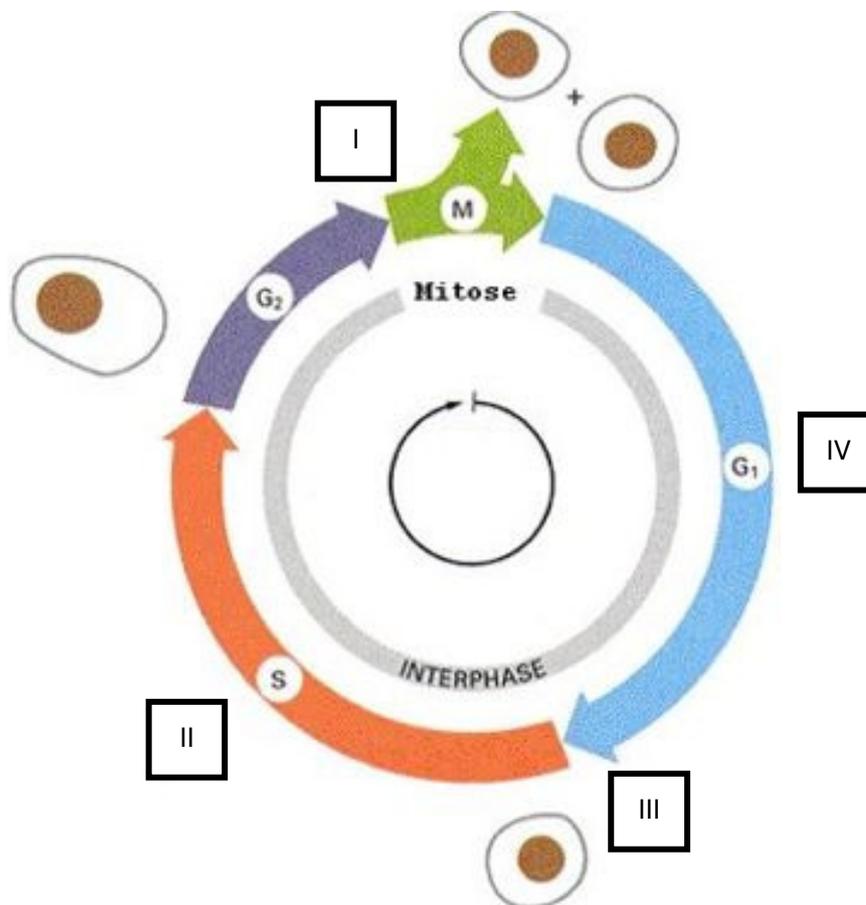
E) In the human body the reaction from left to right takes place in the mammary glands.

01

13- Complete the following diagram by using the answer code. Fill in the blank boxes with the number corresponding to the regulation of the cycle phases.

Answer code:

- I. Cyclin B-Cdk1.
- II. Cyclin A-Cdk2.
- III. Cyclin E-Cdk2.
- IV. Cyclin D- Cdk4.



PLANT ANATOMY AND PHYSIOLOGY (8 questions, 12 points)

The figure in the next page shows the life cycle of a plant.

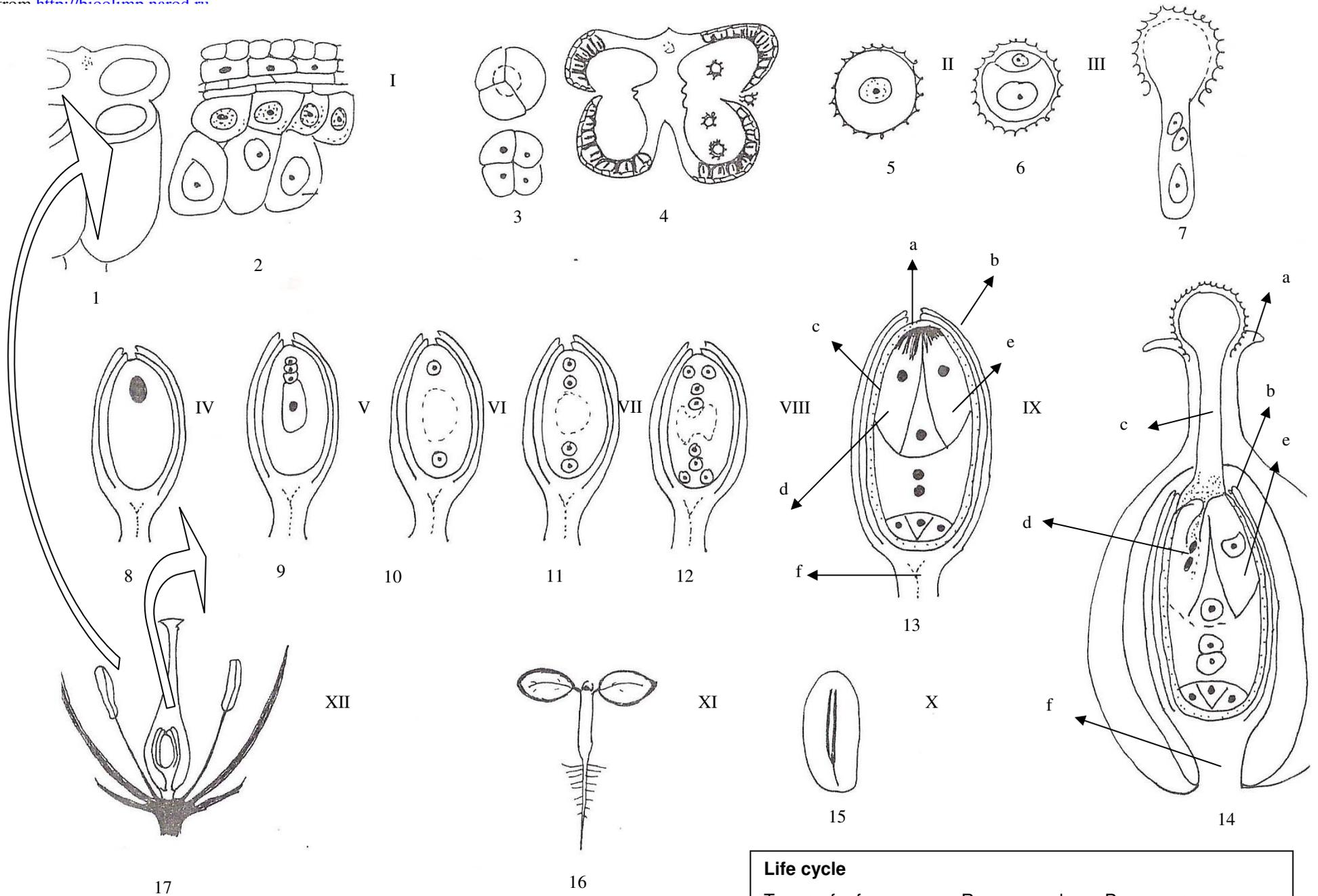
Examine this figure and its captions carefully. Answer questions 14 to 21.

14- This life cycle corresponds to the following taxon:

- A) Bryophyta.
- B) Pinophyta.
- C) Magnoliopsida.**
- D) Liliopsida.

15- Choose and write down the number of the schematic drawing that represents fertilization.

Answer: _____ **14**



Life cycle
 Terms of reference: Roman numerals: Processes
 Arabic numbers: structure
 Letters: Structural Components

16- The following table shows the components that may be parts of the structure you have chosen previously (question 15). Choose the correct option.

	a	b	c	d	e	f
A)	Stigma	Outer integument	Pollen tube	Zygote	Synergid	Funiculus
B)	Pollen tube	Pollen chamber	Ovary	Archegonium	Ovocell	Nucellus
C)	Stigma	Outer integument	Pollen tube	Male gametes	Synergid	Funiculus
D)	Pollen chamber	Synergid	Stigma	Funiculus	Archegonium	Outer integument
E)	Style	Synergid	Stigma	Zygote	Outer integument	Antipodal cells

17- Which of the following statements associated with this life cycle is incorrect?

- A) The anther endothecium develops into the fibrous layer.
- B) The megaspores are arranged in one row and, generally, three of them degenerate.
- C) The mature male gametophyte consists of three cells resulting from two meiotic divisions.**
- D) The seed develops from the ovule.
- E) The embryo constitutes a partially developed young sporophyte.

18- It may be reasonable to conclude that the species that shows the life cycle represented in this figure have the following pool of characteristics:

Answer code:

- 01.** Naked seed.
- 02.** Protected seed.
- 03.** Winged seed.
- 04.** Exalbuminous seed.
- 05.** Perfect flower.
- 06.** Imperfect flower.

- 07. Free pollen grains.
- 08. Pollinium.
- 09. Anatroous ovule.
- 10. Orthotropous ovule.
- 11. Gametophyte generation.
- 12. Sporophyte generation.
- 13. Two alternating generations.
- 14. Hypogeal germination.
- 15. Epigeal germination.

Write down the correct combination of characteristics.

Answer: _____ **02, 05, 07, 10, 13, 15.**

19- Observe the parts of the life cycle that correspond to processes occurring in the ovule before fertilization and paint the corresponding boxes in which mitosis occurs.

I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII

20- Suppose that the plant corresponding to this cycle, besides producing seeds, can reproduce asexually through stem pieces or slips. Which of the following plant hormones would you choose to improve rooting?

- A) Gibberellins.
- B) Cytokinins.
- C) Ethylene.
- D) Auxins.**
- E) Abscisic acid.

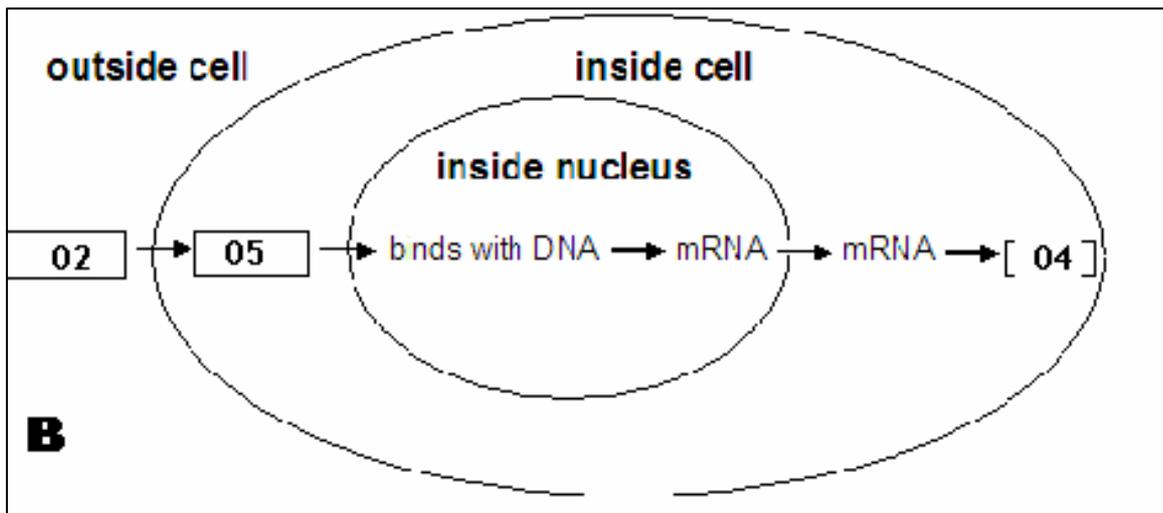
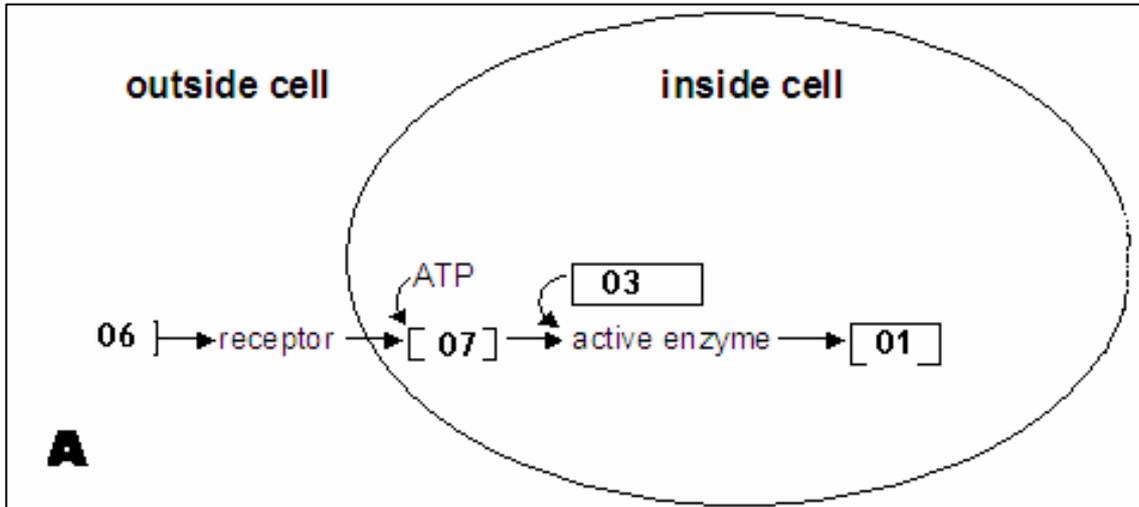
21- In the following table nine mineral elements essential to the plant whose life cycle is represented in the figure are listed. Match both columns and identify the correct combination.

01. Calcium. 02. Potassium. 03. Iron. 04. Nitrogen. 05. Magnesium. 06. Molybdenum. 07. Phosphorus. 08. Zinc. 09. Sulfur.	I. Macronutrients II. Micronutrients
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	I	II
A)	02, 04, 05, 07, 09	01, 03, 06, 08
B)	02, 04, 07, 09	01, 03, 05, 06, 08
C)	01, 02, 04, 05, 09	03, 06, 07, 08
D)	01, 02, 04, 05, 07, 09	03, 06, 08
E)	01, 02, 03, 04, 07	05, 06, 08, 09

ANIMAL ANATOMY AND PHYSIOLOGY (9 questions, 16 points)

22- Diagrams A and B correspond to the mechanisms of hormonal action. Complete them by filling in the boxes with the answer codes.



Answer code:

- 01. chemical reaction.
- 02. steroid hormone.
- 03. inactive enzyme.
- 04. protein.
- 05. receptor.
- 06. peptide hormone.
- 07. cyclical AMP.

23- Complete the following table about the chemical nature of the hormones by using the codes below:

Answer code:

- 01. Peptides or proteins.
- 02. Derivatives of amino acids.
- 03. Fatty acid derivatives.
- 04. Steroid.

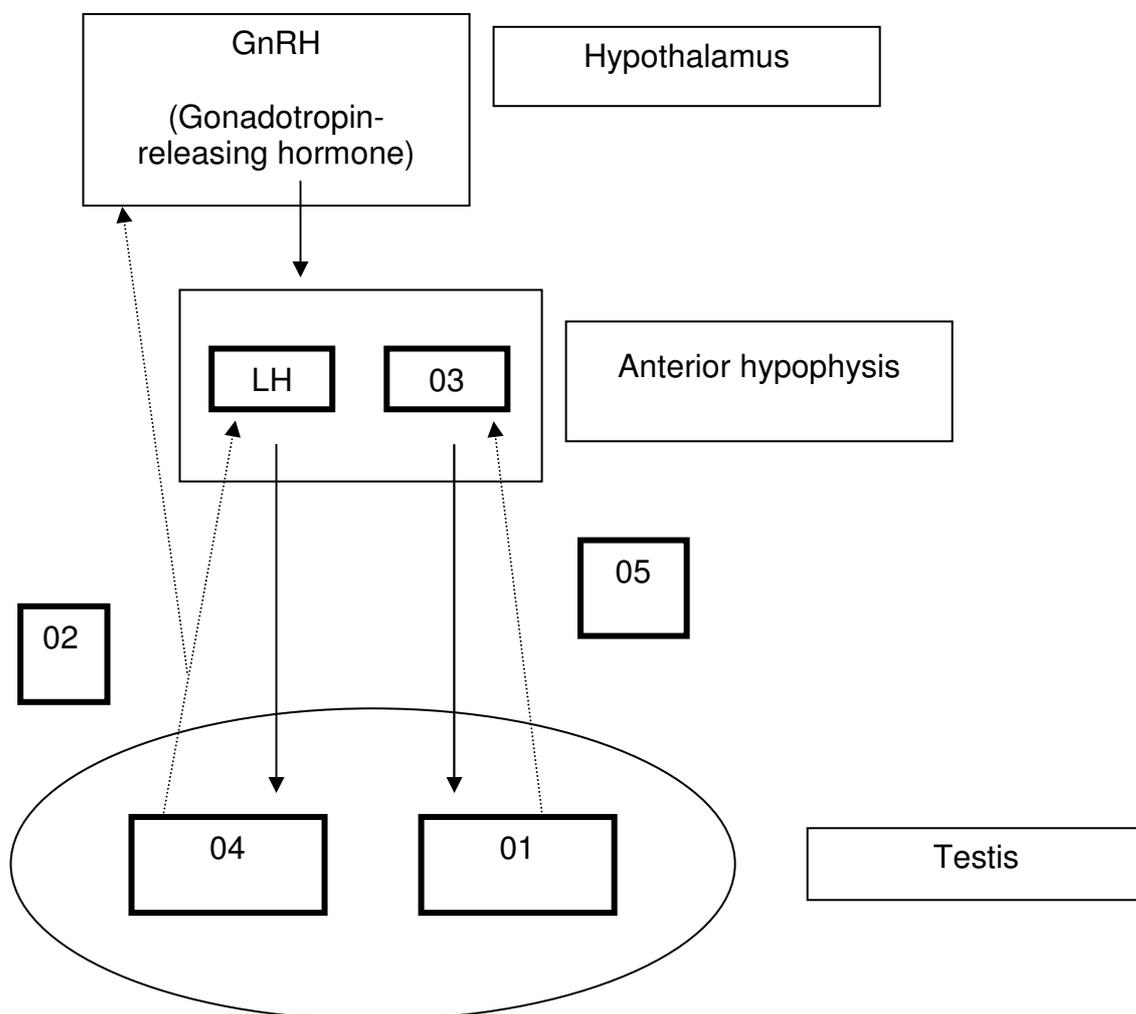
HORMONE	CODE
A) Progesterone	04
B) Insulin	01
C) FSH (Follicle-stimulating hormone)	01
D) LH (Luteinizing hormone)	01
E) Prolactin	01
F) Oxytocin	01
G) Estrogen	04
H) Testosterone	04
I) ACTH (Adrenocorticotropic hormone)	01
J) ADH (Antidiuretic hormone or vasopressin)	01

24- The following figure shows the interactions between the hypothalamus, the anterior hypophysis and the male gonades. The full arrows (→) indicate excitatory effects and the dotted arrows (⋯→) indicate inhibiting effects.

Complete the boxes in the figure by using the corresponding code.

Answer code:

- 01. Sertoli cell.
- 02. Testosterone.
- 03. FSH - Follicle-stimulating hormone.
- 04. Leydig Cells.
- 05. Inhibin.



25- 48 hours after beginning a hyposodic diet, the renal and hormonal conditions of a person are controlled. Which combination of the following conditions does the patient display? Select the correct answer.

Reference signs:

+: increase.

-: decrease.

=: no changes.

	Aldosterone in plasma	ADH in plasma	Na ⁺ reabsorption	Water reabsorption
A)	+	+	+	+
B)	-	-	-	-
C)	+	-	+	=
D)	+	=	=	=
E)	+	-	+	-

26- Next of each kind of receptor, write down the answer code of the corresponding structure.

	CODE
Mechanoreceptor	02, 05, 07, 08
Chemoreceptor	01, 03
Photoreceptor	04, 06

Answer code:

- 01.** Gustatory papillae.
- 02.** Crustacean statocysts.
- 03.** Gustatory hairs in flies.
- 04.** Vertebrate retina.
- 05.** Muscle splindle.
- 06.** Arhtropod omatidium.
- 07.** Diptera halteres.
- 08.** Labyrinth of vertebrate ear.

27- Determine to what kind of muscular tissue corresponds each one of the following sets of characteristics. Write the correct answer codes in the corresponding box.

Muscular kind \ Characteristics	02	03	01
Fibre shape	Elongated, cylindrical, blunt ends	Elongated, spindle-like, pointed ends	Elongated, cylindrical, branched, fibres fuse to each other
Number of nuclei per fibre	Many	One	One or two
Nucleus location	Peripheral	Central	Central
Contraction speed	Very fast	Very slow	Intermediate

Answer code:

- 01. cardiac muscle.
- 02. skeletal muscle.
- 03. smooth muscle.

28- The volume of blood pumped by each ventricle during a beat is known as systolic volume. If it is multiplied by the number of beats per minute, the product is the cardiac cost.

Cardiac cost = systolic volume X cardiac frequency

Which is the cardiac cost (volume of blood pumped by each ventricle in a minute) of an adult person in rest whose heart beats 72 times per minute and pumps 70 millilitres of blood in each contraction?

Answer code:

A) 3 l/min.

B) 5 l/min.

C) 10 l/min.

D) 7 l/min.

29- The cardiac frequency can increase or diminish under the influence of several factors. Complete the column on the right by writing a (+) sign if the factor increases the cardiac frequency and a (-) sign if the factor diminishes it.

FACTOR	SING
A) Hypoxia	+
B) Exhalation	-
C) Fever	+
D) Excitation	+
E) Inspiration	+
F) Exercise	-

30- The following diagram shows some of the factors that influence the cardiac capacity. Complete the blank boxes by using the answer code.

Answer code:

01. Cardiac frequency.

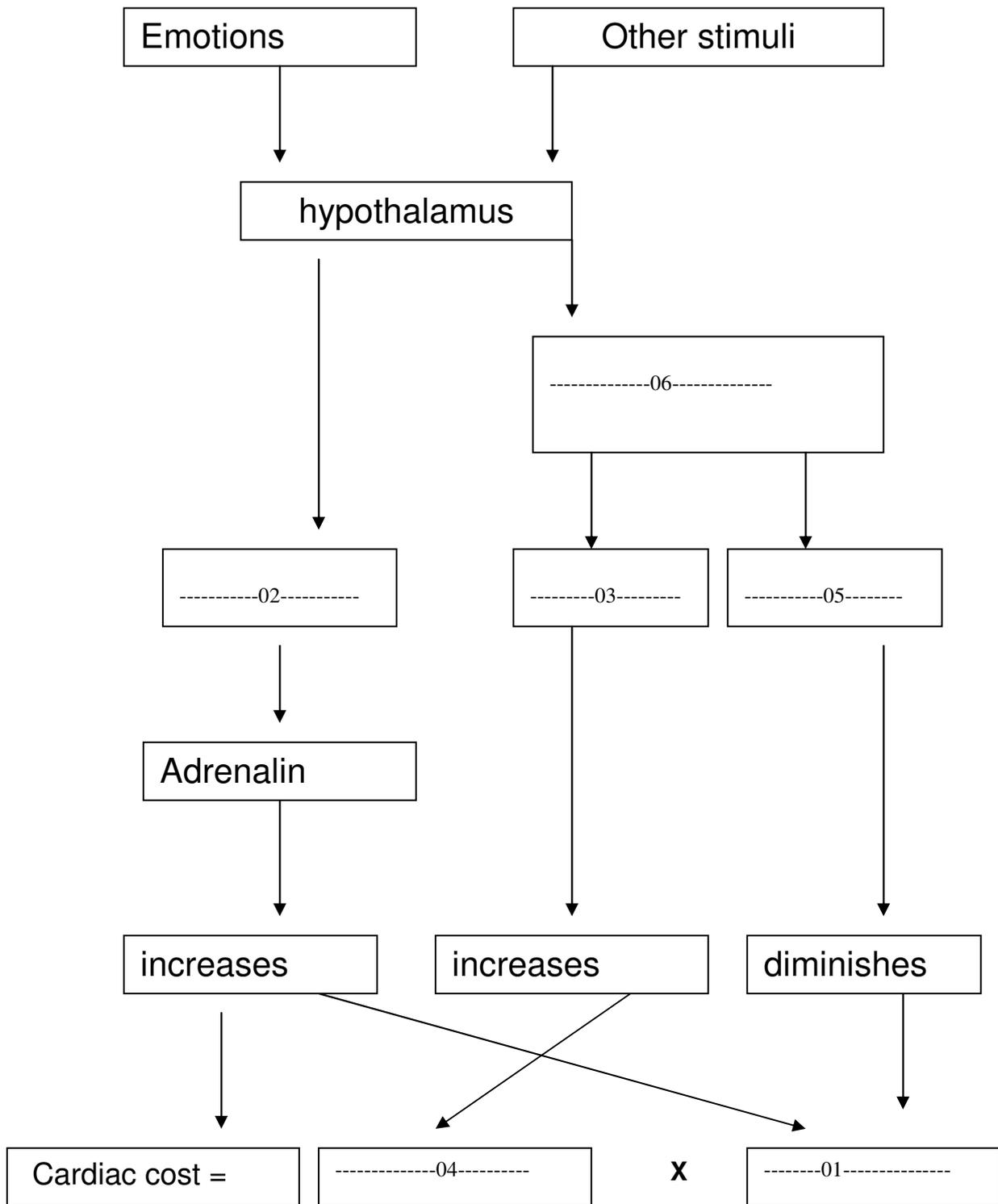
02. Suprarrenal glands.

03. Sympathetic nerves.

04. Systolic volume.

05. Parasympathetic nerves.

06. Cardiac centre in the medula oblongata.



GENETICS (12 questions, 14 points)

**** In a butterfly species, the wing colour is determined by a locus with three alleles: C (black wings) $>$ c^g (grey wings) $>$ c (white wings). In a survey of a large population living in Río Cuarto, the following frequencies were obtained: $C = 0.5$; $c^g = 0.4$, and $c = 0.1$.**



31- If the butterflies continue to mate randomly, the frequencies of black-winged, grey-winged, and white-winged butterflies in the next generation will be:

	Black wings	Grey wings	White wings
A)	0.75	0.24	0.01
B)	0.75	0.15	0.1
C)	0.24	0.75	0.01
D)	0.83	0.16	0.01

32- If the population consists of 6,500 butterflies, how many butterflies of each phenotype will there be?

	Black wings	Grey wings	White wings
A)	3656	374	2470
B)	4875	1560	65
C)	3595	1040	65
D)	4875	156	1469

**** A small group of butterflies of the Río Cuarto population flies to an isolated neighboring site in Las Higueras, and starts a new population. After several generations, there is a large randomly mating population of butterflies in which the following phenotypic frequencies are observed:**

PHENOTYPE	FREQUENCY
black wings	0.00
grey wings	0.75
white wings	0.25

33.a- The allelic frequencies for **C** (black wings), **c^g** (grey wings), and **c** (white wings) under Hardy-Weinberg equilibrium are:

	C	c^g	c
A)	0.25	0.50	0.25
B)	0.00	0.75	0.25
C)	0.00	0.50	0.50
D)	0.25	0.25	0.50

33.b- The change in the allelic frequencies in this population as compared to the original one is an example of:

- A) migration.
- B) selection.
- C) bottleneck effect.
- D) founder principle.**

34- A group of birds migrates into this isolated site in Las Higueras. As the birds find it easier to spot and catch the white-winged butterflies, the relative fitness of the white-winged is reduced to 0.2.

Phenotype	Relative fitness
grey wings	1
white wings	0.2

What will the genotypic frequencies be after one generation of selection?

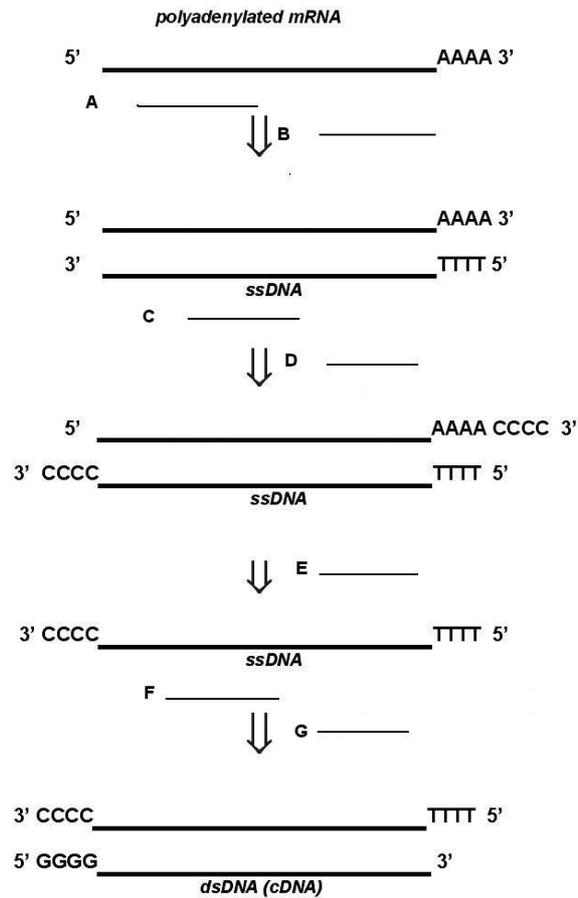
	$c^g c^g$	$c^g c$	cc
A)	0.3125	0.625	0.0625
B)	0.25	0.5	0.05
C)	0.25	0.5	0.2
D)	0.263	0.526	0.211

**** Human lactoferrin (hLf) is an 80kD monomeric glycoprotein originally found in milk that confers antibacterial and iron transport properties to humans. A group of scientists decided to generate transgenic tobacco plants expressing hLf cDNA (complementary DNA).**

35- In order to prepare a cDNA library in *Escherichia coli*, total cellular RNA was extracted from human mammary gland and the mRNA was isolated. Then, they converted the mRNA into cDNA. Look at the following figure, and employing the answer code, determine the correct order of steps (A-G) to obtain cDNA.

Answer code:

01. C bases added to 3' end.
02. Add terminal transferase + dCTP.
03. Add reverse transcriptase + 4 dNTPs + oligo dT primer (TTTT).
04. Second DNA strand synthesized from GGGG primer to 3' end.
05. ssDNA strand synthesized from TTTT primer to 3' end.
06. hydrolyzed RNA leaving DNA.
07. Add DNA polymerase + 4 dNTPs + oligo-dG primer (GGGG).



Answer: _____ **03, 05, 02, 01, 06, 07, 04.**

36- The scientists constructed a cDNA library in a lambda vector. They chose a lambda vector instead of a plasmidic vector because lambda vectors:

- I. can be packaged *in vitro*.
- II. can accommodate larger DNA foreign fragments than plasmid vectors.
- III. don't have to be cut with restriction enzymes.
- IV. are introduced in *Escherichia coli* cells by transformation.
- V. are introduced in *Escherichia coli* cells by infection.
- VI. carry antibiotic-resistance genes.
- VII. lambda libraries are easier to screen.
- VIII. lambda vectors form larger colonies.

Select the combination of the correct options:

A) I, II, VII.

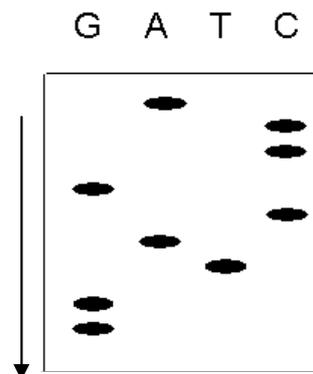
- B) III, V, VI.
- C) II, IV, VIII.
- D) I, II, V.**

37- They identified in the library the cDNA clone encoding *hLf* using the sequence of the *hLf* gene (with a chemical label) as a probe. The screening procedure employed was:

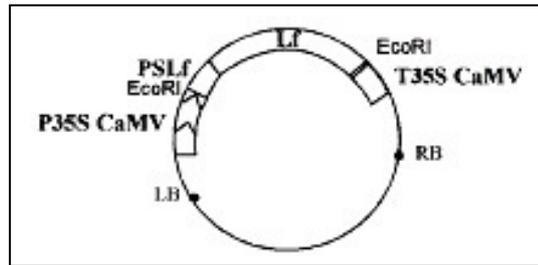
- A) Southern hybridization.
- B) colony hybridization.
- C) Northern hybridization.
- D) plaque hybridization.**
- E) immunological.

38- Once the desired cDNA clon was identified, the scientists isolated and sequenced the insert in order to be sure it was the *hLf* cDNA. Deduce the nucleotide sequence of the original strand of this small fragment sequenced with the dideoxi method.

- A) 5' TGGCTACC 3'.**
- B) 3' TGGCTACC 5'.
- C) 5' ACCGATGG 3'.
- D) 3' ACCGATGG 5'.



39- As the sequencing confirmed it was the *hLf* cDNA, they inserted it into the *EcoRI* site of a plasmid. The plasmid contained: a) the wild type of *hLf* coding sequence including its signal peptide (PSLf) under the control of the 35S strong promoter and the 35S terminator of the cauliflower mosaic virus, and b) the left (LB) and right (RB) borders of T-DNA. It was transformed into *E. coli* and then transferred to *Agrobacterium tumefaciens* by conjugation.



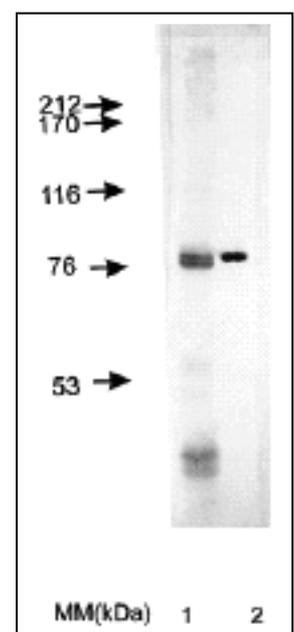
The promoter sequence of the cauliflower mosaic virus was necessary because:

- A) they wanted to sequence the *hLf* cDNA again.
- B) they wanted to express the *hLf* gene throughout the biomass of the transgenic tobacco plant.**
- C) they wanted to express the *hLf* gene in the cauliflower as well.
- D) without a promoter the gene does not replicate.

40- Discs of tobacco (*Nicotiana tabacum*) leaves were infected with recombinant *Agrobacterium tumefaciens*. To determine which tobacco plants were transgenic, the scientists performed:

- A) a Western blot analysis.
- B) a Northern blot analysis.
- C) a Southern blot analysis.**
- D) *in situ* hybridization.

41- Twenty tobacco transgenic plants were screened for the expression of the *hLf* gene: 1g of fresh weight of transgenic leaf tissue was ground in liquid nitrogen and total soluble proteins were extracted. The following figure shows the Western analysis of the total soluble protein extract from transgenic leaves (1. concentrated protein extract; 2. milk hLf. The position of protein standards is shown on the left). The blot was:



- A) immunostained with anti-milk hLf antibodies.**
- B) hybridized with *hLf* mRNA.
- C) hybridized with the cDNA encoding human lactoferrin.
- D) hybridized with the *EcoRI* fragment containing the *hLf* cDNA.

42- After the transformation of tobacco (*N. tabacum*) with a human lactoferrin cDNA under the control of the 35S promoter from cauliflower mosaic virus, using *A. tumefaciens*-based gene transfer, the authors **concluded that**:

- I. it leads to the production of full-length 80-kDa hLf transgenic plants.
- II. the human lactoferrin obtained is different from the hLf produced by human mammary gland.
- III. the human lactoferrin obtained is not a monomeric glycoprotein.
- IV. transgenic plants are able to produce human lactoferrin.
- V. the transgenic tobacco plants produce milk with human lactoferrin.
- VI. the tobacco hLf protein produced, presents a molecular mass closely identical to the native protein.
- VII. carbohydrate compositions of tobacco hLf and milk hLf are the same.
- VIII. the human lactoferrin obtained confers antibacterial and iron transport properties to humans.

Select the correct combination of options:

- A) I, IV, VI.**
- B) I, V, VII.
- C) III, IV, VIII.
- D) II, V, VIII.

ECOLOGY (7 questions, 12 points)

**** In order to determine the mulitas' (*Dasyopus novemcinctus*) eating habitat, a group of scientists conducted a vegetation survey and compared it with the food remains found in the excrements.**

43- The scientists walked in a straight line through a sunflower and a corn fields, and a natural pasture. They conducted a vegetation census in a 1m² square every 50 metres recording the species diversity, the coverage and the fenological stage. Which of the following techniques were employed?

- I. soil sampling.
- II. systematic sampling.
- III. a graphical presentation of life forms by means of a bar diagram.
- IV. coverage estimation (% of the ground covered by the species).
- V. collection of vegetation biomass.
- VI. use of a transect.
- VII. data classification (species and census).
- VIII. species listing.
- IX. random sampling.

Select the combination of the correct options:

- A) I, III, V, VII.
- B) II, IV, VI, VIII.**
- C) II, V, VI, VIII.
- D) I, II, III, IV.
- E) V, VI, VII, VIII.

**** The results of the samples of the mulitas' excrements (I), of the vegetation in the sunflower field (II), in the corn field (III), and in the natural pasture (IV), are shown below. Column I shows plant remains found in the excrements and in which percentage. In columns II, III and IV, the fenological state and the percentage of coverage of each species are presented. The excrement and vegetation samplings**

were performed at the same time.

Species	I	II	III	IV
Species 1			Fruit, 90%	
Species 2		Fruit, 90%		
Species 3	Epidermis, 100%	Flower, 5%	Flower, 10%	Flower, 2%
Species 4		Flower, 10%	Flower, 6%	Flower, 3%
Species 5	Epidermis, 10%	Vegetative, 6%	Vegetative, 2%	Vegetative, 7%
Species 6		Vegetative, 5%	Vegetative, 20%	
Species 7			Vegetative, 8%	Vegetative, 40%
Species 8	Epidermis, 40%	Vegetative, 5%	Vegetative, 90%	Vegetative, 15%
Species 9	Seeds, 20%	Fruit, 30%	Fruit, 40%	Fruit, 5%
Species 10	Epidermis, 10%	Fruit, 30%	Vegetative, 15%	Fruit, 28%
Species 11	Epidermis, 60%	Flower, 10%	Flower, 6%	Flower, 30%
Species 12	Seeds, 80%	Vegetative, 90%	Fruit, 90%	Fruit, 40%
Species 13	Seeds, 100%	Flower, 10%	Fruit, 6%	Flower, 3%

44- In which environment have the mulitas fed?

- A) Only in II.
- B) Only in III.**
- C) Only in IV.
- D) In II and III.
- E) In II and IV.

45- With the purpose of comparing the population size of mulitas between a corn field and a natural pasture, another group of scientists carried out two samplings. In the first one, they caught 130 specimens in each environment, marked them without interfering with their survival, and released them. Three days later, a second random sample was taken. Of the 125 animals captured in the corn field, 72% were marked. In the natural pasture

C) Omnivorous.

D) Saprophagous.

47- An example of a long trophic web is:

A) 5, 8, 4, 11, 1.

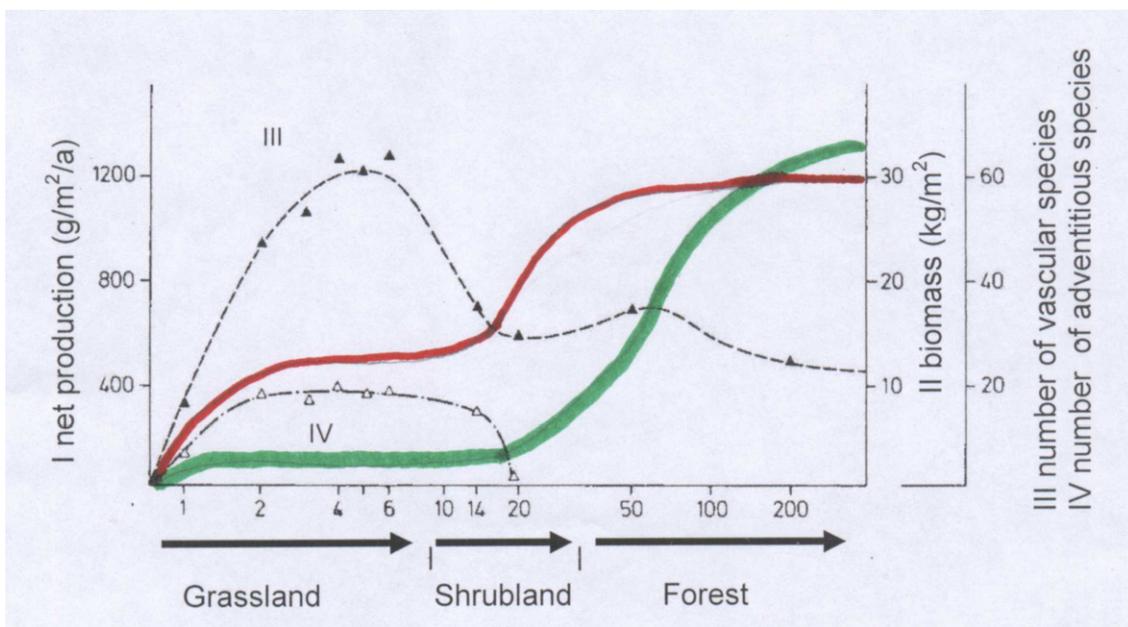
B) 9, 3, mulita, 10, 4.

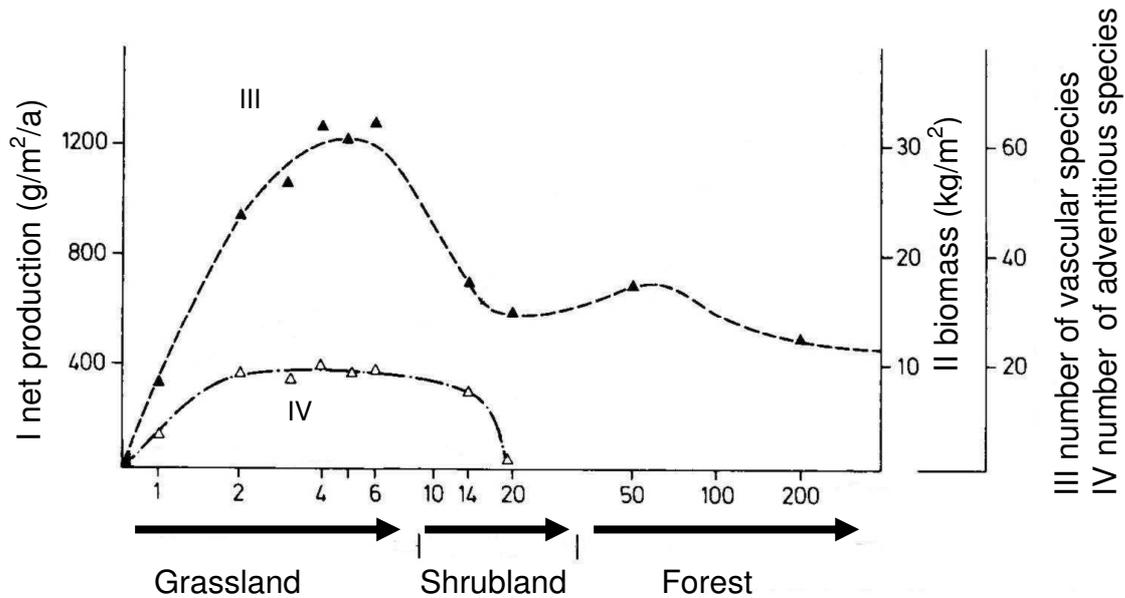
C) 13, 2, mulita, 11, 12.

D) 13, 2, mulita, 4, 1.

**** When a plant community develops by the process of ecological succession, population age structure also varies in the participating species causing changes in the net productivity and in the community biomass. The following figure shows an example of the outcome of a study of reforestation of an abandoned land.**

48- On the answer sheet, complete the figure indicating: net primary production evolution (I) in red pencil, and biomass (II) in green. Use the graph axes help.





49- Using the answer code, say whether the following statements are correct or incorrect according to results shown in the above figure.

Answer code:

- 01. Correct
- 02. Incorrect.

STATEMENTS	CODE
A) In advanced stages of succession, species richness increases.	02
B) During the first stage of succession, the number of vascular species (III) increases.	01
C) Adventitious species (IV) would be eliminated in the shrub phase by competition.	01
D) Between the 5th and 14th years there is a shift in the trajectory of the four characteristics analysed in this study.	02
E) Richness of vascular and adventitious species are inversely proportional.	02
F) The number of vascular species fluctuates until reaching an equilibrium.	01

BIOSYSTEMATICS (3 questions, 6 points)

50- The characteristics of eight taxonomic groups indicated with A up to H are shown in the following table.

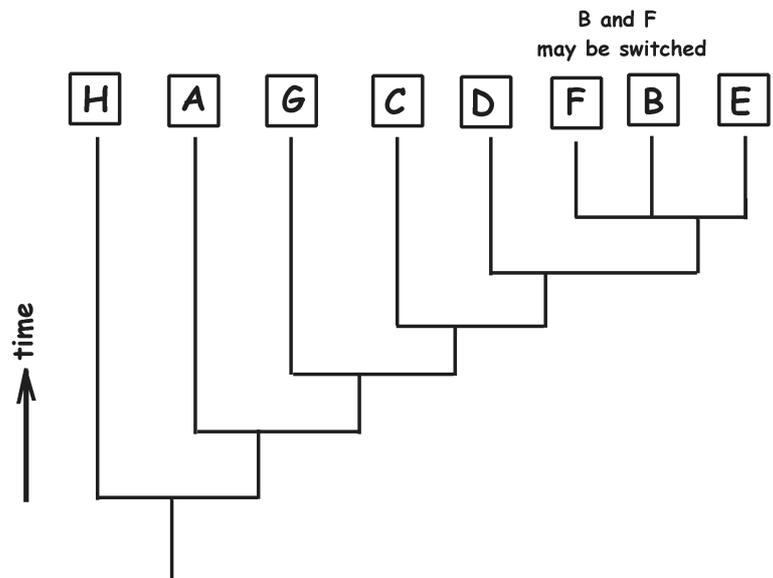
Group	Amniotic egg	Chorda	Hair	Legs	Bony skeleton	Teeth/ Jaws
A	-	+	-	-	-	-
B	+	+	-	+	+	+
C	-	+	-	-	+	+
D	-	+	-	+	+	+
E	+	+	+	+	+	+
F	+	+	-	+	+	+
G	-	+	-	-	-	+
H	-	-	-	-	-	-

References:

+ feature present

- feature absent

Based upon these features complete the following evolutionary tree by writing the correct taxon group letters in the corresponding branches.



51- In the table below you will find several statements about three families of *Liliopsida* class. Match both columns and identify the correct answer.

<p>01. The inflorescence of almost all species of this family is an unbranched fleshy spike composed of numerous very small flowers subtended by a spathe.</p> <p>02. Most species of this family are bulbiferous. The bulbs are tunicated or, sometimes, have numerous imbricate fleshy scales.</p> <p>03. The vegetative body is usually a trunk that terminates in a crown of leaves. Histologically, the woody stem consists of primary tissues, which were originated from the growing tip.</p> <p>04. Stems of most species of this family are short and each one usually ends in an umbel-like inflorescence.</p> <p>05. Leaves are usually pinnate or palmate, and differ enormously in size at maturity, sometimes reaching a length of about 25 m. They can bear a crest or hastula at the junction of the petiole and blade.</p> <p>06. Most species of this family are adapted to disperse their fruits by animals, but some have their fruits dispersed by water due to a very thick fibrous mesocarp.</p> <p>07. The species of this family include a wide range of life forms, many of them are epiphytes, hemiepiphytes, or root climbers.</p> <p>08. Fenestrate or perforated leaves are a special peculiarity of some genera of this family.</p> <p>09. The fruit is usually a loculicidal capsule with several seeds.</p>	<p>I. <i>Araceae</i></p> <p>II. <i>Arecaceae</i></p> <p>III. <i>Liliaceae</i></p>
--	---

	I	II	III
A)	01, 05, 07	04, 08, 09	02, 03, 06
B)	04, 07, 08	01, 05, 06	02, 03, 09
C)	01, 07, 08	02, 05, 06	03, 04, 09
D)	01, 07, 08	03, 05, 06	02, 04, 09
E)	03, 06, 08	02, 05, 07	01, 04, 09

52- In the table below you will find several statements. Using the answer code, indicate whether you consider the statement correct or incorrect.

Answer code:

01. Correct.

02. Incorrect.

STATEMENTS	CODE
A) Careful examination, using cleared and stained leaves of <i>Ginkgo biloba</i> , reveals that the venation is reticulate.	02
B) Lycopodiaceae family is terrestrial or epiphytic. The outer walls of megaspores and microspores have taxonomic significance.	02
C) The leaves of <i>Equisetum</i> are small and whorled. Antherozoids are multiflagellate.	01
D) <i>Juniperus</i> species have female berry-like cones with fleshy scales coalescent at maturity.	01
E) The indusium is a structure that protects sporangia in true ferns.	01

ETHOLOGY (2 questions, 4 points)

**** Guppies are among the first fish that beginners in aquaculture get. They are commonly called "millionaire fish" because of their abundant progeny.**

In 1966, professor C. M. Breder, then director of the New York aquarium, decided to conduct an experiment to investigate the causes of their proliferation.

In a small aquarium - with a capacity of 27.5 liters of water- sufficiently supplied with food and oxygen to maintain up to 500 fish meticulously taken care of, he introduced a couple of guppies (1 adult male and 1 adult female). In the course of the following 6 months and at 4-week-intervals between each breeding (these fish are ovoviviparous), the female produced 102, 87, 94, 71 and 89 offspring, that is a sum total of 443 guppies. A later recount showed that only 9 out of all the newborns remained alive: 6 females and 3 males. All the rest had been devoured by the mother.

At the same time in another aquarium of equal size and identical conditions, the researcher put 8 adult males, 8 adult females and 8 young fish, that is to say, a total of 24 guppies. The females had also abundant offspring here. The data of the proliferation survey along the 6 months following the introduction of the original group of 24 guppies in the aquarium, are shown in the following tables.

		FEMALE 1				
		4° week	8° week	12° week	16° week	20° week
N° of offspring in each breeding	Males	29	24	31	30	33
	Females	58	48	64	58	68
	Total	87	72	95	88	101
N° of offspring recounted hours after breeding	Males	0	0	0	0	0
	Females	0	0	0	0	0
	Total	0	0	0	0	0
Observations: The newborns were devoured by their own mother						

		FEMALE 2				
		4° week	8° week	12° week	16° week	20° week
N° of offspring in each breeding	Males	32	26	33	28	29
	Females	65	50	66	56	58
	Total	97	76	99	84	87
N° of offspring recounted hours after breeding	Males	0	0	0	0	0
	Females	0	0	0	0	0

	Total	0	0	0	0	0
Observations: The newborns were devoured by the own mother						

FEMALE 3						
		4° week	8° week	12° week	16° week	20° week
N° of offspring in each breeding	Males	32	29	25	34	28
	Females	64	56	51	69	55
	Total	96	85	76	103	83
N° of offspring recounted hours after breeding	Males	0	0	0	0	0
	Females	0	0	0	0	0
	Total	0	0	0	0	0
Observations: The newborns were devoured by the own mother						

FEMALE 4						
		4° week	8° week	12° week	16° week	20° week
N° of offspring in each breeding	Males	28	25	35	30	29
	Females	57	49	69	61	60
	Total	85	74	104	91	89
N° of offspring recounted hours after breeding	Males	0	0	0	0	0
	Females	0	0	0	0	0
	Total	0	0	0	0	0
Observations: The newborns were devoured by the own mother						

FEMALE 5						
		4° week	8° week	12° week	16° week	20° week
N° of offspring in each breeding	Males	33	30	30	23	30
	Females	67	59	64	47	60
	Total	100	89	94	70	90
N° of offspring recounted hours after the breeding	Males	0	0	0	0	0
	Females	0	0	0	0	0
	Total	0	0	0	0	0
Observations: The newborns were devoured by their own mother						

FEMALE 6						
		4° week	8° week	12° week	16° week	20° week
N° of offspring in each breeding	Males	30	29	26	35	25
	Females	62	57	53	70	52
	Total	92	86	79	105	77
N° of offspring recounted hours	Males	0	0	0	0	0
	Females	0	0	0	0	0

	Total	0	0	0	0	0
Observations: The newborns were devoured by their own mother						

FEMALE 7						
		4° week	8° week	12° week	16° week	20° week
N° of offspring in each breeding	Males	29	24	33	28	29
	Females	60	50	71	57	62
	Total	89	74	104	85	91
N° of offspring recounted hours after breeding	Males	0	0	0	0	0
	Females	0	0	0	0	0
	Total	0	0	0	0	0
Observations: The newborns were devoured by their own mother						

FEMALE 8						
		4° week	8° week	12° week	16° week	20° week
N° of offspring in each breeding	Males	26	32	33	28	28
	Females	52	65	64	58	57
	Total	78	97	97	86	85
N° of offspring recounted hours after breeding	Males	0	0	0	0	0
	Females	0	0	0	0	0
	Total	0	0	0	0	0
Observations: The newborns were devoured by their own mother						

ORIGINAL GROUP			
	ADULTS		YOUNGSTERS
	Males	Females	
Original number of individuals	8	8	8
N° recounted after a year	3	6	0
Observations:			
- The youngsters of the original group were devoured by the adults of the original group			
- Some adults of the original group died by unknown causes			

53- Which of the following statements can be made from the analysis of the previous data?

- I. Guppies eat their own offspring (infanticide behavior).
- II. Guppies show indiscriminate cannibalism devouring their own offspring until exterminating them.
- III. Guppies show selective cannibalism, that is to say, they preserve the life of their offspring as long as a certain population density is maintained.

IV. Guppies show indiscriminate cannibalism by devouring their own offspring, although they always allow the survival of a random number of them.

Choose the corresponding combination of answers:

- A) I, II.
- B) I, III.**
- C) I, IV.
- D) IV.
- E) I.

54- Which of the following statements is more likely to explain the above mentioned behavior in guppies?

- I. Lack of maturity of the instincts in the young mothers (preadult).
- II. Instinctive conflicts caused by a premature “reawakening” of female heat that, in reaction to male heat, causes the break of mother-offspring bonds.
- III. Instinctive conflicts with addictive impulses such as gluttony.
- IV. The aggressiveness caused by excessive hunger.
- V. An increase of the stress levels, and the consequent increase of aggressiveness due to the overpopulation.
- VI. An increase of the stress levels, and the consequent increase of aggressiveness caused by lack of vital space.

Choose the corresponding combination of answers:

- A) I, II.
- B) III, IV.
- C) V, VI.**
- D) V.
- E) III.



THE END!!!