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ADVANCED LEVEL BIOLOGY

GENERAL COMMENTS

The new Advanced level Syllabus, first introduced in 1966, has been developed to follow on from the new Ordinary level Syllabus and has the same intent: to provide an examination that is based on a functional approach to the subject, emphasizing its physiological and quantitative aspects rather than the anatomical description of types, and one which specifically aims at paying increased attention to the testing of understanding. The examiners have tried to incorporate this new approach in their questions, but it is apparent that the inclusion of some biochemical facts has presented problems for those teachers whose pupils have a very limited chemical knowledge. For example, Krebs' Cycle is often learnt by rote rather than understood in principle, and mistakes in names and formulae are made which indicate a considerable lack of comprehension.

The inclusion of a compulsory question on both theory papers is satisfactory in the sense that it gives a very wide spread of marks and is proving a means of testing objectively the ability of students to handle and reason logically from given data. Every effort has been made to make the practical papers less dependent upon the minutiae of dissection, drawing and observation.

Lack of care in reading the instructions of the rubric is still prevalent. Some candidates still write on both sides of the paper and fail to put their answers in order, to enter the question numbers in the grid provided, or even to number the questions (or pages) at all. Candidates should be provided with string long enough to ensure that, when the pages are tied together, it is possible for examiners to turn the pages over without tearing them from the scripts as a whole.

Each theory paper and the practical papers are reported on separately.

Paper 1

Question 1

In an experiment to investigate the effect of light intensity on the rate of photosynthesis, a small shoot of *Elodea canadensis* was used. The shoot was immersed in a 2 % sodium bicarbonate solution, maintained at 15 °C. in an apparatus which allowed for the collection of the gas evolved. The light intensity was varied by moving a lamp to different distances from the *Elodea* shoot, so that the values (arbitrary units) shown in the table were obtained. The gas given off at the cut end of the shoot was allowed to collect for 3 minutes and then its volume was measured. The results obtained for each light intensity are shown in the table.

Light intensity (arbitrary units)	1	2	3	5	10	20	30	40	50
Evolution of gas (cu. mm./3 min.)	0·35	0·60	0·85	1·20	1·55	1·70	1·80	1·80	1·80

(i) Represent these results graphically.

(ii) What is the reason for using sodium bicarbonate in the experiment?

(iii) If the rate of increase of photosynthetic rate observed over the range of light intensities 1 to 3 arbitrary units had not changed with increasing light intensity, how much gas would have been collected in 3 minutes at 10 arbitrary units?

(iv) Explain the difference between the amount you calculated, and the actual amount measured in the experiment.

(i) Although this question gave a good spread of marks, it was disturbing to find that so many candidates were unable to draw a curved graph. The most common faults were putting light intensity (the independent-variable) upon the *y*-axis, and extrapolating to zero. Many candidates did not mark points clearly or draw lines firmly, indicating lack of confidence in elementary graph drawing. Other more serious errors were the inability to locate points correctly from the co-ordinates and the use of non-linear scales.

(ii) A fair proportion of candidates had not sufficient knowledge of elementary chemistry to enable them to understand the significance of immersing the shoot of *Elodea canadensis* in a 2% solution of sodium bicarbonate and attempted to explain it in terms of reduced solubility of oxygen or even in terms of osmosis.

(iii) Again a fair proportion of candidates had no conception of the way to handle a simple linear change of rate. The remainder solved the problem by calculation or

by extrapolation. In both methods, the results were often inaccurate through carelessness. In the calculation, such simple procedures as addition and multiplication were incorrectly performed and in the graphical method, the inaccurate plotting of points together with careless drawings of the extrapolation line produced a wrong numerical answer.

(iv) Many candidates realized the operation of some limiting factor, although few identified it correctly and fewer actually used the phrase 'limiting factor'. In general the answers indicated a certain lack of training in methods of handling data, particularly in a graphical form. Graphical analysis is so fundamental to the interpretation of biological phenomena, that a proper training cannot be too strongly recommended. In this paper many candidates very properly used graphs to illustrate their answers to Question 2 and Question 6(*a*).

Question 2

What are the characteristics of enzyme action? State the biochemical changes brought about by two animal and two plant enzymes, and comment upon the physiological importance of each.

The characteristics of enzyme action were enumerated fairly adequately, often with graphical reference to the effect of temperature and pH. In the second part, the emphasis was placed upon animal enzymes, particularly digestive enzymes. Many candidates found difficulty in citing plant enzymes, and auxins, chlorophyll and gibberellins were all used as examples. Another common mistake was the confusion of some intermediate metabolite with the enzyme, e.g. hydrogen acceptor, cytochrome, was given as an enzyme. The description of the biochemical change was often slipshod, e.g. 'maltase breaks maltose into sugar'. In comment upon the physiological importance, again candidates showed understanding when discussing the enzymes of digestion, but usually found difficulty when dealing with the role of plant enzymes, except for some good explanations of the role of enzymes in stomatal movement.

Answers to this question suggested that the subject is being taught as two separate aspects, Botany and Zoology. The biochemistry of enzyme action is an aspect where fundamental *biological* principles could be illustrated.

Question 3

In what ways do cells in phloem and nervous tissue differ from a 'typical' plant cell or a 'typical' animal cell? How are the modifications related to the functions of the tissues?

The following are quotations taken from scripts:

'Phloem is stiffened with lignin.'

'There is nothing in the phloem except the starch it is transporting.'

'The axon carries the message.'

'The nerve carries the stimulus.'

Many other quotations could be used to reveal the common errors and slipshod expressions of candidates. First, the difference between tissue and cell was not grasped, and secondly, the relation of cell modifications to functions was not fully appreciated.

The cell is being taught to a very advanced level with detail far beyond what is

expected, e.g. details of organelles and yet detail was lacking from the more elementary work on the structure of phloem and nervous tissue. The storage and mechanical function of the phloem were hardly mentioned and the structure of the sieve tube badly explained. A common mistake was to regard phloem and xylem as having similar structure, but with the one concerned with organic and the other with inorganic materials. The relation of structure and function in the nervous tissue was rarely developed beyond the bald statement about the synapse between two cells.

Question 4

State the functions of the liver of a mammal, indicating the physiological importance of each.

There were some good sound answers but there was also a surprising number of misconceptions about the functioning of the liver, as is shown by the following quotations:

'Excess proteins in the blood are broken into urea.'

'Amino acids are built up into glycogen and urea.'

'Too much blood sugar causes diabetes.'

The average candidate often gave a confused account of the action of the hormones insulin and adrenalin in relation to blood sugar. The biochemical processes associated with changes in levels of these hormones were beyond the comprehension of many. Deamination was likewise beyond many candidates' understanding.

Question 5

What are the characteristics of a virus? Illustrate your answer by reference to one named plant virus, and one named animal virus.

How would you classify a virus?

There were some remarkably good answers on this topic. However, many candidates did not answer the question set in that their examples did not illustrate the characteristics which they had already described. Most of the accounts were about the diseases caused by plant and animal viruses rather than about the specific viruses themselves. The classification of viruses presented some problems. Some candidates chose to try to classify viruses as living or dead. One candidate dismissed the matter with—'Viruses are the smallest known organisms . . . so I cannot regard them as living things'. Others classified them as plant or animal, and still others tried to classify them according to the diseases which they caused. When the case was argued clearly, any interpretation was acceptable.

Question 6

Using a named plant in each case, describe an experiment you would perform to show: (*a*) the effect of temperature on the growth of a root, and (*b*) the effect of the deficiency of an essential element on the growth of a plant.

Give details of the apparatus you would use. What results would you expect to get and how would you record them? In each case what conclusion would you draw?

The general standard of botanical experimental work as revealed by answers was very low. The following quotations are given in illustration:

(*a*) 'I would look to see which is the longest.'

'I would put a bean in a warm place, a cold place and a room for a week.'

'I would put some Geraniums in a thermos flask with boiling water in one, one at 90°, 80° and so on.'

It was clear that many candidates had not carried out any experimental investigations. A common mistake also was to describe the experiment designed to demonstrate the different zones of growth of a root.

(*b*) Light and auxins were described as essential elements and in many scripts candidates gave the effect of the deficiency of several elements, instead of only *one* essential element, thus wasting valuable time. The fact that many candidates appeared to believe that the results from water-culture solution experiments would be observable within a few days emphasizes the need for closer observation of the actual experiment and the measurement of the different plants periodically throughout the period of investigation. In both parts (*a*) and (*b*) the description of the apparatus and the presentation and recording of data were badly done, again suggesting a lack of experimental work and lack of training in handling data.

Question 7

How would you try to explain to a non-scientist the meaning of the terms: gene, chromosome, nucleus?

What are the differences between the inheritance of qualitative and quantitative characters? Give an example of each.

The aim of the first part of the question was not realized in the answers given by candidates. Instead of *simple*, clear accounts of the morphology, chemistry and function of the nucleus and its contents, many candidates concentrated upon the structure of nucleic acid, often including unnecessary detail. Sometimes one received 'Genes are made of several molecules of D.N.A.' and no more. The second part of the question was very badly answered. It is difficult to be precise as to the nature of the mistakes made, there was rather a total lack of understanding of the nature of qualitative and quantitative inheritance. Qualitative characters were often thought of as those to which no metrical measurement could be applied and vice versa. Quantitative characters were also stated to be those features such as the number of eyes or arms etc. possessed by an organism, the inheritance of which is due to the genotype in its entirety.

Question 8

Describe in detail those features of a named bird which show its adaptation to its way of life.

This was a popular question and there were some very good answers. Too many candidates chose birds which they were unlikely to have seen, let alone studied, e.g. albatross, golden eagle, etc. The named bird also tended to get lost as the answer proceeded, for example 'the bird has four toes for gripping a branch' and 'the colour of the bird has been adapted to fit in with the surroundings' (no colour specified nor surroundings specified). On the other hand, some candidates described and illustrated

the correlation between beak and food, and between feet and locomotion. Some answers suggested that little further work had been done on birds since the initial study for Ordinary level Biology.

Question 9

How would you prepare to study the ecology of a small habitat? If you were asked to give quantitative results, what work would you try to carry out?

This was an unpopular question and when chosen the quality of the answer seemed to be in direct relation with the amount of field work that had been done. Perhaps the following sentiment expressed by one of the candidates supplies the reason for lack of popularity: 'To begin with, such a venture requires will-power, for much time and effort must be put into the study.' There were some extraordinarily good answers which showed that practical work in the field had stimulated careful thought and analysis of the relation of the flora and fauna to the environment.

Paper 2

Question 1

(*a*) In comparing the metabolic rates of animals of different size, it is convenient to relate the amount of oxygen absorbed per unit of body weight in a given time. The metabolic rates of some familiar animals are given by the following results:

Animal	c.c. oxygen absorbed/gm./hr.
Mouse	1580
Rat	872
Rabbit	318
Man	202
Elephant	67

How do you interpret and explain these results?

(*b*) In an experiment to measure the oxygen intake and the nitrogen output of a human subject, it was observed that during a 24 hour period the subject consumed 400 litres of oxygen and eliminated 12 gm. of nitrogen in waste substances. It is known that in metabolism 1 gm. of waste nitrogen corresponds to 6·25 gm. of protein, the absorption of 6 litres of oxygen and the production of 26·5 calories of heat. It is also known that 1 litre of oxygen is equivalent to the metabolism of 0·6 gm. of carbohydrate plus 0·3 gm. of fat. Calculate the amounts (in grams) of protein, carbohydrate and fat metabolised by the subject in 24 hours. If the calorific value of carbohydrate is 4 calories/gm. and of fat, 9 calories/gm., calculate the total heat output of the foods metabolised by the subject in 24 hours.

(*a*) Many candidates produced interesting and well-thought-out answers to this part of the question. Acceptable explanations were based upon a changing surface area to volume ratio. A fair proportion of candidates made no reference to surface heat losses at all and a few reasoned illogically and concluded that an elephant will have a higher metabolic rate because there are more grams in its body than in the body of a mouse.

(*b*) The calculation proved too difficult for some candidates. However, written work was generally well organized and neatly presented. A noticeable number of candidates mistakenly used the figure of 400 litres as a starting point for the calculation of carbohydrate and fat used. Such candidates had overlooked the 72 litres of

oxygen needed for protein metabolism. It was disappointing to find so many errors in elementary mathematics that sometimes led to a ridiculous answer for the total heat output of the subject in 24 hours.

Question 2

What are the gametes of a flowering plant? Describe and explain the essential steps in their formation.
What are the differences between a seed and an ovule?

In nearly every answer pollen grains and ovules were said to be the gametes of a flowering plant. If candidates had only considered the nature and behaviour of gametes in, for example, man, this error would have been avoided. Accounts dealing with gamete formation were often complicated by unnecessary detail of meiosis. Again many candidates emphasized irrelevant detail of the nuclear events which follow fertilization.

The distinction between a seed and an ovule presented a real problem to the majority of candidates and it was common to read that

'a seed contains a zygote';
'a seed is a fertilized cell';
'an ovule is an unfertilized gamete';
'an ovule is haploid and a seed is diploid'.

Few candidates referred to the structure of *particular* seeds and only a minority made reference to the *size* difference between a seed and an ovule.

Question 3

Give a labelled drawing of a complete kidney tubule, together with its blood supply.
In cases of severe bleeding no urine is formed. Why is this?
Sea water contains about 3 % salt, the salt content of blood is about 1 % and, as a maximum, the kidneys can excrete only a 2 % salt solution. Give a brief explanation for the serious consequences that occur after drinking a great deal of sea water.

There were many good drawings from the better candidates showing both cellular and vascular detail of the tubule. The coiled loops of the nephron were often badly illustrated.

Many candidates offered teleological answers to account for the absence of urine after severe bleeding. To say that the body *needs* the blood which is lost has no bearing on the fact that *without* hydrostatic pressure capsular filtration will not occur.

In the last part of the question many candidates ignored the direction to give a *brief* explanation and wrote long accounts of renal physiology. Few candidates observed that for every pint of sea water taken in one and a half pints of urine will be formed and so, inevitably, a rapid dehydration of tissues will occur.

Question 4

What does the theory of organic evolution mean to the biologist? What, in your opinion, are the two most convincing kinds of evidence for evolution? Describe each as fully and as critically as you can.

It was anticipated that accounts of fossil evidence would be popular but it rarely emerged that only a common ancestry of species made sense of fossils. Hardly anyone

gave drawings of leg bones of fossil horses or of the fore-limb skeleton of *Archaeopterax*. It was simply asserted that evolution had occurred. One often read of 'man coming from apes' and 'embryonic gill pouches in mammals functioning as gill slits'. Many accounts contained more than two kinds of evidence and there was seldom any critical approach to the facts presented. It appears that, perhaps, too much is attempted in the teaching of evolution so that the real points at issue are hidden in a medley of assertions.

Question 5

Compare the vegetative structure of yeast and *Mucor* (or *Rhizopus*).
Write an account of the life-history of yeast.

This question was generally well done. The facts given concerning the vegetative structure of the two fungi were not always accurate, as the following quotations from scripts reveal:

'starch is found in the cytoplasm of yeast';
'the hyphae of *Mucor* are septate'.

It was often stated that 'the budding of yeast occurs in good conditions', but candidates seldom explained what the conditions were. The better candidates made reference to the fact that the formation of asci is preceded by conjugation of cells in some species, but that this conjugation may occur many cell-generations before ascus formation, so that the yeast cell may exist in either haploid or diploid forms according to the stage of its life cycle. Unnecessary accounts of reproduction in *Mucor* were common.

Question 6

Give a simple, labelled drawing to show the appearance of a motor end-plate. What part does it play in the contraction of a muscle? Without giving biochemical formulae or naming all the intermediate compounds, outline the principal changes that occur in the breakdown of glycogen during muscle activity.
After severe exercise increased amounts of oxygen are required by the body. Why is this?

Drawings of a motor end-plate were often rough sketches with poor detail and rarely showed an intimacy of contact between axon and sarcoplasm. There was much confusion between a nerve fibre and a nerve, a muscle fibre and a muscle.

For the remainder of the question the better candidates limited their answers to the issues involved, maintaining a selective and concise approach throughout. Too often, however, a long account of the mechanics of muscle contraction was substituted for a summary of chemical transmission across the nerve-muscle junction. Again, guidance in the question about intermediate compounds was often ignored. There appears to be a growing tendency among candidates to describe nearly all forms of biochemical change as 'breakdown changes', e.g. glucose is broken down to fructose; pyruvic acid is broken down to lactic acid.

On the whole candidates showed a reasonable understanding of 'oxygen debt'.

Question 7

There are no nerve cells in flowering plants and yet they often show responses beyond the stimulated area. Explain how this is possible. Show, by means of one example in each case, what is meant by 'nastic responses' and by 'photoperiodism'.

The first part of this question was often answered well, candidates describing experiments from which they deduced a co-ordination mechanism. It was clear, however, that many of them did not know how phototropic experiments with coleoptiles are, in fact, carried out. Such candidates offered long, theoretical accounts of tropic phenomena which avoided the main issues.

Some answers on photoperiodism were excellent but nastic responses were less well understood. On a number of occasions the opening of flower buds was confused with the initiation of floral primorida. It was accepted by some candidates that *all* short-day plants require less than 8 hours of light before they will flower.

Question 8

In what ways is a locust (or cockroach) adapted for a terrestrial life?
What advantages has parthenogenesis for some insects?

This was a very popular question and one which very soon spotlighted the determined non-thinkers. Very few candidates were selective and concise. The question of land adaptation was largely ignored and candidates simply wrote down all they appeared to know about the locust (or cockroach). Practically everything written down about the exoskeleton, compound eyes and appendages applies equally to prawns. Only rarely was reference made to the wax layer by those who said that the cuticle prevents desiccation. Many simply described the cuticle as 'hard' or 'strong' or 'protective'. Mosquito larvae, which live in water, also breathe by a tracheal system opening by the equivalent of a spiracle. Thus the real importance of the tracheal system in relation to the question asked is that the loss of water is nearly proportional to the minute area of cross-section of the spiracles. It is difficult to understand why so many candidates waste time and effort drawing mouth parts, legs and life-histories. A few candidates described ecdysis in detail too.

Whilst most candidates knew something about parthenogenetic reproduction in aphids few considered the advantages accruing from this greatly increased reproductive capacity.

Question 9

Write an elementary account of the chemical nature of carbohydrates and fats. What other biological functions do fats have besides providing a source of energy?
Describe one test by which you could identify a fat.

Only a small minority of candidates answered this question satisfactorily because most of them emphasized *physical* properties (the question asked for *chemical* properties) and many candidates gave badly memorized formulae and equations. Some even wrote at length about the physiology of digestion. Only an elementary knowledge of the chemistry involved is needed for an understanding of the behaviour of carbohydrates and fats when they are met for the first time in practical biology, e.g. the

presence or absence of reducing properties of carbohydrates, the salivary digestion of starch (but not of cellulose) and the way oils assume a globular form. 'The heart and kidneys have fat around them to cushion and protect them.' This kind of statement was commonly made by candidates in answer to the question about the biological functions of fats.

Most candidates could identify a fat correctly.

PRACTICAL BIOLOGY (ALTERNATIVE A)

Question 1

The general standard of dissection (the anterior blood vascular system of a frog) was good, some candidates producing work of the highest quality and gaining full marks or thereabouts. Most candidates followed the instructions carefully and gained credit for doing so and there was some improvement in the accuracy of the drawings; those candidates whose drawings corresponded to their dissection were rewarded even though they may have been quite unlike any textbook drawing. There were some candidates who seemed unaware of all that was displayed in their dissections.

Question 2

Was based on the reactions of the enzyme catalase. Many candidates confused their observations and interpretations; in many cases both observations and interpretations were recorded in the table. Insufficient care was taken over observing the reactions; the different rates of reaction were too often ignored as were the differences in colour and texture between the raw liver and boiled liver and between raw potato and boiled potato. Frequently the candidate stated that oxygen had been evolved without confirming this by test. Many candidates still refer to enzymes being 'killed' on boiling, a term to be avoided in any serious biological descriptions.

Question 3

This question on the fern (pinna and a prothallus of *Dryopteris*) was badly answered; only a few candidates revealed any ability for accurate and detailed observation. There was much confusion over the terms 'indusium', 'sorus' and 'sporangium'. Very few candidates responded to the instructions to annotate their drawings.

Question 4

The comparison in the table was satisfactorily carried out but only a few candidates were able to devise a simple key. There was a frequent confusion over naming the phyla to which the specimens belonged, e.g. 'Insecta' was often given for the phylum to which **K6** (stick insect) belonged, it being assumed that the division of the body into head, thorax and abdomen and the presence of three pairs of thoracic legs was an arthropod characteristic.

The handwriting of some of the candidates was almost indecipherable; and some of the spelling was dreadful. Candidates should realize that they may penalize themselves if, as a result of neglect of this kind, the examiners are unable to understand what is written.

Most of the dissections (removal of brain from skull of a rat) were well done, the better candidates causing little damage to projecting structures such as the paraflocculi. Whilst many candidates drew and labelled the pituitary body even though it had been completely removed, others did not draw features that were clearly visible, e.g. the division of the hind brain, the origin of the optic nerves and the trigeminal tract. Many candidates do not appear to appreciate that, in a practical examination, it is the accurate recording of *observable features* that is wanted. Too often the drawings were of a low standard and bore little resemblance to the actual dissections. Textbook drawings, which are generally stylized, are not necessarily accurate representations and are not wanted.

In Question 2 (based on osmotic pressures in beetroot slices) colour observations were not well recorded, unhelpful terms such as 'clear' and 'transparent' being used to describe colour. A lack of understanding was displayed in the brief explanation such that the terms 'osmosis', 'endosmosis' and 'plasmolysis' were given as explanations of most physiological phenomena. Some candidates made no mention of the cell, others seemed to believe that the cell wall is a semipermeable membrane, there being no mention of the cytoplasmic membrane or of proteins. A number of candidates seemed to believe that the object of the water bath was merely to prevent the boiling tubes from being cracked if they were heated by a naked flame.

In Question 3 Specimen **K21** (inflorescence of *Avena sativa*) was difficult to handle. Nevertheless some very good drawings were produced, but there were also many textbook diagrams. A common failure was to produce drawings that were far too small so that the examiners were faced with the problem of having to interpret what could best be regarded as smudges and blobs. The production of a key that would distinguish specimens **K21**, **K22** (inflorescence of plantain) and **K23** (inflorescence of sycamore) defeated almost all candidates. Most candidates, in fact, produced a tabulation of not very accurate observations.

The plan diagram of a T.S. of stem of *Cucurbita* (**K24**, Question 4) was well done but that of a vascular bundle usually left much to be desired. The chief defect here was the drawing of large numbers of circles to represent, inaccurately, the various kinds of cells that could be seen. As has so often been emphasized, a plan diagram, conventionally, is a means of recording the proportions, relative sizes and distribution of tissues *without any details of the individual cells*. The latter should always be shown by *accurate* drawings. The degree of accuracy required makes it impossible, under examination conditions, to draw more than a very few individual cells.

Only about half of the candidates were able to place **K25** (medusa of *Obelia*) in the Coelenterata. Some of the guesses were inexcusable, e.g. 'a protozoan surrounded by cilia', 'an ovum being fertilized by sperm'.

In general an analytical approach to questions was lacking. Answers tended to lack the depth of understanding expected of Special Paper candidates. For instance, the amoeba–earthworm–frog–mammal syndrome was greatly in evidence. Few candidates gave poor answers but even fewer gave really good answers.

Question 1

Compare and contrast nervous control with control by hormones. What advantage is it to an organism to possess both systems?

There was a general vagueness about the physiology of nervous and endocrine systems. The inter-connections of brain and endocrine system via hypothalamus and pituitary was seldom mentioned and the phenomenon of neuro-secretion not at all.

Question 2

How far are the appearances of structures that go to make up 'typical' plant and animal cells a reflection of their function?

There were a number of elementary omissions in consideration of the appearance of the structure of plant and animal cells. In particular, ribosomes were almost entirely neglected, and the difference between plant and animal cell walls was not discussed adequately.

Question 3

How, and why, are substances taken into and ejected from cells?

Answers to this question were probably the worst in the paper. Active transport as shown by intestinal or kidney tubule cells was not dealt with, nor was the nature of secretion.

Question 4

Describe the process of photosynthesis and point out, giving your reasons, which steps you think to be the most significant. What connection is there between the existence of the process of photosynthesis and the division of most organisms into animals and plants?

Biophysical considerations in the process of photosynthesis were dealt with rather cursorily; in particular the energy relations of the transfer of light energy to chemical energy were often not discussed so that the real significance of the process was missed.

Question 5

What factors affect the temperature of an organism? What are the advantages and disadvantages to an organism of maintaining its body at a more or less constant temperature?

The role of the hypothalamus in body temperature regulation in mammals was not discussed but most answers were adequate.

Question 6

What is the importance of sexual reproduction to the process of evolution?

In some cases a full description of meiosis was given without pointing out the relevance of any of the stages to the question asked; in other cases crossing over and chiasma formation were not mentioned at all.

Question 7

What is meant by the term 'respiration'? Outline the ways in which animals provide for a supply of oxygen to their respiring tissues, and point out the features that contribute most to the efficiency of the process.

Formation of ATP was all too frequently coupled directly to the citric acid cycle. Oxidative phosphorylation was seldom mentioned and very few candidates understood the role of oxygen as a terminal electron acceptor in the respiratory chain. Clearly, the need for oxygen in cellular respiration is not appreciated.

Question 8

A new island is formed by a pushing up of part of the sea floor. Describe what you think would be the probable course of events in its colonization by living organisms.

There was an inadequate consideration of edaphic and climatic matters. The sequence of colonization described was often that for a Northern Temperate zone, without a proper realization that this is what was being described.

Question 9

Frogs have four legs yet trees have a variable number of branches. Consider this statement.

Candidates who attempted this question obviously found it very difficult. Answers tended to concentrate on a teleological/evolutionary discussion that ignored the differences in growth patterns.