

2010 – 11 New Zealand International Biology Olympiad Programme



SELECTION EXAMINATION – 23 February 2011

This examination consists of 75 multi-choice questions on tutorials 1 – 5; Cell Structure & Function, Ecology, Plant Anatomy & Physiology, Animal Behaviour, and Genetics & Evolution (75 marks).

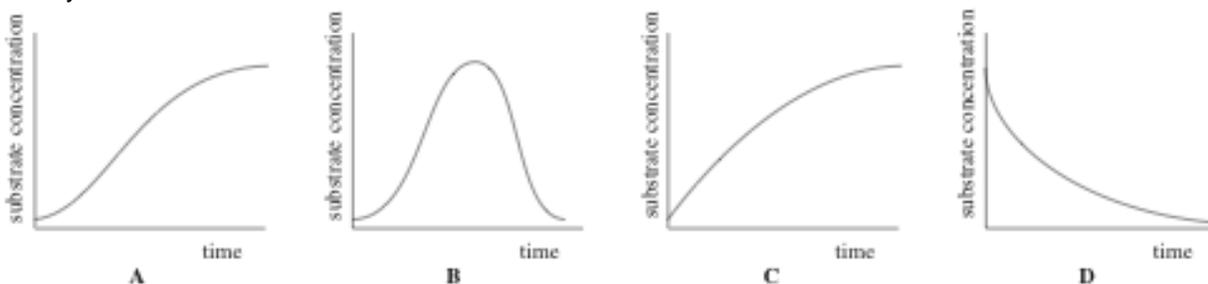
Time allowed: 2 hours.

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Tutorial 1 – Cell Structure & Function (10 marks)

Q1. Which one of the following graphs best represents the changes in substrate concentration during the course of an enzyme reaction *in vitro*?



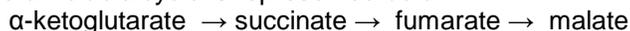
Q2. Which of the following correctly lists the flow of membrane lipids and proteins through the organelles of the endomembranous system of a eukaryotic cell.

- A. Rough ER → smooth ER → transport vesicles → Golgi → plasma membranes
- B. Nuclear envelope → rough ER → smooth ER → transport vesicles → Golgi → transport vesicles → plasma membranes
- C. Nuclear envelope → rough ER → transport vesicles → smooth ER → transport vesicles → Golgi → plasma membranes
- D. Nuclear envelope → rough ER → transport vesicles → smooth ER → transport vesicles → Golgi → transport vesicles → plasma membranes
- E. Rough ER → smooth ER → transport vesicles → Golgi → transport vesicles → plasma membranes

Q3. During an investigation of mitochondrial metabolism, isolated mitochondria were maintained in a solution of 0.4 molar sucrose. The sucrose solution was used

- A. as a respiratory substrate
- B. to buffer the pH of the medium
- C. as a carbon source of Krebs (tricarboxylic acid) cycle intermediates
- D. to prevent the mitochondrial membranes rupturing

Q4. Part of the citric acid cycle is represented below.



If the enzyme responsible for the conversion of succinate to fumarate became inactive, which one of the following would **NOT** occur?

- A. some accumulation of succinate
- B. a halt in the production of malate
- C. gradual disappearance of fumarate
- D. continued conversion of α -ketoglutarate
- E. an increase in the concentration of α -ketoglutarate

Q5. Plasmolysis occurs when living plant cells such as those of the onion bulb scale epidermis, are placed in strong sugar solution. After plasmolysis, which one of the following occupies the region between the plasma membrane and the cell wall?

- A. sugar solution
- B. pure vacuolar sap
- C. diluted vacuolar sap
- D. water
- E. air

Q6. In the Hill reaction, methylene blue may be reduced by illuminated isolated chloroplasts. The donor of electrons is

- A. Water
- B. Chlorophyll
- C. Oxygen
- D. ATP
- E. NADP

- Q7.** Contractile vacuoles are found in a wide variety of unicellular organisms, but not in the cells of mammals. This is because mammalian cells
- have membranes that are not selectively permeable
 - are generally surrounded by solutions with the same solute potential
 - have ionic pumps
 - expend energy to maintain cell volume
 - are more osmotically resistant to osmotic stress
- Q8.** Which one of the following steps represents the essential link between the light-dependent and light-independent stages of photosynthesis?
- photolysis of water and photophosphorylation
 - carbon dioxide fixation
 - activation of chlorophyll molecules
 - production of reduced electron carriers and photophosphorylation
 - reduction of phosphoglycerate
- Q9.** In chloroplast lamellae, the photosystems comprise proteins and are embedded in a phospholipid bilayer. To extract the two photosystems in a functional state the best treatment would be to
- use a mild detergent
 - boil and cool the chloroplast
 - denature the membrane proteins with acid
 - reduce the chlorophyll molecules by illumination
 - separate by differential centrifugation
- Q10.** Four important steps in meiosis are
- | | |
|-----|-----------------------------------|
| I | pairing of homologous chromosomes |
| II | chromatids moving apart |
| III | division of the centromeres |
| IV | replication of DNA |

The correct order of these steps is

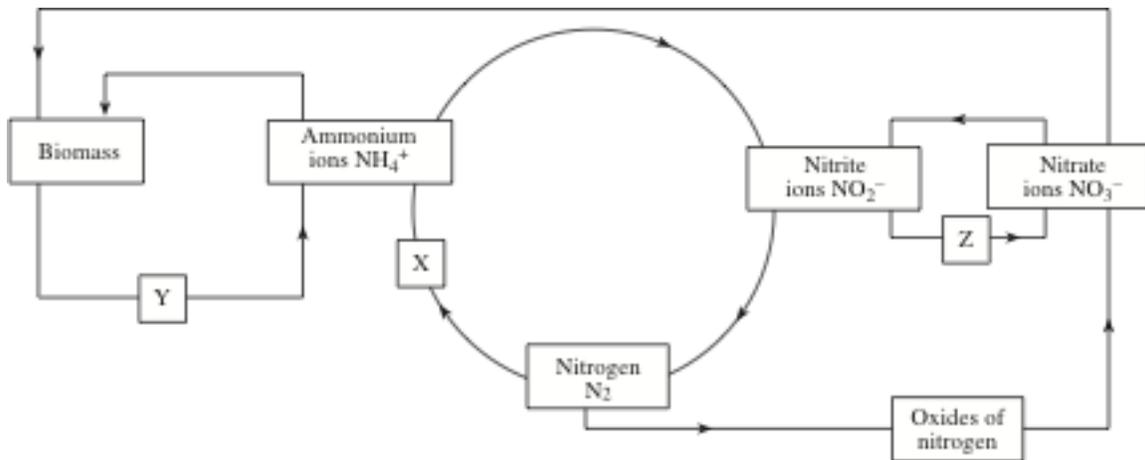
- IV → I → II → III
- IV → III → I → II
- IV → II → I → III
- IV → I → III → II
- I → II → IV → III

Tutorial 2 – Ecology (13 marks)

- Q11.** When an animal population is being estimated by the capture-recapture technique, which one of the following would lead to the size of the population being underestimated?
- a higher predation of marked than of unmarked animals
 - a greater attraction of marked than of unmarked animals to traps
 - an immigration of animals into the area between samplings
 - a high but proportionately equal mortality of both marked and unmarked animals
 - emigration of a higher proportion of marked than unmarked individuals from the sampling area

QUESTIONS CONTINUED ON THE NEXT PAGE

Q12. The diagram below represents the nitrogen cycle.



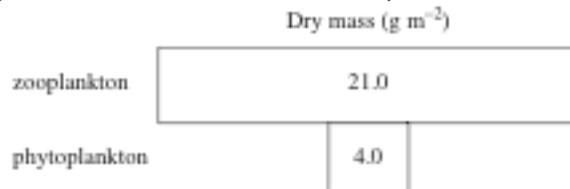
Which one of **A to E** correctly identifies the events happening at points X, Y and Z in the cycle?

	X	Y	Z
A.	Non-biological nitrogen fixation	Decay by microorganisms	Nitrification
B.	Biological nitrogen fixation	Nitrification	Denitrification
C.	Non-biological nitrogen fixation	Decay by microorganisms	Denitrification
D.	Non-biological nitrogen fixation	Nitrification	Denitrification
E.	Biological nitrogen fixation	Decay by microorganisms	Nitrification

Q13. Which one of the following assumptions is not necessary in order to estimate the size of an isolated mouse population, using the capture/mark/recapture method?

- A.** Marked and unmarked mice are randomly distributed in the population
- B.** Recaptured mice are a random sample of the population
- C.** There is no difference in the survival of marked and unmarked mice
- D.** Marked and unmarked mice have the same reproductive success
- E.** Marked and unmarked mice are equally likely to be recaptured

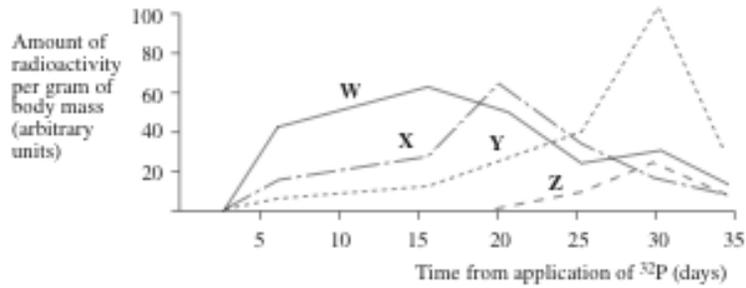
Q14. The diagram represents a pyramid of biomass based on samples taken from marine plankton.



Which one of the following statements best explains this inverted pyramid?

- A.** The sampling technique was incorrect
- B.** The whole of the phytoplankton material is not eaten by the zooplankton
- C.** The productivity of the zooplankton must be higher than that of the phytoplankton
- D.** The productivity of the phytoplankton must be higher than that of the zooplankton
- E.** The zooplankton must be recycling energy

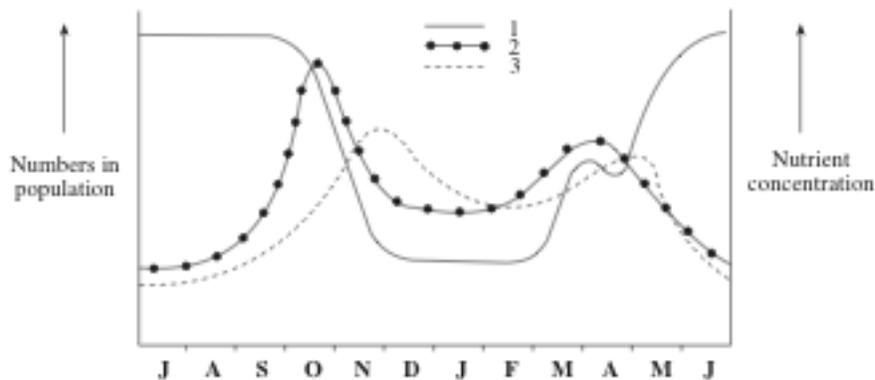
Q15. Radioactive phosphate ($^{32}\text{PO}_4$) was applied to a plot of natural grassland. During the next 35 days, samples of four species of arthropod were investigated for radioactive content. The graph shows the relative amounts of radioactivity found in the four species, W, X, Y and Z.



Which one of the rows **A – E** represents the organisms in the graph?

	W	X	Y	Z
A.	decomposer	herbivore	herbivore	carnivore
B.	herbivore	carnivore	decomposer	herbivore
C.	carnivore	herbivore	decomposer	herbivore
D.	grasses	herbivore	carnivore	decomposer
E.	herbivore	herbivore	carnivore	decomposer

Q16. The graph refers to the surface layers of the Tasman Sea. It shows the seasonal changes in numbers of phytoplankton and zooplankton, and in inorganic nutrient concentration.



Which one of the following sequences correctly represents the passage of nutrients through the ecosystem?

- A. 1 → 2 → 3
- B. 1 → 3 → 2
- C. 2 → 1 → 3
- D. 2 → 3 → 1
- E. 3 → 2 → 1

Q17. Which one of the following conditions is essential to maintain a large, balanced fresh-water community?

- A. The number of autotrophs must be greater than the number of heterotrophs
- B. The productivity of the plants must be greater than the productivity of the animals
- C. The energy lost by the plants must not exceed the energy lost by the animals
- D. The number of carnivores must not exceed the number of herbivores
- E. The total biomass of the autotrophs must exceed the total biomass of the heterotrophs

- Q18.** Increasing the supply of food from a limited area of land could best be achieved by increasing the
- gross production of the producers
 - net production of the producers
 - rate of energy turnover of the producers
 - net production of the primary consumers
 - density of the primary consumers
- Q19.** The stellate barnacle, *Elminius modestus*, is found in the midlittoral zone of New Zealand's estuaries and sheltered rocky shores. The barnacle is hermaphroditic, though it requires cross-fertilization. It reaches sexual maturity about 8 weeks after settling and an average sized animal produces about 1800-4000 eggs (Barnes & Barnes, 1968). The generation time is short and up to 12 successive broods are produced, 2 weeks apart. The nauplius larvae hatch and develop into cypris larvae which are attracted to places where adult conspecifics are present, settling and maturing into the adult barnacle.

The dispersion pattern and type of survivorship curve shown by this species is

- Clumped, I
 - Uniform, I
 - Clumped, II
 - Clumped, III
 - Uniform, III
- Q20.** Which of the following is **NOT** a density-dependent factor that influences population density
- Competition
 - Disease
 - Drought
 - Toxic waste
 - Predation
- Q21.** 10 different Australian honeyeaters are found in the Mount Lofty Ranges near Adelaide, South Australia. The species differ in beak length with shorter beaked species feeding chiefly on insects and longer -beaked species feeding more often on flowers. Insect eating species may glean insects from leaves and bark or capture them in the air. The co-existence of these species in the same habitat is an example of
- Competition
 - Resource partitioning
 - Character displacement
 - Competitive exclusion

- Q22.** The following table shows the interaction between pairs of species

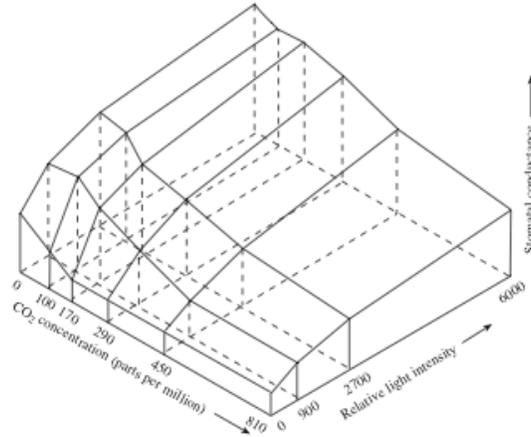
Pair	Species 1	Species 2
1	0	+
2	-	+
3	+	+
4	+	-
5	+	-

Which one of the following gives the correct type of interactions for species 1 – 5

- mutualism, parasitism, commensalism, herbivory, predation
 - mutualism, parasitism, commensalism, predation, herbivory
 - commensalism, parasitism, mutualism, herbivory, predation
 - commensalism, herbivory, parasitism, mutualism, predation
- Q23.** Which of the following factors is likely to increase species diversity in a forest community?
- Moderate levels of disturbance
 - Stable conditions with low disturbance
 - Human protection of the community to prevent disturbance
 - Intensive human disturbance
 - Frequent natural disturbance such as fires and floods

Tutorial 3 – Plant Anatomy & Physiology (19 marks)

Q24. Measurements of the rate of diffusion through stomata ('stomatal conductance') were made under various CO₂ concentrations, and the following stereograph was drawn.



Which one of the following is a valid deduction from the stereograph?

- A. Stomatal conductance is maximal when conditions for photosynthesis are optimal
- B. Increasing light intensity increases stomatal conductance at all CO₂ levels shown
- C. Stomatal conductance is unaffected by an increase in CO₂ concentration from 170 to 810 p.p.m
- D. Changes in CO₂ concentration have a greater influence on stomatal conductance than changes in light intensity
- E. Changes in light intensity have a greater influence on stomatal conductance than changes in CO₂ concentration

Q25. The table shows the amount of plant hormone that passes through short segments of young stems when it is applied either to the end nearest to the shoot-tip or to the end furthest from the shoot tip. Three experiments were carried out under different conditions as indicated below.

Site of hormone application	Amount of hormone passing through stem (arbitrary units)		
	At 3 °C	At 25 °C	At 25 °C + cyanide
basal end	3.3	3.8	3.9
apical end	3.5	15.9	4.2

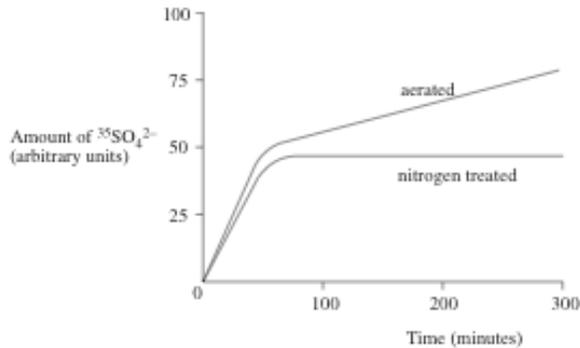
The best interpretation of these results is that

- A. the hormone used was auxin
- B. the hormone shows unidirectional transport
- C. active transport of the hormone occurs
- D. diffusion accounts for the transport of the hormone
- E. diffusion speeds up with rise in temperature

Q26. When plant cells from the zone of elongation are compared with those from the apical meristem, they have

- A. a larger surface area to volume ratio
- B. a higher proportion undergoing mitosis
- C. a larger nuclear to cytoplasmic ratio
- D. more prominent vacuoles
- E. a larger number of ribosomes

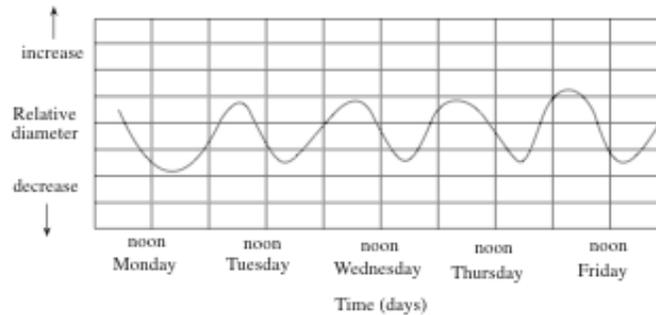
- Q27.** In photosynthesis, light is most directly involved in
- reduction of CO_2 to phosphoglycerate
 - synthesis of starch
 - release of oxygen from CO_2
 - splitting of water
 - regeneration of ribulose biphosphate
- Q28.** Portions of roots were immersed in culture solutions containing radioactive sulfur as $^{35}\text{SO}_4^{2-}$. One set was aerated and a second set had nitrogen bubbled through it. The amount of $^{35}\text{SO}_4^{2-}$ in the roots was measured at intervals and the results are shown in the graph below.



From these results the *best* conclusion is that

- the nitrogen interferes with ATP production
 - passive diffusion of $^{35}\text{SO}_4^{2-}$ occurs between the solution and the roots
 - the uptake of $^{35}\text{SO}_4^{2-}$ is an active process
 - the uptake of $^{35}\text{SO}_4^{2-}$ involves both active and passive processes
- Q29.** Which one of the following can only be explained by mass flow of solutes through the phloem?
- Sap is exuded when a sieve tube element is pierced
 - The phloem conducts heat longitudinally only in the direction in which solutes are being transported
 - Movement through the phloem ceases when living cells in the stem are killed by heat
 - Metabolic inhibitors stop solute flow through the phloem
 - A sudden reduction in sap pressure causes precipitation of p-protein
- Q30.** Phloem tissue, taken from the storage root of carrot plants, and cultured on a nutrient medium, will produce completely new carrot plants. This is possible because the phloem cells
- are not fully differentiated
 - synthesise the necessary growth hormone
 - are genetically totipotent
 - are normally meristematic
 - retain the capacity to divide after differentiation
- Q31.** In still air, the transpiration rate is low because
- stomata open more when the diffusion gradient changes.
 - the concentration gradient of water molecules is reduced
 - the water molecules move more slowly
 - root pressure is reduced
 - water molecules are more strongly attracted to each other
- Q32.** The light reaction of photosynthesis can be made to occur experimentally in the absence of
- water
 - carbon dioxide
 - chlorophyll
 - ADP
 - NADP

Q33. The relative diameter of a tree trunk was measured over a period of several days. The results are shown in the graph.



The best hypothesis to explain these data is that in a transpiring plant

- A. phloem tissue is not involved in transpiration
 - B. root pressure reaches a maximum value just after noon
 - C. xylem vessels are sometimes under tension
 - D. water is transported in the xylem vessels
 - E. the rise of sap shows an endogenous rhythm
- Q34.** A homozygous tall maize plant is fertilised by a dwarf maize plant. From which one of the following tissues of the resultant grain will the allele for dwarfness be **absent**?
- A. cotyledon
 - B. endosperm
 - C. fruit wall
 - D. coleoptile

Q35. Two species of plant, X and Y, were grown in each of two regimes of day length, and their flowering response recorded.

Regime 1: 8 hours daylight, 16 hours darkness;
Result: X flowered, Y did not flower.

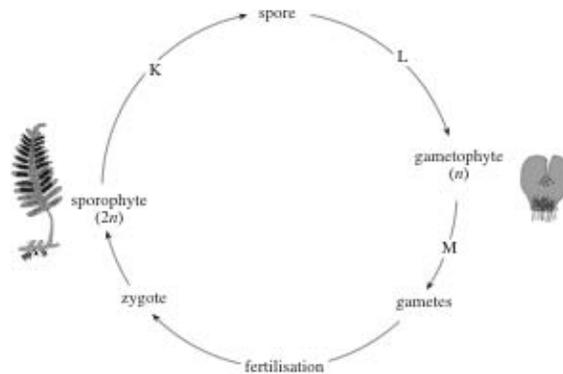
Regime 2: 8 hours of daylight, 16 hours of darkness, interrupted after 8 hours by 10 minutes of bright light from an incandescent lamp;
Result: X and Y both flowered.

The probable explanation of these results is that

- A. X is a long-day plant, Y is a short-day plant
 - B. X is a long-day plant, Y is a day-neutral plant
 - C. X is a day-neutral plant, Y is a long-day plant
 - D. X is a day-neutral plant, Y is a short-day plant
 - E. X is a short-day plant, Y is a long-day plant
- Q36.** A vacuolated plant cell is equilibrated in pure water, and then transferred to a sucrose solution with a water potential of -800 kPa. Which one of the rows **A - D** shows what would happen next?

	Direction of net water movement	Pressure potential (ψ_p)
A.	into cell	increases
B.	out of cell	decreases
C.	into cell	decreases
D.	out of cell	increases

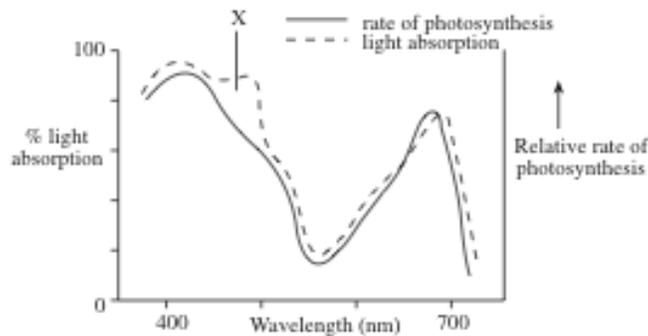
Q37. The diagram represents the life cycle of a fern, with the stages drawn to different scales.



Which one of the rows A to E correctly represents the nuclear events occurring at stages K, L and M?

	K	L	M
A.	mitosis	meiosis	mitosis
B.	mitosis	mitosis	meiosis
C.	mitosis	meiosis	meiosis
D.	meiosis	meiosis	mitosis
E.	meiosis	mitosis	mitosis

Q38. The graph shows the effect of wavelength of light on the rate of photosynthesis and on the amount of light absorbed by the pigments in a green seaweed.



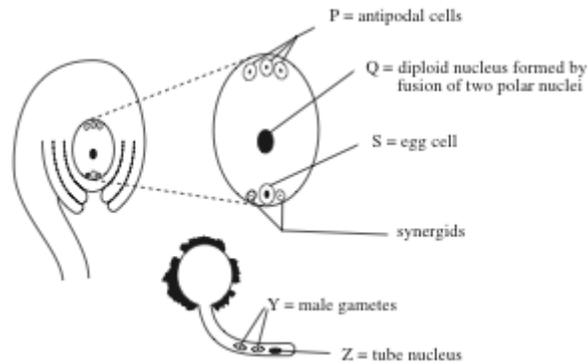
The difference between the two curves at X is due to

- A. inefficient trapping of light energy by the chlorophyll
- B. no production of ATP at that wavelength
- C. photorespiration occurring at that wavelength
- D. carotenoids absorbing light that is not then used in photosynthesis
- E. fluorescence of carotenoids

Q39. During the light-dependent reactions of photosynthesis, NADP^+ is converted into NADPH . This requires the addition of

- A. one hydrogen atom
- B. one electron and a H^+ ion
- C. two electrons and a H^+ ion
- D. two H^+ ions and an electron
- E. two electrons and two H^+ ions

- Q40.** If light were a limiting factor, the rate at which bubbles of gas would be given off by *Elodea* (a pondweed), when exposed to a small but bright light source, would be increased four-fold if
- the light were placed at half of the original distance from the plant
 - the light were placed at a quarter of the original distance from the plant
 - the temperature were raised 10 °C
 - the carbon dioxide supply were increased four-fold
 - the carbon dioxide supply were doubled
- Q41.** Which one of the following would *not* increase the rate of water uptake from soil to root?
- an increase in the concentration of soluble metabolites in root cells
 - a decrease in the concentration of mineral ions in the soil
 - an increase in root surface area
 - a decrease in pressure potential of the root xylem sap
 - a decrease in the concentration gradient of soluble metabolites across the root cortex
- Q42.** The diagrams show vertical sections of an ovule and of a pollen grain from the same species of flowering plant.



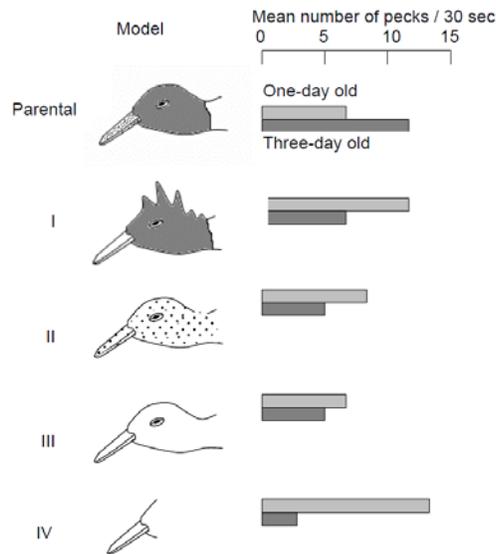
Which one of the following combinations, **A – E**, represents the structure which, after fertilisation, becomes the endosperm?

- Z + Q
- Z + S
- Y + S
- P + Y
- Y + Q

QUESTIONS CONTINUED ON THE NEXT PAGE

Tutorial 4 – Animal Behaviour (7 marks)

- Q43.** A male Siamese fighting fish will respond to a model fish by producing a threat display. With continued presentation of the model fish the response is reduced. This is an example of
- classical conditioning
 - imprinting
 - operant conditioning
 - habituation
 - a simple reflex
- Q44.** A series of experiments were conducted with one-day and three-day old chicks. The one-day old chicks were removed from the parents at hatching whereas the three-day old chicks had been reared with their parents until the time of the experiment. Both sets of chicks were presented with models of the parent head and the following responses obtained:



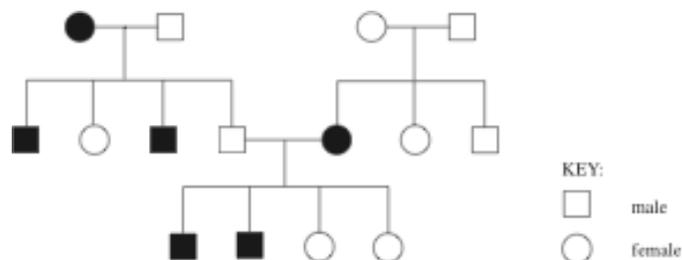
Which is the best interpretation of these results?

- Pecking behaviour is a fixed action pattern where any long pointed object acts as an equally effective stimulus.
 - The pecking rate of laughing gull chicks increases with age
 - The response of one-day old chicks is more pronounced when the model is closer to that of the parent
 - The act of pecking is an innate behaviour whilst the discriminatory capacity of the chick is a result of learning
 - Pecking behaviour is triggered by a sign stimulus, the head colour of the adult gull
- Q45.** The flatworm (*Dendrocoelum lacteum*) increases its rate of turning as light intensity increases and, as a consequence, is found aggregated in dark places. This is an example of:
- Negative klinokinesis
 - Klinokinesis
 - Negative phototaxis
 - Orthokinesis
 - Negative orthokinesis

- Q46.** The tamarin, a New World monkey, lives in groups containing a dominant female who suppresses ovulation in subordinates, causing her to be the only one capable of reproduction. The dominant female births multiple offspring fertilized by more than one male. The males have a high investment in the care of the offspring with males often carrying infants on their backs, even when they are not the father. Both related and unrelated males cooperate to care for the young. Which of the following terms best describes the behavior of the female tamarins?
- Monogamy
 - Polygamy
 - Polygyny
 - Polyandry
 - Promiscuity
- Q47.** Blue jays are omnivorous birds who supplement their vegetarian diet with insects. When a blue jay eats a monarch butterfly the foul taste of the butterfly causes the blue jay to vomit up the food. Blue jays who have previously consumed a monarch butterfly will avoid them in future with the result that wild monarch butterflies are less susceptible to natural predation by blue jays than other species of butterfly. The blue jays avoidance of monarch butterflies as a food is a result of:
- Habituation
 - Classical conditioning
 - Operant conditioning
 - Observational learning
 - Insight learning
- Q48.** Vampire bats feed solely on blood and can only survive about two days without a meal. When a bat fails to find food it will “beg” from other members of the colony. The other bat will then regurgitate a small amount of blood, even if the “begging” bat is unrelated. This reciprocal altruism is
- largely limited to species living in stable social groups
 - adaptive only if the aided individual returns the favour at a later date
 - seen when there are likely to be negative consequences associated with not returning favours
 - B and C only
 - A, B and C
- Q49.** Which of the following is **NOT** true of a typical co-operative breeding system in birds?
- It involves breeding pairs plus helpers
 - the group defends an all-purpose territory
 - helpers are genetically related to the breeding pair
 - helpers are usually only females
 - all of the above are true

Tutorial 5 – Genetics & Evolution (26 marks)

- Q50.** The diagram shows the pedigree of a human family in which the individuals marked with shaded symbols are deaf.



- Deafness in this family is inherited as
- an autosomal dominant characteristic
 - an autosomal recessive characteristic
 - an X-linked dominant characteristic
 - an X-linked recessive characteristic
 - a Y-linked characteristic

Q51. Day-old chicks are difficult to sex but their down feathers will reveal the effects of a sex-linked dominant allele called 'barred'. In birds the female is the heterogametic sex. Which one of the following crosses allows correct sexing of the resultant chicks?

	Hen	Cock
A.	barred	heterozygous barred
B.	unbarred	homozygous barred
C.	barred	unbarred
D.	unbarred	heterozygous barred

Q52. A population in Hardy-Weinberg equilibrium has a frequency of a particular recessive allele of 0.2. The percentage of heterozygotes in the population would be

- A. 0.16
- B. 0.8
- C. 16
- D. 32
- E. 64

Q53. The light and dark forms of the peppered moth *Biston betularia* illustrate discontinuous variation. This means that

- A. there are no intermediate forms
- B. they are confined to certain areas
- C. selection by predation has eliminated further variation
- D. they are unlikely to vary in nature
- E. the frequency of the rarer form is lower than that which could be accounted for by recurrent mutation

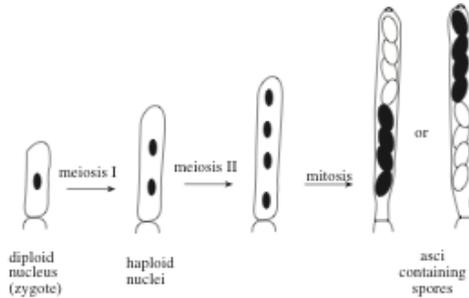
Q54. Which one of the following pieces of information provides the **MOST** direct evidence that individuals who are heterozygous for the sickle cell condition have a selective advantage in areas where malaria is endemic?

- A. The geographical distribution of malaria and high sickle cell allele frequency are closely correlated
- B. Mortality from malaria is lower in heterozygous individuals than in those with normal blood
- C. Heterozygous individuals are less susceptible to experimentally induced malaria than are homozygous individuals
- D. Counts of malarial parasites in the blood of heterozygous individuals are lower than in those with normal blood
- E. Malarial parasites grow more slowly in heterozygous individuals than in those with normal blood

Q55. In mice the allele *C* must be present before colour pigments are produced in the fur. Individuals lacking this allele are albino. Another pair of alleles determines whether the fur will be agouti (*A*) or black (*a*). Which one of the rows **A to E** shows, as far as these two pairs of alleles are concerned, the number of different genotypes which could result in albino, agouti and black mice?

	albino	agouti	black
A.	3	4	2
B.	4	2	3
C.	2	3	4
D.	3	1	2
E.	4	4	2

Q56. In the fungus *Sordaria fimicola*, a diploid nucleus containing alleles for both black and for white spore colours can give rise to an ascus containing one of several spore patterns. The spores are arranged linearly in the ascus according to the order in which they are formed. Two possible asci, and their method of formation, are shown in the following diagram.



The arrangement of spores in the two asci is explained by the alleles for spore colour undergoing

- A. crossing over
 - B. independent assortment
 - C. segregation during meiosis I
 - D. segregation during meiosis II
 - E. mutation
- Q57.** In a series of breeding experiments using *Drosophila*, a linkage group composed of five genes was found to show the following recombination frequencies per 100 fertilised eggs.

	Singed Bristles (<i>sn</i>)	Vermilion eye (<i>v</i>)	White Eye (<i>w</i>)	Ruby Eye (<i>rb</i>)	Tan Body (<i>t</i>)
Singed Bristles (<i>sn</i>)	0.0	12.0	19.5	13.5	6.5
Vermilion eye (<i>v</i>)	12.0	0.0	31.5	25.5	5.5
White eye (<i>w</i>)	19.5	31.5	0.0	6.0	26.0
Ruby eye (<i>rb</i>)	13.5	25.5	6.0	0.0	20.0
Tan body (<i>t</i>)	6.5	5.5	26.0	20.0	0.0

From this table of results it can be deduced that the correct sequence of the genes on the chromosomes is

- A. *sn—t—v—rb—w*
 - B. *sn—v—w—rb—t*
 - C. *w—t—sn—rb—v*
 - D. *w—rb—sn—t—v*
 - E. *w—rb—t—sn—v*
- Q58.** Which one of the following is an example of divergent evolution?
- A. eye of locust and blackbird
 - B. forelimb of pigeon and dolphin
 - C. wings of cockroach and bat
 - D. skeleton of tortoise and lobster
 - E. scales of shark and trout

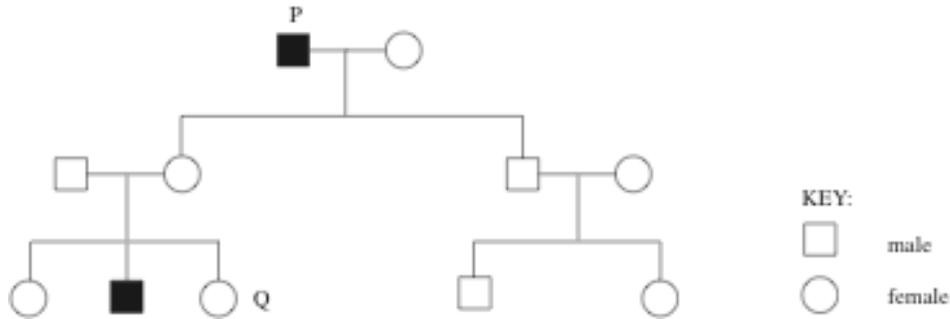
- Q59.** Colour blindness results from the presence of a sex-linked allele which is recessive in females. A colour blind woman and a man with normal vision produced a child with normal vision and a sex chromosome complement XXY. This suggests that chromosomes failed to separate during the formation of the
- sperm
 - egg
 - sperm and egg
 - sperm or egg
- Q60.** Which one of the following pieces of information provides the most direct evidence that the puffs, seen on the giant (polytene) chromosomes of fly larvae, are regions of active gene transcription?
- Substances such as chloramphenicol, which inhibit protein synthesis in the cytoplasm, do not reduce the formation of chromosome puffs
 - During metamorphosis, puffs appear in new regions of the chromosomes. Injecting ecdysone (insect moulting hormone) induces similar changes
 - In cells supplied with radioactive uridine (a uracil-containing nucleotide), the giant chromosomes become most densely labelled in the region of the puffs
 - Substances such as actinomycin D, which inhibit RNA synthesis, do not prevent puffing of giant chromosomes
- Q61.** The table shows the results of an investigation into survival in relation to clutch size in Swiss starlings.

Number of young in clutch	1	2	3	4	5	6	7	8
Number of young marked	65	328	127 8	395 6	617 5	315 6	651	120
Number of marked birds recaptured after 3 months	0.0	1.8	2.0	2.1	2.1	1.7	1.5	0.8

The information suggests that clutch size in Swiss starlings is a result of

- disruptive selection
 - stabilising selection
 - directional selection
 - artificial selection
 - recurrent mutation
- Q62.** E and T represent alleles of two linked genes in maize. Plants of the genotype *EETT* were crossed with plants of the genotype *eett*. The resulting F1 plants were backcrossed with *eett* plants to produce a generation of which 36 391 plants showed either both dominant or both recessive characters, while 9141 plants showed only one of the dominant characters. Which one of the following most closely represents the cross-over value between the two genes?
- 0.25%
 - 5%
 - 30%
 - 25%
 - 20%

Q63. The diagram shows the pedigree of a human family in which the individuals marked with shaded symbols have no sweat glands. This is a rare condition.

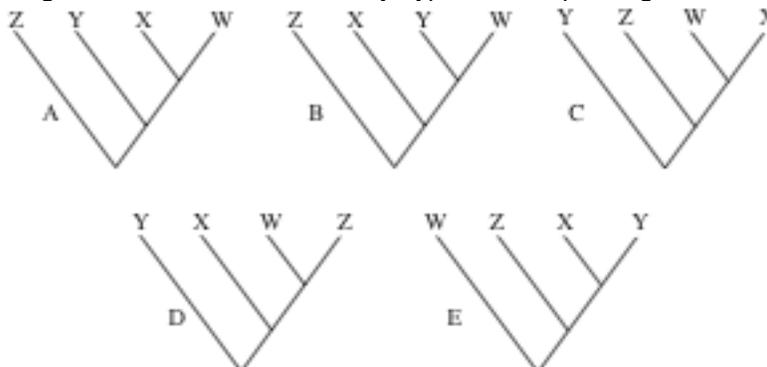


Which of the following would be the best inference from the data?

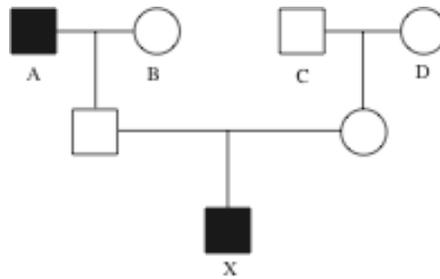
- A. A mutation occurred in individual P
 - B. The mutant allele is on the X chromosome
 - C. The normal allele is incompletely dominant
 - D. Individual Q is carrying the mutant allele
- Q64.** Genetic adaptation is best described as
- A. a process by which an individual organism gradually changes itself to suit its environment
 - B. a change in allele frequencies in a population as a result of changing environmental circumstances
 - C. the emergence of new forms as a result of mutations in the genetic material
 - D. a change in the genotype of an individual organism as a result of selection pressure
 - E. the occurrence of advantageous mutations
- Q65.** A cladogram is a branching diagram in which groups of closely related species (i.e. those sharing many characteristics) are shown to have branched away from the common line of descent via the same ancestor. The table gives a number of characteristics which are found in a group of four species, W, X, Y and Z.

Characteristic	Species			
	W	X	Y	Z
Fingers and toes	shaded	shaded	shaded	shaded
Endothermy	shaded	shaded	shaded	shaded
3 ear ossicles	shaded	shaded	shaded	shaded
Amnion	shaded	shaded	shaded	shaded
Placenta	shaded	shaded	shaded	shaded
Internal fertilisation	shaded	shaded	shaded	shaded
Mammary glands	shaded	shaded	shaded	shaded
Oviparity (lays eggs)	shaded	shaded	shaded	shaded
Webbed feet	shaded	shaded	shaded	shaded
Hair	shaded	shaded	shaded	shaded
Feathers	shaded	shaded	shaded	shaded

Which one of the cladograms below is the most likely hypothesis explaining the distribution of characters?



Q66. In the following pedigree of a human family carrying the sex-linked allele for red-green colour-blindness, colour-blind individuals are shown by shaded symbols.

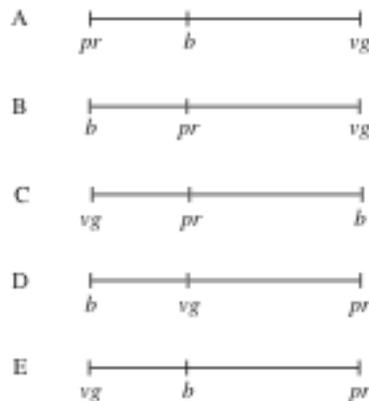


Assuming no mutations, from which grandparent, A, B, C or D did X inherit his colour blindness?

Q67. The table shows the recombination (crossover) values found in an investigation of three linked alleles.

Between alleles	% recombination
<i>Pr</i> and <i>b</i>	6.1
<i>Pr</i> and <i>vg</i>	10.2
<i>B</i> and <i>vg</i>	16.3

Which one of the following is the correct linkage map?



Q68. The diagram shows the sequence of bases in a strand of DNA that codes for a polypeptide composed of ten amino acids. An additional base sequence coding for the start signal is on the left.

T A C G G T C A A T C T G G T T C T G G T T C T T C T C A G C A A

When the polypeptide for which this gene codes was hydrolysed, it yielded the amino acids shown in the table.

Amino acid	Number of amino acid residues per polypeptide
w	1
x	2
y	3
z	4

The correct sequence of amino acids in the polypeptide is

- A. x y z x z y z z w y
- B. y z x y z z y z w x
- C. z x y z y z y y w z
- D. y x z y z y z z x w
- E. y x z y z y z z w x

- Q69.** Chickens of the variety 'Wyandotte' are white because they possess the dominant allele (*I*) of a colour inhibitor gene in addition to the dominant allele (*F*) of a colour factor gene. Hens of the variety 'leghorn' are white because they are homozygous recessive for the colour factor gene.

The ratio of white to coloured offspring in the second generation of a cross between white Wyandotte (*IIF*) and white leghorn (*iff*), if the genes assort independently, would be

- A. 15 white : 1 coloured
 - B. 13 white : 3 coloured
 - C. 12 white : 4 coloured
 - D. 10 white : 6 coloured
 - E. 9 white : 7 coloured
- Q70.** Dandelions are triploid and their pollen is sterile. This is most likely to be because
- A. the germinating pollen contains three gametic nuclei
 - B. the stigmas lack a specific chemical necessary for pollen tube formation
 - C. polyploids are infertile
 - D. the meiotic mechanism breaks down
- Q71.** During the 19th century an accidental hybridisation occurred between *Spartina anglica* ($2n = 56$) and *S. alterniflora* ($2n = 70$). The result was *S. townsendii*, a fertile hybrid. How many chromosomes would be expected in cells of the hybrid?
- A. 56
 - B. 63
 - C. 70
 - D. 126
 - E. 252
- Q72.** In Guinea pigs, black hair (B) is dominant over white (b), rough coat texture (R) is dominant over smooth (r), and short hair (S) is dominant over long hair (s). These genes are found on separate chromosomes. A homozygous black, rough, short-haired Guinea pig was crossed with a white, smooth, long-haired one. The offspring of this cross were mated and 200 offspring were produced. How many of these F₂ offspring would you expect to be black with a rough long haired coat?
- A. 9
 - B. 14
 - C. 28
 - D. 42
 - E. 84
- Q73.** In humans, identical twins occur in about one in 300 births. Assuming that red hair is recessive to dark hair, what are the chances of a dark-haired couple, each of whom had a red-haired parent, having red-haired identical twin boys?
- A. 1/600
 - B. 1/1200
 - C. 1/2400
 - D. 1/4800
 - E. 1/9600
- Q74.** In a breeding experiment, two white-flowered sweet peas were crossed and all the offspring had purple flowers. This result could be explained if the parent plants
- A. both carried the genes for the synthesis of purple pigment.
 - B. had different genotypes, one carrying the genes for purple pigment and the other carrying the genes for the enzyme activating them.
 - C. were both lacking one of the genes controlling the enzymes on the pathway synthesising purple pigment.
 - D. had the same genotype and were both heterozygous for the genes responsible for synthesising purple pigment.

- Q75.** Some clover plants are *cyanogenic* because they produce hydrogen cyanide when the leaves are mechanically damaged. *Acyanogenic* plants do not produce cyanide. When two acyanogenic plants were crossed, the following results were obtained.

Offspring	Cyanogenic	Acyanogenic
F ₁	All	None
F ₂	151	41

These results could be explained if the parent plants

- A.** both lacked the allele for an enzyme to convert the substrate to hydrogen cyanide
- B.** both lacked the allele for the synthesis of the substrate from a precursor
- C.** had different genotypes, one carrying the allele for the enzyme and the other for the synthesis of the substrate
- D.** had the same genotype, being heterozygous for both substrate and enzyme genes
- E.** had different genotypes, one being heterozygous for two loci, the other homozygous recessive for both

END OF EXAM