Year 2019 Examination

ISC

Analysis of Pupil Performance

BIOLOGY

Research Development and Consultancy Division

Council for the Indian School Certificate Examinations

New Delhi

Year 2019

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Pragati House, 3rd Floor

47-48, Nehru Place

New Delhi-110019

Tel: (011) 26413820/26411706
E-mail: council@cisce.org

FOREWORD

This document of the Analysis of Pupils' Performance at the ISC Year 12 and ICSE Year 10 Examination is one of its kind. It has grown and evolved over the years to provide feedback to schools in terms of the strengths and weaknesses of the candidates in handling the examinations.

We commend the work of Mrs. Shilpi Gupta (Deputy Head) of the Research Development and Consultancy Division (RDCD) of the Council and her team, who have painstakingly prepared this analysis. We are grateful to the examiners who have contributed through their comments on the performance of the candidates under examination as well as for their suggestions to teachers and students for the effective transaction of the syllabus.

We hope the schools will find this document useful. We invite comments from schools on its utility and quality.

Gerry Arathoon
Chief Executive & Secretary

October 2019

PREFACE

The Council has been involved in the preparation of the ICSE and ISC Analysis of Pupil Performance documents since the year 1994. Over these years, these documents have facilitated the teaching-learning process by providing subject/ paper wise feedback to teachers regarding performance of students at the ICSE and ISC Examinations. With the aim of ensuring wider accessibility to all stakeholders, from the year 2014, the ICSE and the ISC documents have been made available on the Council's website www.cisce.org.

The documents include a detailed qualitative analysis of the performance of students in different subjects which comprises of examiners' comments on common errors made by candidates, topics found difficult or confusing, marking scheme for each question and suggestions for teachers/ candidates.

In addition to a detailed qualitative analysis, the Analysis of Pupil Performance documents for the Examination Year 2019 also have a component of a detailed quantitative analysis. For each subject dealt with in the document, both at the ICSE and the ISC levels, a detailed statistical analysis has been done, which has been presented in a simple user-friendly manner.

It is hoped that this document will not only enable teachers to understand how their students have performed with respect to other students who appeared for the ICSE/ISC Year 2019 Examinations, but also provide information on how they have performed within the Region or State, their performance as compared to other Regions or States, etc. It will also help develop a better understanding of the assessment/ evaluation process. This will help teachers in guiding their students more effectively and comprehensively so that students prepare for the ICSE/ ISC Examinations, with a better understanding of what is required from them.

The Analysis of Pupil Performance document for ICSE for the Examination Year 2019 covers the following subjects: English (English Language, Literature in English), Hindi, History, Civics and Geography (History and Civics, Geography), Mathematics, Science (Physics, Chemistry, Biology), Commercial Studies, Economics, Computer Applications, Economic Applications, Commercial Applications.

Subjects covered in the ISC Analysis of Pupil Performance document for the Year 2019 include English (English Language and Literature in English), Hindi, Elective English, Physics (Theory), Chemistry (Theory), Biology (Theory), Mathematics, Computer Science, History, Political Science, Geography, Sociology, Psychology, Economics, Commerce, Accounts and Business Studies.

I would like to acknowledge the contribution of all the ICSE and the ISC examiners who have been an integral part of this exercise, whose valuable inputs have helped put this document together.

I would also like to thank the RDCD team of Dr. M.K. Gandhi, Dr. Manika Sharma, Mrs. Roshni George and Mrs. Mansi Guleria who have done a commendable job in preparing this document.

Shilpi Gupta
Deputy Head - RDCD

October 2019

CONTENTS

INTRODUCTION

This document aims to provide a comprehensive picture of the performance of candidates in the subject. It comprises of two sections, which provide Quantitative and Qualitative analysis results in terms of performance of candidates in the subject for the ISC Year 2019 Examination. The details of the Quantitative and the Qualitative analysis are given below.

Quantitative Analysis

This section provides a detailed statistical analysis of the following:

- Overall Performance of candidates in the subject (Statistics at a Glance)
- State wise Performance of Candidates
- Gender wise comparison of Overall Performance
- Region wise comparison of Performance
- Comparison of Region wise performance on the basis of Gender
- Comparison of performance in different Mark Ranges and comparison on the basis of Gender for the top and bottom ranges
- Comparison of performance in different Grade categories and comparison on the basis of Gender for the top and bottom grades

The data has been presented in the form of means, frequencies and bar graphs.

Understanding the tables

Each of the comparison tables shows N (Number of candidates), Mean Marks obtained, Standard Errors and t-values with the level of significance. For t-test, mean values compared with their standard errors indicate whether an observed difference is likely to be a true difference or whether it has occurred by chance. The t-test has been applied using a confidence level of 95%, which means that if a difference is marked as ‘statistically significant’ (with * mark, refer to t-value column of the table), the probability of the difference occurring by chance is less than 5%. In other words, we are 95% confident that the difference between the two values is true.

t-test has been used to observe significant differences in the performance of boys and girls, gender wise differences within regions (North, East, South and West), gender wise differences within marks ranges (Top and bottom ranges) and gender wise differences within grades awarded (Grade 1 and Grade 9) at the ISC Year 2019 Examination.

The analysed data has been depicted in a simple and user-friendly manner.

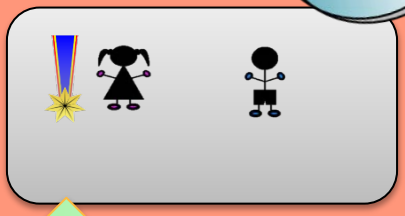
Given below is an example showing the comparison tables used in this section and the manner in which they should be interpreted.

Comparison on the basis of Gender

Gender	N	Mean	SE	t-value
Girls	2,538	66.1	0.29	11.91*
Boys	1,051	60.1	0.42	

*Significant at 0.05 level

Girls performed significantly better than boys.



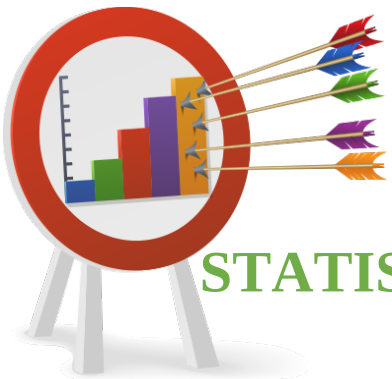
The table shows comparison between the performances of boys and girls in a particular subject. The t-value of 11.91 is significant at 0.05 level (mentioned below the table) with a mean of girls as 66.1 and that of boys as 60.1. It means that there is significant difference between the performance of boys and girls in the subject. The probability of this difference occurring by chance is less than 5%. The mean value of girls is higher than that of boys. It can be interpreted that girls are performing significantly better than boys.

The results have also been depicted pictographically. In this case, the girls performed significantly better than the boys. This is depicted by the girl with a medal.

Qualitative Analysis

The purpose of the qualitative analysis is to provide insights into how candidates have performed in individual questions set in the question paper. This section is based on inputs provided by examiners from examination centres across the country. It comprises of question wise feedback on the performance of candidates in the form of *Comments of Examiners* on the common errors made by candidates along with *Suggestions for Teachers* to rectify/ reduce these errors. The *Marking Scheme* for each question has also been provided to help teachers understand the criteria used for marking. Topics in the question paper that were generally found to be difficult or confusing by candidates, have also been listed down, along with general suggestions for candidates on how to prepare for the examination/ perform better in the examination.

QUANTITATIVE ANALYSIS



STATISTICS AT A GLANCE

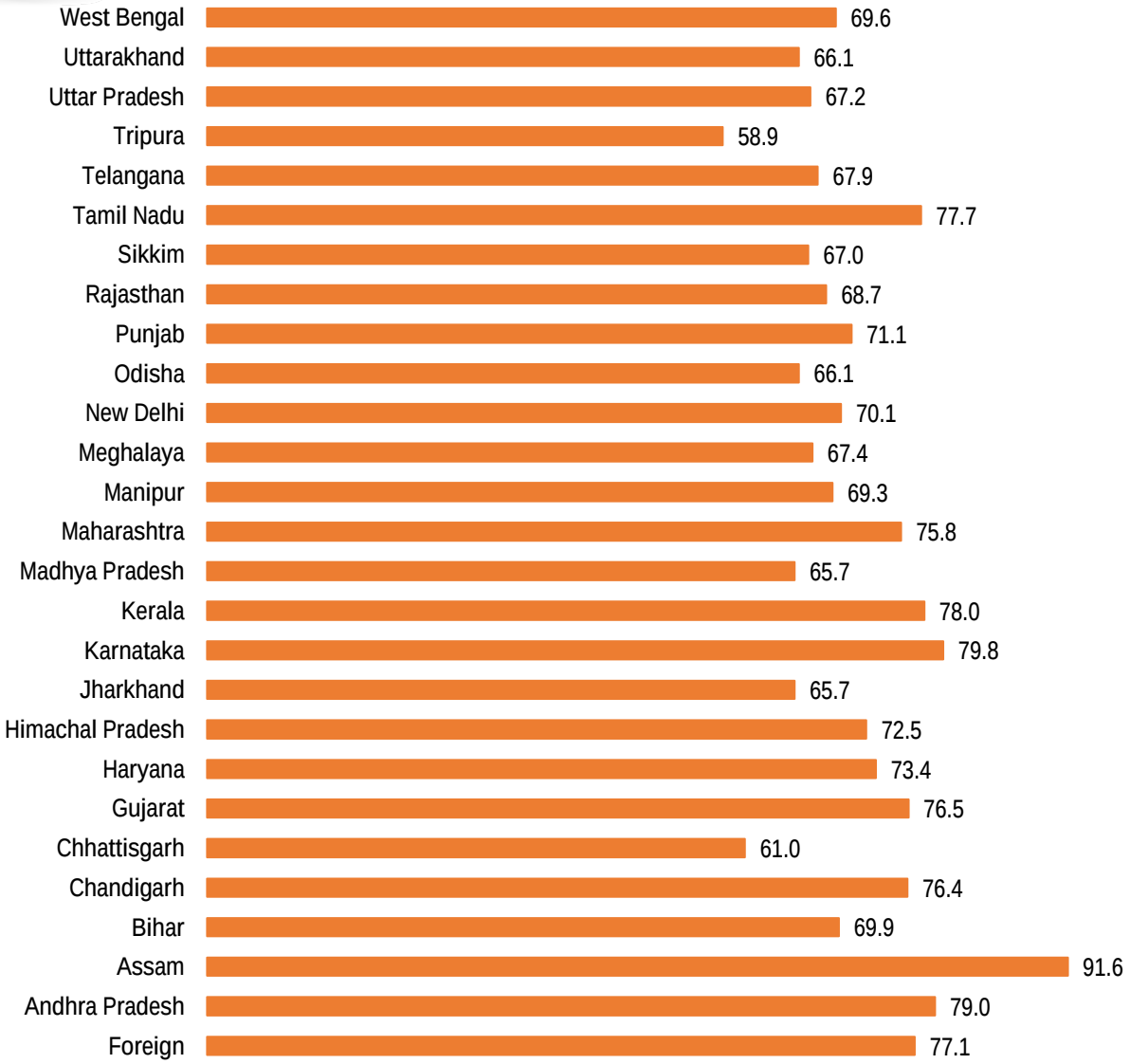
Total Number of Candidates: 17,945

Mean Marks: 70.1

Highest Marks: 100

Lowest Marks: 10

PERFORMANCE (STATE-WISE & FOREIGN)



The States of Assam, Karnataka and Andhra Pradesh secured highest mean marks. Mean marks secured by candidates studying in schools abroad were 77.1.

GENDER-WISE COMPARISON

GIRLS

Mean Marks: 71.4

Number of Candidates: 10,670

BOYS

Mean Marks: 68.0

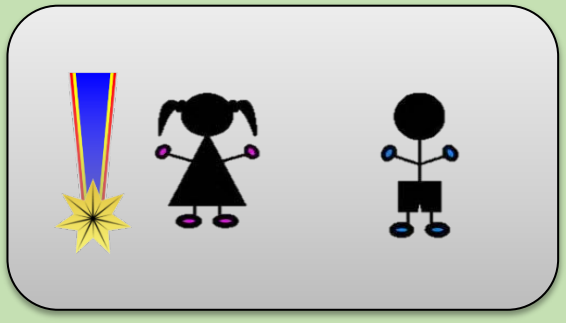
Number of Candidates: 7,275

Comparison on the basis of Gender

Gender	N	Mean	SE	t-value
Girls	10,670	71.4	0.15	13.84*
Boys	7,275	68.0	0.19	

*Significant at 0.05 level

Girls performed significantly better than boys.



REGION-WISE COMPARISON

East

Mean Marks: 68.7

Number of Candidates: 7,200

Highest Marks: 100
Lowest Marks: 10

North

Mean Marks: 67.4

Number of Candidates: 6,954

Highest Marks: 100
Lowest Marks: 14

REGION

Mean Marks: 77.9

Number of Candidates: 2,921

Highest Marks: 100
Lowest Marks: 26

South

Mean Marks: 75.7

Number of Candidates: 779

Highest Marks: 100
Lowest Marks: 23

West

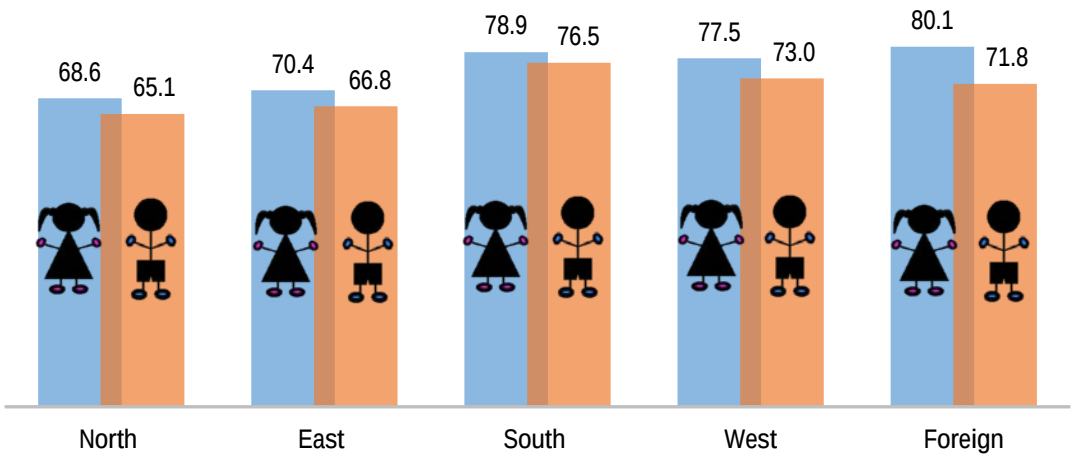
Mean Marks: 77.1

Number of Candidates: 91

Highest Marks: 100
Lowest Marks: 44

Foreign

Mean Marks obtained by Boys and Girls-Region wise

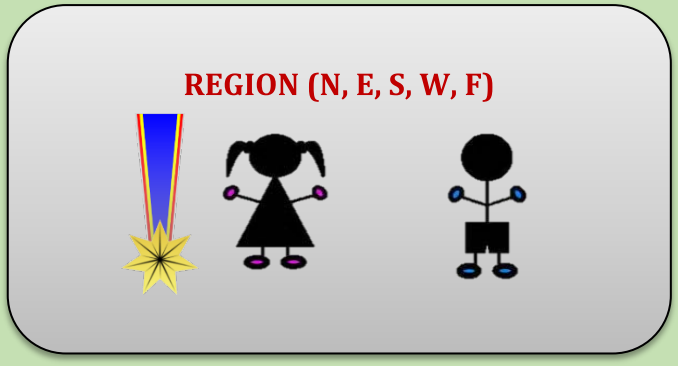


Comparison on the basis of Gender within Region

Region	Gender	N	Mean	SE	t-value
North (N)	Girls	4,477	68.6	0.24	8.37*
	Boys	2,477	65.1	0.34	
East (E)	Girls	3,871	70.4	0.24	9.49*
	Boys	3,329	66.8	0.29	
South (S)	Girls	1,789	78.9	0.30	4.93*
	Boys	1,132	76.5	0.40	
West (W)	Girls	475	77.5	0.69	4.02*
	Boys	304	73.0	0.86	
Foreign (F)	Girls	58	80.1	1.82	2.66*
	Boys	33	71.8	2.52	

*Significant at 0.05 level

The performance of girls was significantly better than that of boys in all the regions.

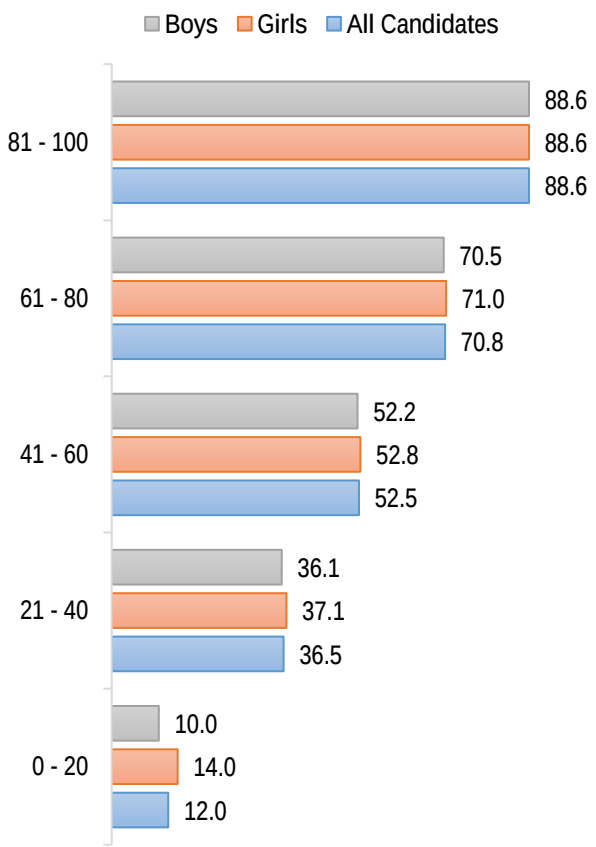


MARK RANGES : COMPARISON GENDER-WISE

Comparison on the basis of gender in top and bottom mark ranges

Marks Range	Gender	N	Mean	SE	t-value
Top Range (81-100)	Girls	3,460	88.6	0.09	-0.02
	Boys	1,941	88.6	0.12	
Bottom Range (0-20)	Girls	1	14.0	0	-
	Boys	1	10.0	0	

No significant difference was found in the performance of girls and boys.

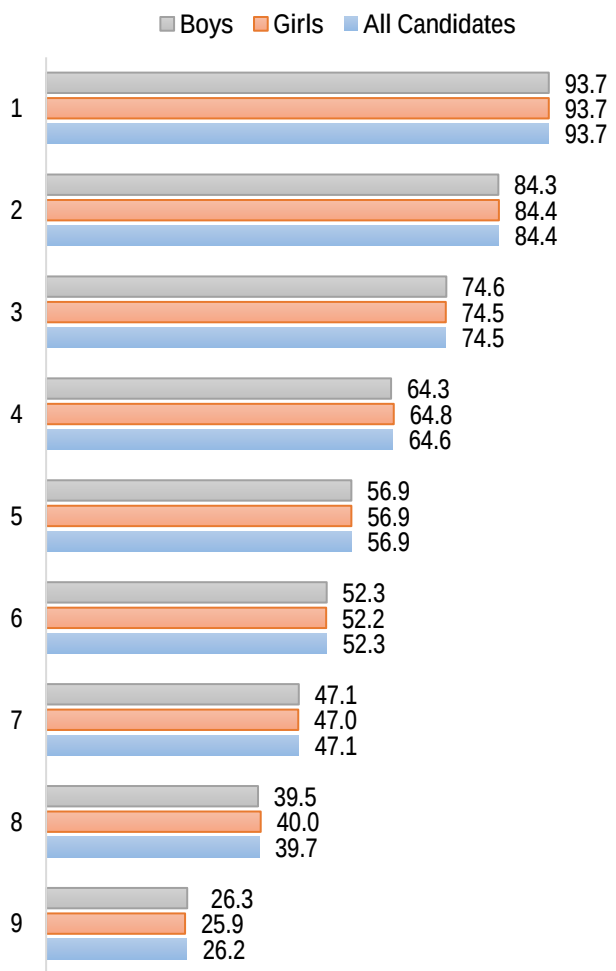


GRADES AWARDED : COMPARISON GENDER-WISE

Comparison on the basis of gender in Grade 1 and Grade 9

Grades	Gender	N	Mean	SE	t-value
Grade 1	Girls	1,437	93.7	0.07	-0.35
	Boys	831	93.7	0.10	
Grade 9	Girls	17	25.9	0.92	-0.43
	Boys	46	26.3	0.48	

No significant difference was observed between the performance of girls and boys.



PART I (20 Marks)

Answer all questions

Question 1

(a) Answer the following questions briefly and to the point: **[8×1]**

(i) Name the antibody which is most effective in allergies.

(ii) What is the function of GEAC?

(iii) What is a *clone?*

(iv) What do detritus food chains begin with?

(v) Give the full form of EFB.

(vi) How many chromosomes are present in meiocytes of a fruit fly?

(vii) Name the common ancestor of apes and man.

(viii) Give the scientific term used for the preservation of germplasm at a very low temperature.

(b) Each of the following sub-parts, (i) to (iv) has four choices. Choose the best option in each case: **[4×1]**

(i) Eyelids in human foetus separate in:

(1) 14 weeks

(2) 16 weeks

(3) 24 weeks

(4) 40 weeks

(ii) Study the given monohybrid cross:

P_1 TT × tt

↓

F_1 Tt

A test cross for this F_1 will be:

(1) Tt × TT

(2) Tt × tt

(3) Tt × Tt

(4) TT × tt

(iii) Montreal Protocol aims at:

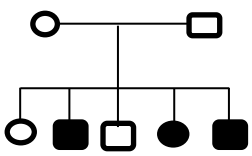
(1) Reduction of ozone depleting substances

(2) Biodiversity conservation

(3) Control of water pollution

(4) Control of CO_2 emission.

(iv) In the given pedigree chart, the trait shown is:



(1) Autosomal dominant

(2) Autosomal recessive

(3) X-linked

(4) Y-linked

(c) Give *one* significant contribution of each of the following scientists: **[4×1]**

(i) Wallace

(ii) R. Mishra

(iii) G. Gamow

(iv) Sanger

(d) Define the following: **[2×1]**

(i) Carrying capacity

(ii) Homologous chromosomes

(e) Give a reason for each of the following: **[2×1]**

(i) Bagging is essential in artificial hybridisation.

(ii) Climax stage is achieved quickly in secondary succession as compared to primary succession.

Comments of Examiners

(a) (i) Several candidates mixed up *antibody* with *antibiotic* and wrote *Penicillin* as the answer. Many candidates wrote histamine and antihistamine. Some gave the names of medicines like Avil, Cetrizine, Allegra. A few mentioned IgG and IgM also.

(ii) Many candidates, either wrote only the full form of GEAC or mentioned its role as monitoring research on environment and ecology, without discussing the role of genetically modified organisms. Some of them wrote self-devised expansions of the term like "Gas Emission Association Community".

(iii) Majority of the candidates missed out on the key words *Genetically* & *Morphologically identical individuals*, writing *identical individuals*.

(iv) Several candidates, instead of writing *dead organic matter*, wrote only *organic matter*. Others gave incorrect answers like *producers*, *consumers*, *phytoplanktons* or *carnivores*. Some repeated the term detritus which was mentioned in the question itself. A few candidates wrote *Detrivores*.

(v) Several candidates did not attempt this question. Many who attempted it, wrote their own terminologies like Extended Forest Board, Elimination of the fittest, Energy Food Bureau. Some candidates expanded B as Biology instead of Biotechnology.

(vi) Many candidates were confused between Meiocytes and Gametes, hence they wrote 4 instead of 8. Some wrote incorrect numbers like 46, 10, etc. Some only mentioned haploid and diploid without mentioning the actual number.

(vii) Very few candidates wrote Dryopithecus with the correct spelling. Majority of the candidates wrote a variety of answers from Monkeys to Apes, Cro-magnon and Neanderthal man.

(viii) Most candidates wrote terms such as cryptopreservation, cold storage and cryogenesis. Some candidates repeated the term germplasm preservation given in the question.

Suggestions for teachers

- Discuss the basis of classifying antibodies into different types as well as features and functions of each antibody.
- Teach the special role of each immunoglobin in a tabular form.
- Explain to the students that the abbreviation of the term itself describes function with reference to Genetic Engineering.
- Teach and instruct students to learn all the definitions mentioned in the syllabus, with emphasis on key words.
- Do a comparative study of Grazing and Detritus food chains in the class so that the students get clarity about the nature of these food chains and their components. Explain the meaning of the terms like Detritus and Detrivores.
- Ensure that the students are well versed with the list of abbreviations given in the scope of the syllabus and conduct regular tests on the same.
- While discussing Gametogenesis, explain that the cells which undergo meiosis are called meiocytes.
- Advise the students to memorize the organisms and the corresponding chromosome numbers in their somatic cell and germ cell of those specific plant and animal species which are mentioned in the syllabus.
- Discuss the importance of each ancestor and the correct sequence of ancestors while teaching Human Evolution.
- Emphasise on the biological names.
- Summarise, in a tabular form, trimester wise and week wise, the major landmarks, changes and events taking place in human embryo.

(b) (i) Most candidates wrote the incorrect option.

(ii) Many candidates were confused between test cross and back cross and chose the incorrect option Tt x TT.

(iii) Majority of the candidates did not choose the correct option expressing the main agenda of Montreal Protocol.

(iv) Majority of candidates were unable to identify the trait shown in the given pedigree chart correctly.

(c) (i) Many candidates gave the contribution as, Origin of life /divided earth into six continents /Geographical divisions of the earth.

(ii) Some candidates gave answers such as, Father of Biology /Father of Green Revolution/ Father of Plant Embryology.

(iii) Instead of writing *triplet nature of codon*, many candidates wrote gave the contribution as, concept of genetic code/discovered DNA/ developed method of DNA finger printing.

(iv) Many candidates wrote the contribution of Sanger as, discovered nucleic acid/proteins/proposed Recapitulation theory instead of *DNA sequencing/protein sequencing*.

(d)(i) Many candidates wrote incorrect definitions like, *the capacity of a population to carry the load by organisms* or *ability of an area to carry individuals*. Several candidates did not write the key word *maximum*, only mentioning the number of individuals an environment can support. Some candidates mistook carrying capacity as the ability of the uterus to carry the foetus during gestation.

(ii) Many candidates confused homologous chromosomes with homozygous and heterozygous. Some candidates defined homologous chromosomes in terms of homologous organs and wrote chromosomes having similar structure and different functions, not mentioning the key word *corresponding chromosomes*.

(e)(i) Many candidates wrote that bagging is essential to protect the plant from damage. Some candidates got confused with artificial insemination, emasculation and hybridization.

- Explain test cross and back cross separately and clearly. Lay stress upon F_1 crossed with recessive parent for test cross.
- Familiarize the students with major international initiatives taken towards reducing pollution related issues, discussing each case separately, by laying emphasis on main agenda of these initiatives.
- Teach the rules for analysis of pedigree charts to the students and make them practice different types of pedigree charts. Also, discuss different patterns of inheritance.
- Familiarise the students with the significant contributions of the scientists mentioned in the syllabus. Discuss the role of the scientist when teaching the relevant chapter itself. This will make it easier for the students to write exact & precise contribution of the concerned scientist.
- Compare the roles of Esau (Plant Anatomy), M. S. Swaminathan (Green Revolution) and P. Maheshwari (Plant Tissue Culture) together to avoid overlaps and confusion.
- Explain clearly to the students about the technical terms/ definitions in detail with reference to the context. While discussing the technique of hybridization, discuss the importance of each step of the technique.
- Explain the concept of succession, citing examples and analogies as far as possible.
- Emphasise the importance of key words in all answers of definitions as well as in the differences.
- Discuss the sequence of different seral stages and the role of each seral stage in creating the ideal conditions for the next stage.

(ii) Majority of the candidates did not attempt this question. Some repeated the question and wrote Climax stage was achieved quickly because it was fast or because it came after secondary.

MARKING SCHEME

Question 1

(a)	(i)	IgE
	(ii)	Monitors the safety standards of genetically modified organisms (products) released for public service. Validate/regulates GM research and safety of introducing GM (Transgenic) organisms
	(iii)	Morphologically and genetically similar individuals / Individuals produced by asexual reproduction /progeny exactly similar to parents
	(iv)	Dead organic matter/dead plant or animal matter.
	(v)	European Federation of Biotechnology
	(vi)	4 pairs / 8
	(vii)	*Dryopithecus / Ramapithecus*
	(viii)	Cryopreservation
(b)	(i)	(3) **or** 24 weeks
	(ii)	(2) **or** Tt × tt
	(iii)	(1) **or** Reduction of ozone depleting substances
	(iv)	(2) **or** Autosomal recessive
(c)	(i)	**Wallace:** Divided the earth into biogeographical regions / natural selection
	(ii)	**R. Mishra**: Father of Indian ecology
	(iii)	**G. Gamow**: Triplet nature of the codon
	(iv)	**Sanger**: DNA/ protein sequencing
(d)	(i)	The maximum number of individuals / people / animals/ organisms / crops which a given area of the environment can support without environmental degradation
	(ii)	A pair of corresponding chromosomes of the same shape, size and sequence of genes, one from each parent. *(diagram also accepted)*
(e)	(i)	To prevent contamination from foreign / self / unwanted pollen grains
	(ii)	The rate of succession is much faster in secondary succession as the nutrient/ substratum (soil) is already present as compared to primary succession where the process starts from a bare area (rock) / OR Soil is rich in nutrients.

PART II
SECTION A (14 Marks)
*(Answer **all** questions)*

Question 2

[2]

Enumerate *any four* essential features of good and effective poultry farm management practices.

Comments of Examiners

Majority of the candidates were unable to answer this question correctly. Some candidates ignored the word *poultry* and discussed about dairy farm management. Some discussed the economic advantages derived from poultry farms. Several candidates repeatedly used the same concept in different ways for e.g. give food, nutritious food, clean water, filtered water and so on. A few candidates mentioned breeding and hatching techniques.

Suggestions for teachers

- Discuss poultry farm management and dairy farm management in detail.
- Discuss specific measures regarding feed, protection, disease, doctor, cleanliness and care.

MARKING SCHEME

Question 2

Essential features of good and effective poultry farm management practices:

- Selection of high yielding / disease resistant breeds/ proper (indigenous/ exotic) species of fowl.
- Shed must be clean, roofed with a sloping floor
- Safe enclosure / protection from predators / enemies
- Nutritious food and clean water must be provided
- Proper hygiene must be maintained
- Animals must be maintained disease free by vaccination
- Regular visit by the doctor / veterinarian
- Culling of diseased animals
- Regular inspection and record keeping
- Proper spacing to an individual fowl
- Proper lighting
- Proper ventilation
- Segregation according to age

(Any four features)

Question 3

[2]

What is a *single cell protein?* How is it significant for human welfare?

Comments of Examiners

Many candidates interpreted *single cell protein* as single-celled protein. Several candidates did not mention the significance of a single cell protein. Some candidates wrote that it is a source of food or that it is used as monoclonal antibody.

Suggestions for teachers

- While discussing the sources of single cell protein, lay stress that the term *single* indicates single type of cell not a single cell.
- Explain clearly to students: how a single cell protein is useful; the necessity of developing such proteins; significance as a substitute of protein and not just a source of food; dried mass of microbes being used as a source to obtain protein, with suitable examples like *Spirulina*, *Candida*, etc.

MARKING SCHEME

Question 3

Single cell protein: **Proteins** obtained from **microbes**/ algae, fungi, bacteria, yeast. Any **microbial biomass** / multicellular bacteria, yeast, fungi, algae which can be used as **food**.

Significance:
- Cost effective / cheap
- Rich in protein
- Low on fat
- Reduced pressure on agriculture
- Use of organic wastes and industrial effluents in raising SCP will reduce environmental pollution
- Absence of pathogenicity & toxicity
- Easy to digest *(Any two)*

Question 4

[2]

(a) List *four* reasons for drug addiction.

OR

(b) List *four* effects of alcoholism on human health.

Comments of Examiners

(a) Most of the candidates wrote *effects* of drug addiction like hallucination and sleepiness instead of giving *reasons* for drug addiction. Some candidates gave different reasons for drug addiction but referred to the same concept in different words. A few candidates confused drug addiction with alcoholism.

(b) Several candidates repeated the same point in different ways, e.g. alcohol affects different organs, alcohol affects the liver, it affects the brain and so on. Many candidates wrote *causes* instead of *effects* of alcoholism.

Suggestions for teachers

- Discuss the *reasons* and *effects* of drug addiction separately.
- Instruct students not to repeat the same point.

MARKING SCHEME

Question 4

(a)	Reasons for drug addiction: - Peer pressure / Friends - Curiosity - Need of adventure / experiments / excitement / To remove boredom - Avoid stress / Overcome hardships/relaxation - Depression and frustration / low self-esteem / inferiority complex/emotional turbulence/sexual dysfunction/impotency. - Avoid unsupportive family structure - To enhance the performance in sports - To relieve pain - For weight loss - Genetic history/ family history *(Any four reasons)*
	OR
(b)	Effects of alcoholism on human health: - Lowering of blood sugar - Damage to internal organs - Loss of memory - Socio-economic impact / lack of interest / low self-esteem - Loss of reflexes /lack of muscles coordination. - Sexual dysfunction / impotency - Dependence / addiction - Malnutrition - Hallucination - Cancer - Hyperacidity - Genetic defects - Potentiates the effect of drugs - Loss of sleep (amnesia) - Lowers immunity *(Any four effects)*

Question 5

[2]

State *four* features of flowers pollinated by insects.

Comments of Examiners

Many candidates, instead of describing the features of flowers pollinated by insects, described those of wind pollinated flowers. Some candidates wrote the advantages of cross pollination.

Suggestions for teachers

- Show to the students, a variety of specimens of entomophilous and anemophilous flowers and discuss their features in detail with them for better understanding.
- Train students to read the question paper carefully.

MARKING SCHEME

Question 5

Features of flowers pollinated by insects:

- Flowers are large in size
- Brightly coloured petals
- Flowers are usually scented / sweet smelling / fragrant
- Flowers contain nectar / Nectar guidelines on petals
- Sticky stigma
- Less wastage of pollen
- Stigmas are usually small, compact / do not protrude out of the flower / within the flower
- Flowers found in clusters
- Pollen grains are sticky and spiny

(Any four features)

Question 6

[2]

What is *reproductive fitness?* Explain it with the help of an example.

Comments of Examiners

Majority of the candidates wrote more about reproduction, sperm count, healthy females, etc. Several candidates described reproductive fitness with reference to reproductive health. Very few candidates could interpret reproductive fitness in terms of Darwinian fitness and give the example accordingly.

Suggestions for teachers

- Clarify to the students, that reproductive fitness is related to reproductive rate, supplementing the explanation with examples.
- While teaching Darwinism, explain survival of the fittest with reference to Reproductive fitness of the individual.

MARKING SCHEME

Question 6

Reproductive fitness is the individual's **reproductive success** (equal to average contribution to gene pool). **OR**

It is the **relative production** of fertile offspring by a genotype. **OR**

Ability of an individual to add **more number of progeny** in the population. **OR**

Individual's **contribution** to next generation by **reproduction**. **OR**

Individual's **contribution** to phenotype and genotype of **next generation**. **OR**

Ability to pass the genes to subsequent generations.

Examples: *Ascaris* lays 2 crore eggs, sea urchin / crabs / cod fish - millions of eggs, African driver ant – 3 to 4 million eggs **OR** any example where reproductive rate is high

Question 7

[2]

Give *one* significant difference between *primary lymphoid organs* and *secondary lymphoid organs*. Give *one* example of each.

Comments of Examiners

Most of the candidates reversed the concept of primary and secondary lymphoid organs and did not cite example of each. Many candidates quoted spleen as a primary lymphoid organ. Several candidates mentioned the origin of B lymphocytes and T Lymphocytes but wrote *maturation* in *secondary* instead of *proliferation and transfer*. Some candidates mentioned that lymph is produced in primary organs and is stored in secondary organs. A few candidates interpreted both Primary and Secondary organs as primary and secondary immune response.

Suggestions for teachers

Clearly explain to students the reasons for primary lymphoid organs and secondary lymphoid organs being called so. This will help them to correlate the examples also.

MARKING SCHEME

Question 7

Difference between primary and secondary lymphoid organs:

	Primary lymphoid organs	Secondary lymphoid organs
1.	Sites where lymphocytes **originate** / **mature** / transform / acquire antigen-specific receptors	Sites to which lymphocytes **migrate** from primary lymphoid organs / Site for **interaction** (response) of lymphocytes with antigen/ proliferation of lymphocytes
2.	Contain either B cells or T cells	Contain both, T and B cells.
3.	Atrophy with age	Increase in size with age
4.	Antigen cannot enter	Antigen enters
5.	Site of natural immune system	Site of acquired immune system
	Example: bone marrow, thymus	**Example**: spleen, lymph nodes, tonsils, appendix, Payers patches. / MALT / GALT

Question 8

[2]

(a) Explain the term *biofortification.* How is this technique useful for the production of *golden rice?*

OR

(b) Write a short note on *Electrophoresis*.

Comments of Examiners

(a) Several candidates defined *fortification* instead of *biofortification*. Many candidates wrote that *golden rice* contains high level of protein. Some candidates wrote about Vitamin A but very few mentioned about the introduction of genes of β - carotene.

(b) Many candidates wrote about *electroporation* instead of *electrophoresis*. Many of those candidates who discussed about electrophoresis, ignored the importance of electric field in the process of separation of biomolecules.

Suggestions for teachers

- Explain to the students the term biofortification and its need and how it is different from fortification. Also discuss the usefulness of this technique for the production of *golden rice in detail*.
- Spell out the basic principle operating behind different techniques used in molecular biology and biotechnology.
- Point out clearly the difference between the terms electrophoresis and electroporation. Explain the importance of electric field in the process.

MARKING SCHEME

Question 8

(a)	Biofortification: **Enrichment** of crops with **nutrients**. OR **Golden rice**: - The grains are yellow as it contains **β -carotene** which is precursor of **Vitamin A**. - Produced to **control night blindness** / overcome vitamin A **deficiency**. *(Any two)*
	OR
(b)	**Electrophoresis**: It is a process of separation of **biomolecules** by placing them in mild **electric** field. 1. **Fragments of DNA** are separated by **agarose gel** electrophoresis 2. DNA fragments being **negatively charged** move **towards positive** electrode/anode 3. Fragments separate **according to size / charge** 4. Separated fragments are **stained with ethidium bromide** and exposed **to UV rays** 5. They form **orange coloured bands** 6. The bands are extracted by **elution / blotting** *(Any four)*

SECTION B (21 Marks)

*(Answer **all** questions)*

Question 9

[3]

Explain the evolution of long neck of giraffe according to Charles Darwin.

Comments of Examiners

Most of the candidates attempted explaining the elongation of giraffe neck according to Lamarckism. They were confused between Darwinian and Lamarckian interpretation of giraffe neck elongation.

Suggestions for teachers

- Discuss the basic concepts of Lamarckism and Darwinism in a tabular form for better clarity.
- Emphasise *Natural Selection* when teaching Darwinism.

MARKING SCHEME

Question 9

Evolution of long neck of giraffe according to Charles Darwin:

1. **Two varieties** initially / **short necked** and **long necked**
2. Ground **vegetation disappeared**
3. Short necked **could not feed / perished**
4. Long neck **could feed easily** / **survived**
5. **Adaptation/ Natural selection**
6. Characters passed to the offspring/inheritance

Question 10

[3]

(a) Draw a labelled diagram of the T.S. of a mature anther.

OR

(b) Draw a labelled diagram of the internal structure of human ovary.

Comments of Examiners

(a) Some candidates made the following errors:
- Drew the L.S of anther instead of T.S of anther
- Drew stamens
- Drew the whole flower
- Did incorrect labelling.

(b) Many candidates got mixed up in the growth and development of the follicles. Some candidates drew the diagram of ovule, T.S of ovary of flower and mammalian ovum. A few only explained the parts without making the diagram. In several cases, the diagrams were not neat, and the labellings were incorrect.

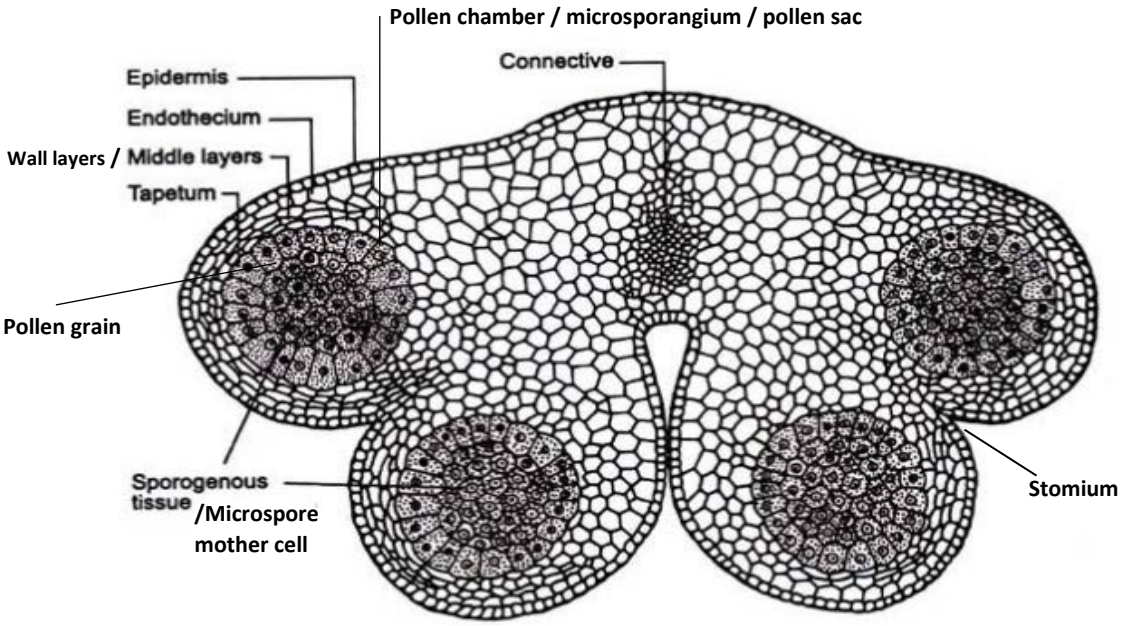
Suggestions for teachers

- Explain the correct position, shape and size of the parts of the flower and their functions.
- Teach the sequence of development of follicles. Emphasize on size of the follicles at different stages.
- Lay stress on the importance of drawing neat diagrams with proper labelling. Give adequate practice to the students in drawing diagrams.

MARKING SCHEME

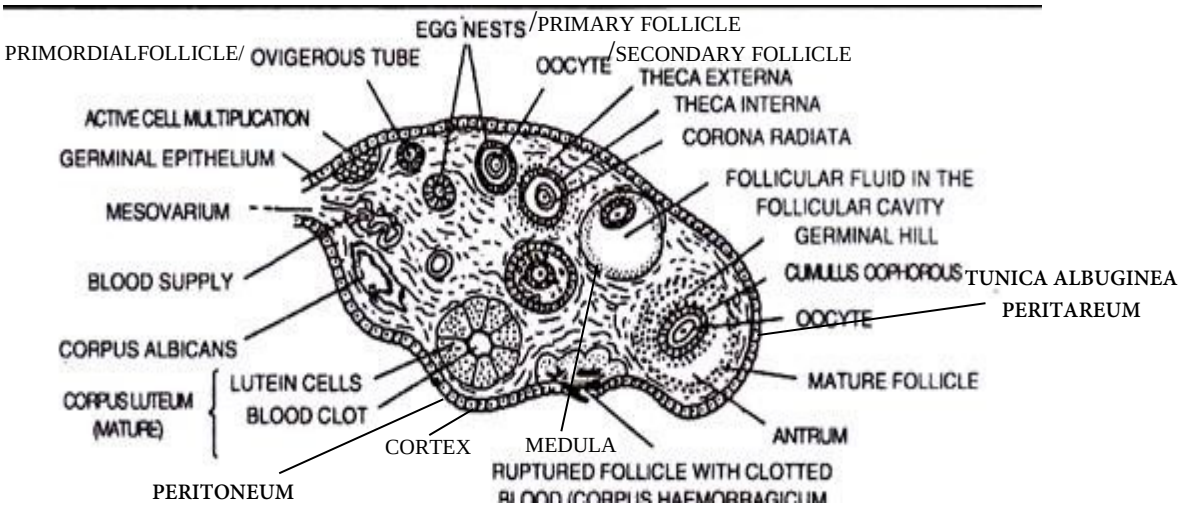
Question 10

(a) T.S. of a mature anther (*any six to be labelled):*



OR

(b) Internal structure of human ovary:



(Labelling - any six)

Question 11

[3]

Describe the structure of a nucleosome with the help of a well-labelled diagram.

Comments of Examiners

Many candidates did not attempt this question. Some candidates, instead of describing the structure of a *nucleosome* discussed nucleotides of DNA. Some candidates drew the nucleus. A few described prokaryotic/eukaryotic cells.

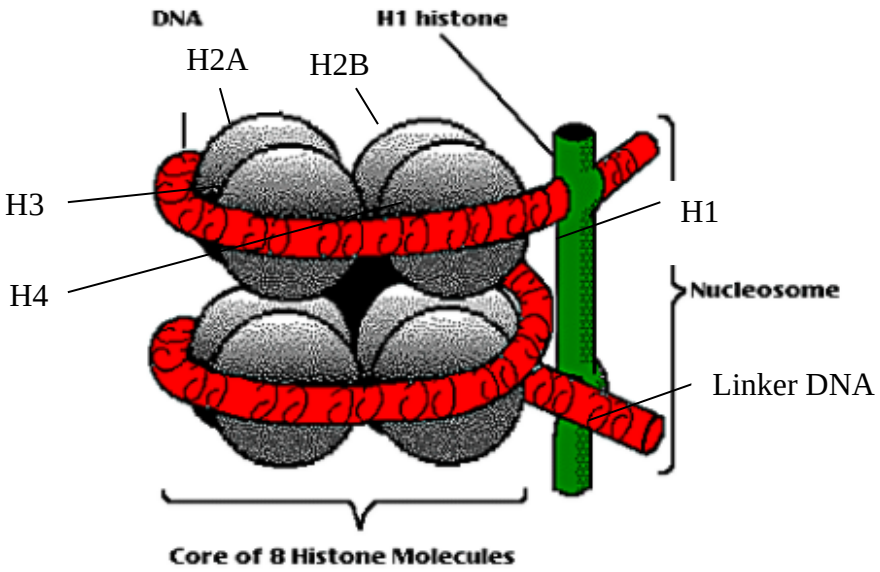
Suggestions for teachers

Ensure that the students understand the level of packaging of genetic material, which enables a long thread of DNA to be packed inside the nucleus. This will make the students clear about the significance of nucleosome.

MARKING SCHEME

Question 11

Structure of a nucleosome:



(Any three points from diagram or description)

1. Core of 8 histones (octamer)
2. Core formed by two units each of H2A, H2B, H3 AND H4 molecules
3. DNA winds around the core (1¾ turn involving approximately 146 base pairs)
4. Two successive nucleosomes are joined together by Linker DNA (approximately 80 BP)
5. H1 histone holds the entire complex by connecting the linker DNA at the points of entry and exit
6. Repeating units in chromatin fibre
7. As beads on a string

Question 12

[3]

(a) Explain the *Rivet Popper* hypothesis.

OR

(b) Define:

(1) Standing crop

(2) Stenothermal organisms

(3) Niche

Comments of Examiners

(a) Most of the candidates described the *Rivet Popper* hypothesis by taking the example of an aeroplane without explaining the corresponding ecology terms. Several candidates did not write the role of keystone species. Some candidates wrote that it was proposed by Haeckel.

(b) (i) Many candidates wrote about standing crop as crops which remain standing in fields/stand erect/never bend with wind, etc. Several candidates did not mention *organic/biomass.*

(ii) Most candidates confused *stenothermal* with *poikilothermic* and *homeothermic.* Many candidates, instead of writing the operative word *narrow range* wrote *low/high/hot/cold,* etc.

(iii) Majority of the candidates took the word literally and defined *niche* as the lower part of the body. Most candidates could not distinguish between habitat and niche. The key word *functional role* was missing in several answer scripts.

Suggestions for teachers

- Clarify the *Rivet Popper* hypothesis in detail to the students.
- Explain the importance of each species (thus biodiversity) in the ecosystem.
- Train the students to write crisp and precise definitions, highlighting the key words.

MARKING SCHEME

Question 12

(a)	Rivet popper hypothesis: - **Paul Ehlrich** proposed the rivet popper hypothesis - Explains the effect of decrease in biodiversity / **species richness** on the ecosystem. - An **aeroplane** has thousands of rivets aeroplane corresponds to ecosystem. - **Rivet** corresponds to **species** - Removal of rivets by passengers **may not affect the safety of the flight initially**. - **Removal of rivet of a critical part** like the wing (species performing major functions) will pose serious threat to the safety of the flight / ecosystem. - In an ecosystem, role **of each species is important**. *(Any six)*	
	OR	
(b)	(1)	Standing crop: amount of **organic matter** present at each **trophic level** at a given time **or Biomass** per unit **area** at a given time.
	(2)	Stenothermal organisms: organisms which can **tolerate narrow range of temperature**.
	(3)	Niche: **Functional role** of an organism **in its ecosystem/habitat**.

Question 13

[3]

Give the biological names of the following:

(i) The mould from which penicillin is obtained.

(ii) Baker's yeast.

(iii) The microbe used to control insect larvae growing on cotton.

(iv) The microbe used to produce Swiss cheese.

(v) The fungus that is being developed as a bio-control agent.

(vi) A symbiotic nitrogen fixing bacterium found in root nodules.

Comments of Examiners

Most candidates did not follow the Binomial Nomenclature. Several candidates wrote incorrect spellings of genera and species.

Suggestions for teachers

Explain the importance of the Rules of Binomial Nomenclature while teaching biological names and test the students regularly on them ensuring that they follow the rules.

MARKING SCHEME

Question 13

(i)	*Penicillium notatum*
(ii)	*Saccharomyces cerevisiae*
(iii)	*Bacillus thuringiensis*
(iv)	*Propionibacterium sharmanii*
(v)	*Trichoderma polysporum / Aspergillus niger*
(vi)	*Rhizobium leguminosarum*

Question 14

[3]

Explain the different types of endosperms in angiosperms.

Comments of Examiners

Several candidates named the types of endosperms as cell type, nucleus type, free type, mango type and so on. Many candidates did not make a clear-cut distinction between cellular and nuclear endosperms on the basis of cytokinesis and karyokinesis. Several candidates wrote only the names. They did not know the examples of cellular and helobial type. A few candidates were confused between endospermic and non-endospermic seeds.

Suggestions for teachers

- Explain the types of endosperms with the help of diagrams showing successive and simultaneous cell wall formation.
- Show animated clips to the students for better clarity.

MARKING SCHEME

Question 14

Different types of endosperms in angiosperms:

1. **Free nuclear OR Nuclear type-** Endosperm nucleus divides to give rise to a number of free nuclei which remain in periphery. Finally, cell wall formation occurs. Examples: *Coconut, maize, wheat, rice, sunflower/ common in polypetalous dicots*
2. **Cellular type** – Division of primary endosperm nucleus is immediately followed by wall formation so that the endosperm is cellular from beginning. Example: *Impatiens, Datura, Petunia / common in gamopetalous dicots*
3. **Helobial Type-** Endosperm development is intermediate between the free nuclear and cellular type. A partition wall develops between the two nuclei resulting in the first division of the endosperm. Examples:*Asphodelus, Muscari* (grape hyacinth), *Saxifraga, Echium* (borage)

Question 15

[3]

A homozygous pea plant with round seed coat and yellow cotyledons is crossed with another homozygous pea plant having wrinkled seed coat and green cotyledons.

(i) Give the types of gametes produced by plants of F_1-generation.

(ii) Give the dihybrid phenotypic ratio with the corresponding phenotypes.

(iii) State the Mendel's principle involved in this cross.

Comments of Examiners

(i) Most candidates did not write the gametes. Many candidates were unable to recognize whether it was a monohybrid or dihybrid cross. Several candidates did not understand how many or what types of alleles were there in the gametes, like only R or y, RR, Yy. Some candidates mentioned RRYY.

(ii) Some candidates wrote 1:2:1 or 1:3:3:9 which did not correspond to the relevant phenotypes mentioned by them.

(iii) Most of the candidates were, either unable to state the correct law or give the correct explanation of the law.

Suggestions for teachers

- Explain Dominant and Recessive traits while teaching genetics.
- Lay stress upon the formation of gametes.
- Teach appropriate examples of monohybrid and dihybrid crosses.
- Summarize the genotypic and phenotypic ratios of monohybrid and dihybrid cross and give adequate practice to the students in solving different problems. Encourage students to make Punnett square and write the phenotype inside the grid. Clarify how the genes/alleles separate and enter singly in the gametes of parents.
- Interpret Mendel's Laws with appropriate examples of monohybrid and dihybrid crosses.

MARKING SCHEME

Question 15

(i)	RY, Ry, rY, ry
(ii)	9 : Round yellow 3: Round green 3: Wrinkled yellow 1: Wrinkled green
(iii)	Law of Independent Assortment: Alleles of different characters **assort independently** of each other **during gamete formation**.

SECTION C (15 Marks)

*(Answer **all** questions)*

Question 16

[5]

(a) Describe the physico-chemical events that take place during fertilization in humans.

OR

(b) (i) Define and give the role of amniocentesis.

(ii) Name the causative agent and give *any one* symptom of Gonorrhoea.

(iii) What is the significance of dispersal of seeds? Give any two points.

(iv) What are seasonal breeders? Give an example.

(v) How is the chromosome number maintained in sexually reproducing organisms?

Comments of Examiners

(a) The answers of most of the candidates were not written systematically, the sequence of events being written in random order, for e.g. *capacitation* was discussed before *insemination*. Many candidates described the embryonic development instead of fertilization. Several candidates described the process of double fertilization in plants. Several candidates wrote gametogenesis. Some drew the female reproductive system only. A few candidates discussed the menstrual cycle.

(b) (i) The role of amniocentesis was incorrectly given by some candidates as determination of sex, which is actually a misuse of this technique. A few candidates defined amniocentesis simply as a prenatal diagnostic technique, without mentioning the role of amniotic fluid.

(ii) Many candidates mis-spelt the biological name of the bacteria. Some candidates only wrote the name of the species without writing the name of the genus. A few candidates wrote vague symptoms such as fever, pain, headache, etc.

(iii) Most of the candidates *defined* dispersal of seeds and fruits instead of their *significance.* Some candidates interpreted dispersal as transfer of

Suggestions for teachers

- Ensure that the students understand the importance of proper sequence of events in physiology-based questions.
- Discuss the fundamental principle behind the role of amniocentesis.
- Discuss the use and misuse of biological tools and techniques to sensitize students towards the issues like bioethics.
- Emphasise that biological names should be correctly spelt and written according to the rules.
- Ensure that students are well versed with the characteristic symptoms of different diseases mentioned in the syllabus.
- Demonstrate the dispersal of seeds in the school compound so that students can actually visualize the importance of this process in avoiding over-crowding.

pollen grains and adaptations in seeds for dispersal (like presence of wings). A few candidates wrote only one point whereas the question clearly asked for two points.

(iv) Most of the candidates attempted this question correctly. However, some candidates wrote about heat period for seasonal breeders but did not mention the particular period in a year.

(v) Many candidates wrote about fertilization but missed writing meiosis or gamete formation part. Some candidates mentioned only one process, either gamete formation or fertilization. Some did not mention haploid number from each parent and diploid in the offspring.

- Clearly explain the difference between seasonal and continuous breeders, laying stress on time period differences with examples.
- Discuss simultaneously the role of meiosis and fertilization in the life cycle of sexually reproducing organisms.
- Make the students recall the life cycles of different plant groups studied by them in Class XI, where the haploid and diploid phases were clearly demarcated.
- Advise the students to read the question paper carefully and answer the questions accordingly.

MARKING SCHEME

Question 16

(a)		1. **Insemination** 2. **Coagulation** of semen 3. **Transfer/Movement** of coagulated semen into uterus by **peristalsis** 4. **Liquefaction** of coagulated semen 5. **Capacitation** of the sperm 6. **Acrosome** reaction: **Hyaluronidase** digests the cement holding cells of corona radiata so that they are dispersed 7. **Acrosin** digests zona pellucida. **Calcium ions** are needed for this 8. The egg cytoplasm extends around the head of sperm to form a **fertilization cone** that engulfs the sperm so that the **head and mid piece enter** the ovum 9. **Cortical reaction**: Formation of **fertilization membrane** around the egg which **prevents polyspermy / allows single sperm to enter** 10. Completion of **2nd meiotic** division of the ovum causing release of **second polar body**. 11. Amphimixis or Karyogamy: The sperm nucleus travels through the ovum to its nucleus The intermingling of paternal and maternal chromosomes is called **amphimixis**. The fertilized egg is now called the **zygote**
(b)	(i)	Definition: Technique of **withdrawing amniotic fluid** from the amniotic sac Role: **Prenatal diagnosis** of genetic defects.

	(ii)	Causative agent: *Neisseria gonorrhoeae*. Symptom of Gonorrhoea: - Itching in genital region - Fluid discharge - Pain and swelling - Sterility *(Any one)*
	(iii)	Significance of dispersal of seeds: - Avoids intraspecific competition - Avoids overcrowding - Helps in rapid evolution - To provide suitable conditions for germination *(Any two)*
	(iv)	Seasonal breeders become reproductively active only during favourable seasons. Examples: Tiger, cat, dog, sheep, goat, horse, cattle, pig. *(Any one)*
	(v)	During gametogenesis the chromosome number is reduced to half by **meiosis**. During **fertilization**, the diploid number is restored in the zygote.

Question 17

[5]

(a) (i) What are *restriction endonucleases?* Give the rules of their nomenclature.

(ii) Explain the mechanism of action of restriction endonucleases that makes them suitable for genetic engineering.

OR

(b) (i) Explain what are the desirable characteristics of an ideal cloning vector used in rDNA technology.

(ii) Describe *two* vectorless methods of gene transfer used in rDNA technology.

Comments of Examiners

(a) (i) Most of the candidates mixed up the mechanism of *restriction endonucleases* with its definition. Many candidates did not write the rules of their nomenclature correctly. Some candidates wrote that restriction endonucleases were used to cut DNA but did not mention *at specific sites*. Some described the rules of binomial nomenclature, instead of restriction endonucleases.

(ii) Many candidates wrote that restriction enzymes cut the DNA into fragments which could be separated by gel electrophoresis, without mentioning production of sticky ends which are used to ligate foreign DNA. Some candidates drew pBR 322 plasmid.

(b) (i) Some candidates confused it with PCR while some others described RE or Molecular scissors. A few candidates gave very vague features like, easy availability or it being harmless, ignoring the major features like origin of replication, selectable markers, multiple cloning sites, etc.

(ii) Many candidates wrote 'microinjection'. Some candidates mentioned ***Agrobacterium***, pBR 322, BAC and YAC as tools of gene transfer without realizing that these were vectors, whereas the question was about vector-less methods. Some candidates did not write both the methods completely. A few candidates wrote $CaCl_2$ and heat shock as different points.

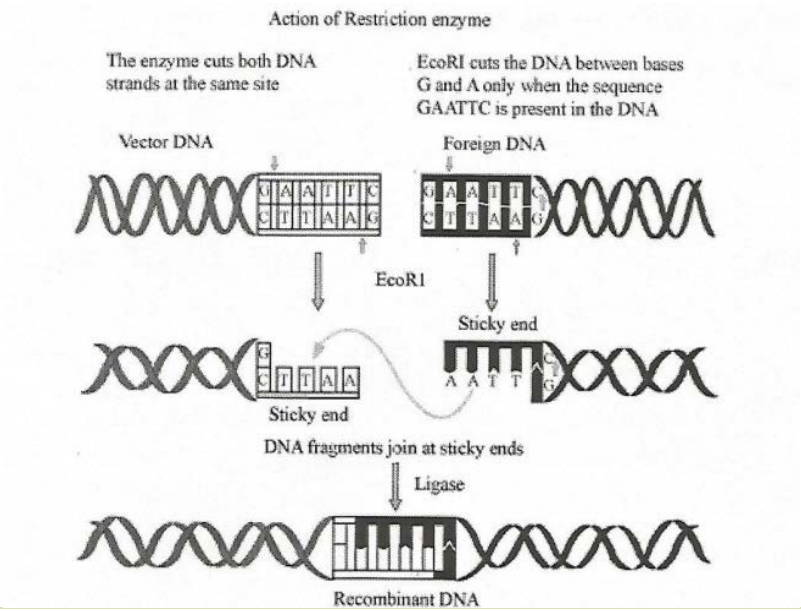
Suggestions for teachers

- Explain the logic behind using the term *restriction*. Clarify the rules of nomenclature of restriction endonucleases by taking an example of a restriction enzyme.
- Explain the action of restriction enzymes by taking specific target sequences of different DNA molecules.
- Show the sticky ends in both the DNA molecules by using different colours. These can then be shown to hybridize due to their complementary nature.
- Teach points of ideal cloning vector with the features and functions of the parts.
- Draw the diagrams of pBR 322 or pUC 19 and explain each feature.
- Separately discuss vector mediated and vector-less methods, highlighting

MARKING SCHEME

Question 17

(a) (i)	*Restriction endonucleases* are **enzyme** that target the **interior of the DNA** molecule and cleave the molecule at palindromic sequence. OR The enzymes which cut DNA at specific sequences. OR The rules of their nomenclature: 1. **First** alphabet = the **genus** from which these enzymes are isolated 2. **Next** two alphabets = the **species** from which these enzymes are isolated 3. **Fourth** alphabet = name of the **strain** from which they are isolated 4. **The roman number** = the **order** in which the enzyme was isolated. Eg: Eco RI.

(ii)	Mechanism of Action: 1. Each RE recognises a specific **palindromic** base sequence in the DNA. 2. **Cuts sugar-phosphate backbone** of both strands of the double helix **at specific points** in the palindromic sequence. 3. The **foreign** DNA and **vector** DNA are cut by **same RE**. 4. It produces a complementary **sticky end** / **staggered cut** in both the DNA molecules. 5. So that both can be joined by enzyme **ligase**. *Alternative diagram* 
	OR
(b) (i)	- **Origin** of replication (ori) This is the sequence from which **replication starts** and the foreign gene linked to it will clone itself and it also controls the copy number of the linked DNA - **Cloning sites**: The **ligation of alien DNA** is carried out at this recognition site. - **Selectable marker**: These will help in **identifying** and eliminating non-transformants and selectively permitting the growth of transformants. - **Small** in size/ less than 10 kB
(ii)	Describe *two* vector-less method of gene transfer used in rDNA technology - **Gene gun** / **Biolistic**: Gold or tungsten beads coated with DNA are bombarded with high velocity on the host tissue. The foreign gene gets incorporated in host DNA. - **Microinjection**: Using a micropipette/ microneedle DNA is injected into the nucleus. - **Transformation** /**Transfection**: Bacteria are made competent to take up foreign gene by placing them in cold calcium chloride /by heat shock.

	- **Electroporation**: This is introduction of r DNA into bacterial cells by exposing them to a high electric pulse. - **Liposome** mediated transfer - lipid droplets

Question 18

[5]

(a) Give a graphic representation of carbon cycle in nature.

OR

(b) Give a graphic representation of phosphorus cycle in nature.

Comments of Examiners

(a) Many candidates drew the food chain or food web. Some candidates wrote the Calvin Cycle. In many cases, correct arrows were not shown. Some candidates wrote in a paragraph. A few candidates used graph paper to attempt this question as the question mentioned *graphic representation*. In many cases, the cycle was not in a proper form.

(b) Many candidates did not show the cycle properly. Major components like producers, consumers and decomposers were not shown interconnected.

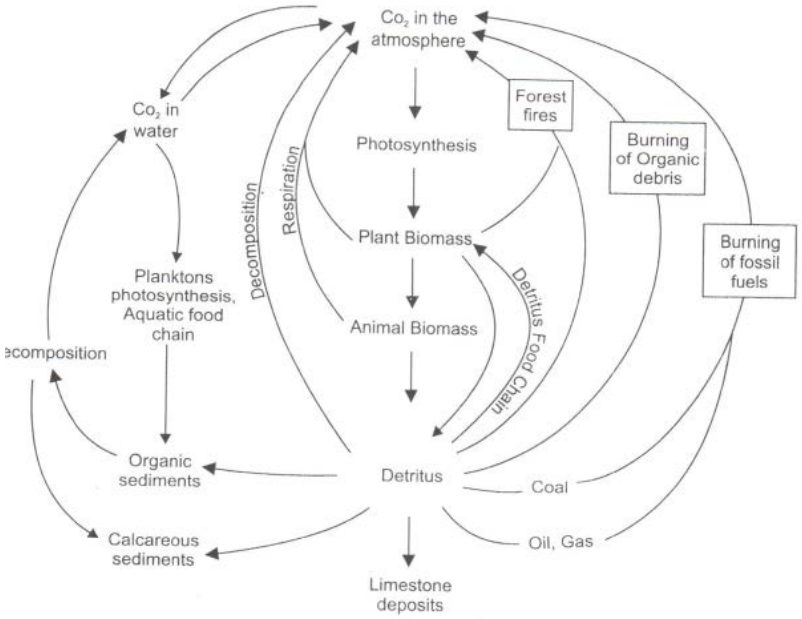
Suggestions for teachers

- Discuss the bio geo chemical cycles by using simple flow charts.
- Ensure that the flow charts are not too complicated and over stuffed with irrelevant information.
- Highlight systematic transfer of nutrients at each step of the Phosphorous Cycle and the importance in consumers at different levels and decomposers, etc.

MARKING SCHEME

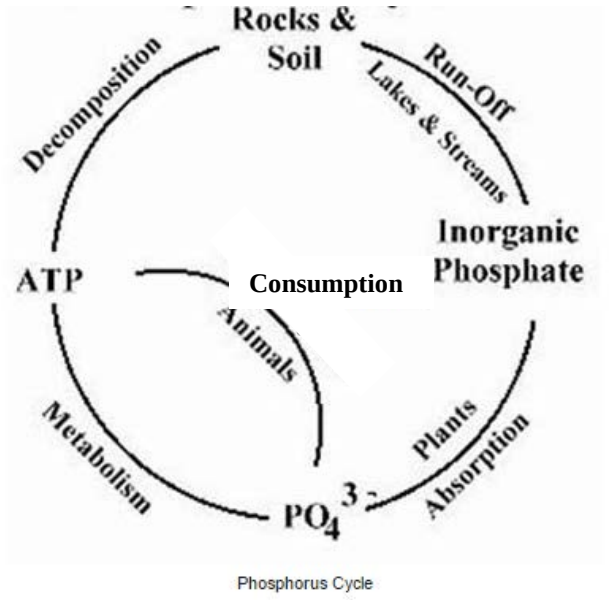
Question 18

(a) Give a graphic representation of carbon cycle in nature.



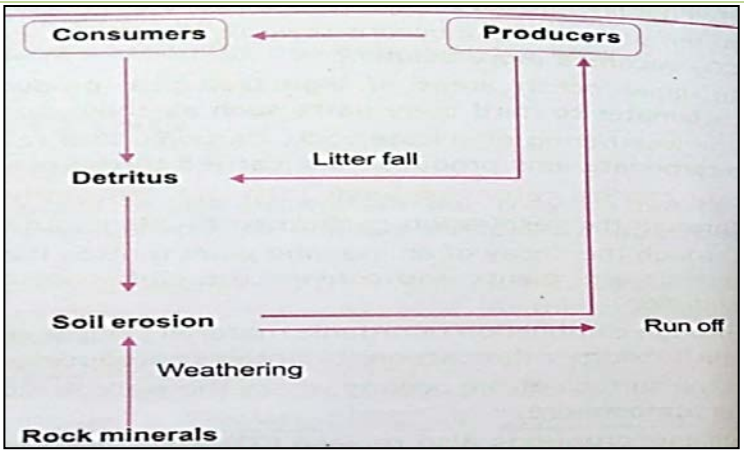
OR

(b) Give a graphic representation of phosphorus cycle in nature.



Phosphorus Cycle

Phosphorous Cycle



Note: For questions having more than one correct answer/solution, alternate correct answers/solutions, apart from those given in the marking scheme, have also been accepted.

GENERAL COMMENTS

Topics found difficult by candidates

- Detritus.
- Pedigree analysis.
- Nucleosome.
- Standing crops.
- GEAC.
- EFB full form.
- Contribution of Scientists R. Mishra & Sanger.
- Secondary succession.
- Significance of SCP.
- Golden rice.
- Nomenclature of RE.

Concepts in which candidates got confused

- Meiocytes and gametes.
- Back cross and test cross.
- Primary and secondary succession.
- Reproductive fitness and reproductive health.
- Primary and secondary lymphoid organs.
- Electrophoresis and electroporation.
- Lamarckism and Darwinism.
- Ovary and ovum/ovule.
- Stenothermal and cold-blooded organisms.

Suggestions for candidates

- Refer to different text books, journals and magazines.
- Practice writing the answers in stipulated time.
- Practice drawing the diagrams and labelling them correctly.
- Solve previous years' question papers and get the answers checked by the subject teacher to assess the performance.
- Read the question paper carefully and follow the instructions given.
- Attempt all parts and sub-parts of a question in proper sequence.
- Highlight the key words.
- Write the answers point wise.
- Draw diagrams and flow charts.