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LIFE SCIENCES

**Kumar Pushkar
&
Dr. A. P. Singh**

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CSIR UGC
NET/JRF/SET
LIFE SCIENCES

By

Kumar Pushkar

&

Dr. A. P. Singh

==== **Highlights** =====

- Specific Mezzotint
- Comprehensive Points (Exam-oriented)
- Topicwise Questions–Answers
- Previous years' questions and their answers at the end of each topic
- Clear-cut Exemplifications
- Down-to-earth Points
- Enticing Illustrations with description
- Distinct Tables
- Modern Scientific Approach

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About the Author

Kumar Pushkar is time-tested cyto-geneticist, possessing a mental make up commensurate with needs of hour of information and technology in his subject. The brilliant academic record is his proud possession.

To his credit he is NET qualified and is consultant-counsellor of genetics and its related revelations as off shoots of latest biotechnology. Mr. Pushkar is a celebrated freelance writer of various books on CSIR-UGC NET/JRF for Life Sciences and on premedical examinations of various Indian states. His book on CSIR-UGC NET/JRF/SET of Life Sciences and 'Comprehensive Botany' have become the choice book for concerned aspirants. He has an abiding interest in writing articles on biology for various Indian magazines.

The present book **CSIR-UGC NET/JRF/SET Life Sciences** is a collection of breath-taking technological advances. I trust this book will fulfil all the requirements of CSIR-UGC NET/JRF/SET aspirants. On all hands keep unswerving loyalty in this book and achieve your goal.

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GENERAL INFORMATION

EXAM SCHEME

TIME : 3 HOURS MAX. MARKS : 200

Single Paper Test having Multiple Choice Questions (MCQs) is divided in three parts—

Part 'A'

This part shall carry 20 questions pertaining to General aptitude with emphasis on logical reasoning graphical analysis, analytical and numerical ability, quantitative comparisons, series formation, puzzles etc. The candidates shall be required to answer any 15 questions. Each question shall be of two marks. The total marks allocated to this section shall be 30 out of 200.

Part 'B'

This part shall contain 50 Multiple Choice Questions(MCQs) generally covering the topics given in the syllabus. A candidate shall be required to answer any 35 questions. Each question shall be of two marks. The total marks allocated to this section shall be 70 out of 200.

Part 'C'

This part shall contain 75 questions that are designed to test a candidate's knowledge of scientific concepts and/or application of the scientific concepts. The questions shall be of analytical nature where a candidate is expected to apply the scientific knowledge to arrive at the solution to the given scientific problem. A candidate shall be required to answer any 25 questions. Each question shall be of four marks. The total marks allocated to this section shall be 100 out of 200.

There will be negative marking @25% for each wrong answer.

To enable the candidates to go through the questions, the question paper booklet shall be distributed 15 minute before the scheduled time of the Exam. The answer sheet (OMR

sheet) shall be distributed at the scheduled time of the Exam.

SYLLABUS

Part 'A'

This part shall carry 20 questions pertaining to General aptitude with emphasis on logical reasoning graphical analysis, analytical and numerical ability, quantitative comparisons, series formation, puzzles etc. The candidates shall be required to answer any 15 questions. Each question shall be of two marks. The total marks allocated to this section shall be 30 out of 200.

(Common Syllabus for Part B & C)

1. Molecules and their Interaction Relevant to Biology
2. Cellular Organization
3. Fundamental Processes
4. Cell Communication and Cell Signalling
5. Developmental Biology
6. System Physiology – Plant
7. System Physiology – Animal
8. Inheritance Biology
9. Diversity of Life Forms
10. Ecological Principles
11. Evolution and Behavior
12. Applied Biology
13. Methods in Biology.

1. MOLECULES AND THEIR INTER-ACTION RELEVANT TO BIOLOGY

- A. Structure of atoms, molecules and chemical bonds.
- B. Composition, structure and function of biomolecules (carbohydrates, lipids, proteins, nucleic acids and vitamins).
- C. Stabilizing interactions (Van der Waals, electrostatic, hydrogen bonding, hydrophobic interaction, etc.).

- D. Principles of biophysical chemistry (pH, buffer, reaction kinetics, thermodynamics, colligative properties).
 - E. Bioenergetics, glycolysis, oxidative phosphorylation, coupled reaction, group transfer, biological energy transducers.
 - F. Principles of catalysis, enzymes and enzyme kinetics, enzyme regulation, mechanism of enzyme catalysis, isozymes.
 - G. Conformation of proteins (Ramachandran plot, secondary structure; domains; motif and folds).
 - H. Conformation of nucleic acids helix (A-, B-, Z-), *t*-RNA, micro-RNA).
 - I. Stability of proteins and nucleic acids.
 - J. Metabolism of carbohydrates, lipids, amino acids, nucleotides and vitamins.
- B. RNA synthesis and processing :** Transcription factors and machinery, formation of initiation complex, transcription activators and repressors, RNA polymerases, capping, elongation and termination, RNA processing, RNA editing, splicing, polyadenylation, structure and function of different types of RNA, RNA transport.
 - C. Protein synthesis and processing :** Ribosome, formation of initiation complex, initiation factors and their regulation, elongation and elongation factors, termination, genetic code, aminoacylation of *t*RNA, *t*RNA-identity, aminoacyl *t*RNA synthetase, translational proof-reading, translational inhibitors, post-translational modification of proteins.
 - D. Control of gene expression at transcription and translation level :** Regulating the expression of phages, viruses, prokaryotic and eukaryotic genes, role of chromatin in gene expression and gene silencing.

2. CELLULAR ORGANIZATION

- A. Membrane structure and function :** Structure of model membrane, lipid bilayer and membrane protein diffusion, osmosis, ion channels, active transport, membrane pumps, mechanism of sorting and regulation of intracellular transport, electrical properties of membranes.
- B. Structural organization and function of intracellular organelles :** Cell wall, nucleus, mitochondria, Golgi bodies, lysosomes, endoplasmic reticulum, peroxisomes, plastids, vacuoles, chloroplast, structure & function of cytoskeleton and its role in motility.
- C. Organization of genes and chromosomes :** Operon, interrupted genes, gene families, structure of chromatin and chromosomes, unique and repetitive DNA, heterochromatin, euchromatin, transposons.
- D. Cell division and cell cycle :** Mitosis and meiosis, their regulation, steps in cell cycle, regulation and control of cell cycle.
- E. Microbial physiology :** Growth, yield and characteristics, strategies of cell division, stress response.

3. FUNDAMENTAL PROCESSES

- A. DNA replication, repair and recombination :** Unit of replication, enzymes involved, replication origin and replication fork, fidelity of replication, extrachromosomal replicons, DNA damage and repair mechanisms, homologous and site-specific recombination.
- B. Cell signalling :** Hormones and their receptors, cell surface receptor, signalling through G-protein coupled receptors, signal transduction pathways, second messengers, regulation of signalling pathways, bacterial and plant two-component systems, light signalling in plants, bacterial chemotaxis and quorum sensing.
- C. Cellular communication :** Regulation of hematopoiesis, general principles of cell communication, cell adhesion and roles of different adhesion molecules, gap junctions, extracellular matrix, integrins, neurotransmission and its regulation.
- D. Cancer :** Genetic rearrangements in progenitor cells, oncogenes, tumor suppressor genes, cancer and the cell cycle, virus-induced cancer, metastasis, interaction of cancer cells

4. CELL COMMUNICATION AND CELL SIGNALLING

with normal cells, apoptosis, therapeutic interventions of uncontrolled cell growth.

- E. Innate and adaptive immune system :** Cells and molecules involved in innate and adaptive immunity, antigens, antigenicity and immunogenicity. B and T cell epitopes, structure and function of antibody molecules, generation of antibody diversity, monoclonal antibodies, antibody engineering, antigen-antibody interactions, MHC molecules, antigen processing and presentation, activation and differentiation of B and T cells, B and T cell receptors, humoral and cell-mediated immune responses, primary and secondary immune modulation, the complement system, Toll-like receptors, cell-mediated effector functions, inflammation, hypersensitivity and autoimmunity, immune response during bacterial (tuberculosis), parasitic (malaria) and viral (HIV) infections, congenital and acquired immunodeficiencies, vaccines.

5. DEVELOPMENTAL BIOLOGY

- A. Basic concepts of development :** Potency, commitment, specification, induction, competence, determination and differentiation; morphogenetic gradients; cell fate and cell lineages; stem cells; genomic equivalence and the cytoplasmic determinants; imprinting; mutants and transgenics in analysis of development.
- B. Gametogenesis, fertilization and early development :** Production of gametes, cell surface molecules in sperm-egg recognition in animals; embryo sac development and double fertilization in plants; zygote formation, cleavage, blastula formation, embryonic fields, gastrulation and formation of germ layers in animals; embryogenesis, establishment of symmetry in plants; seed formation and germination.
- C. Morphogenesis and organogenesis in animals :** Cell aggregation and differentiation in *Dictyostelium*; axes and pattern formation in *Drosophila*, amphibia and chick; organogenesis – vulva formation in *Caenorhabditis elegans*; eye lens induction, limb development and regeneration in vertebrates; differentiation of neurons, post embryonic development—larval formation,

metamorphosis; environmental regulation of normal development; sex determination.

- D. Morphogenesis and organogenesis in plants :** Organization of shoot and root apical meristem; shoot and root development; leaf development and phyllotaxy; transition to flowering, floral meristems and floral development in *Arabidopsis* and *Antirrhinum*.
- E. Programmed cell death, aging and senescence.**

6. SYSTEM PHYSIOLOGY – PLANT

- A. Photosynthesis :** Light harvesting complexes; mechanisms of electron transport; photoprotective mechanisms; CO₂ fixation-C3, C4 and CAM pathways.
- B. Respiration and photorespiration :** Citric acid cycle; plant mitochondrial electron transport and ATP synthesis; alternate oxidase; photorespiratory pathway.
- C. Nitrogen metabolism :** Nitrate and ammonium assimilation; amino acid biosynthesis.
- D. Plant hormones :** Biosynthesis, storage, breakdown and transport; physiological effects and mechanisms of action.
- E. Sensory photobiology :** Structure, function and mechanisms of action of phytochromes, cryptochromes and phototropins; stomatal movement; photoperiodism and biological clocks.
- F. Solute transport and photoassimilate translocation :** Uptake, transport and translocation of water, ions, solutes and macromolecules from soil, through cells, across membranes, through xylem and phloem; transpiration; mechanisms of loading and unloading of photoassimilates.
- G. Secondary metabolites :** Biosynthesis of terpenes, phenols and nitrogenous compounds and their roles.
- H. Stress physiology :** Responses of plants to biotic (pathogen and insects) and abiotic (water, temperature and salt) stresses.

7. SYSTEM PHYSIOLOGY - ANIMAL

- A. Blood and circulation :** Blood corpuscles, haemopoiesis and formed elements, plasma function, blood volume, blood volume regulation, blood groups, haemoglobin, immunity, haemostasis.

- B. Cardiovascular system :** Comparative anatomy of heart structure, myogenic heart, specialized tissue, ECG – its principle and significance, cardiac cycle, heart as a pump, blood pressure, neural and chemical regulation of all above.
- C. Respiratory system :** Comparison of respiration in different species, anatomical considerations, transport of gases, exchange of gases, waste elimination, neural and chemical regulation of respiration.
- D. Nervous system :** Neurons, action potential, gross neuroanatomy of the brain and spinal cord, central and peripheral nervous system, neural control of muscle tone and posture.
- E. Sense organs :** Vision, hearing and tactile response.
- F. Excretory system :** Comparative physiology of excretion, kidney, urine formation, urine concentration, waste elimination, micturition, regulation of water balance, blood volume, blood pressure, electrolyte balance, acid-base balance.
- G. Thermoregulation :** Comfort zone, body temperature – physical, chemical, neural regulation, acclimatization.
- H. Stress and adaptation.**
- I. Digestive system :** Digestion, absorption, energy balance, BMR.
- J. Endocrinology and reproduction :** Endocrine glands, basic mechanism of hormone action, hormones and diseases; reproductive processes, gametogenesis, ovulation, neuroendocrine regulation.
- 8. INHERITANCE BIOLOGY**
- A. Mendelian principles :** Dominance, segregation, independent assortment.
- B. Concept of gene :** Allele, multiple alleles, pseudoallele, complementation tests.
- C. Extensions of Mendelian principles :** Codominance, incomplete dominance, gene interactions, pleiotropy, genomic imprinting, penetrance and expressivity, phenocopy, linkage and crossing over, sex linkage, sex limited and sex influenced characters.
- D. Gene mapping methods :** Linkage maps, tetrad analysis, mapping with molecular markers, mapping by using somatic cell hybrids, development of mapping population in plants.
- E. Extrachromosomal inheritance :** Inheritance of mitochondrial and chloroplast genes, maternal inheritance.
- F. Microbial genetics :** Methods of genetic transfers – transformation, conjugation, transduction and sexduction, mapping genes by interrupted mating, fine structure analysis of genes.
- G. Human genetics :** Pedigree analysis, lod score for linkage testing, karyotypes, genetic disorders.
- H. Quantitative genetics :** Polygenic inheritance, heritability and its measurements, QTL mapping.
- I. Mutation :** Types, causes and detection, mutant types – lethal, conditional, biochemical, loss of function, gain of function, germinal *versus* somatic mutants, insertional mutagenesis.
- J. Structural and numerical alterations of chromosomes :** Deletion, duplication, inversion, translocation, ploidy and their genetic implications.
- K. Recombination :** Homologous and non-homologous recombination, including transposition.
- 9. DIVERSITY OF LIFE FORMS**
- A. Principles and methods of taxonomy :** Concepts of species and hierarchical taxa, biological nomenclature, classical and quantitative methods of taxonomy of plants, animals and microorganisms.
- B. Levels of structural organization :** Unicellular, colonial and multicellular forms; levels of organization of tissues, organs and systems; comparative anatomy, adaptive radiation, adaptive modifications.
- C. Outline classification of plants, animals and microorganisms :** Important criteria used for classification in each taxon; classification of plants, animals and microorganisms; evolutionary relationships among taxa.
- D. Natural history of Indian subcontinent :** Major habitat types of the subcontinent, geographic origins and migrations of species; common Indian mammals, birds; seasonality and phenology of the subcontinent.

- E. Organisms of health and agricultural importance :** Common parasites and pathogens of humans, domestic animals and crops.
- F. Organisms of conservation concern :** Rare, endangered species, conservation strategies.

10. ECOLOGICAL PRINCIPLES

- A. The environment :** Physical environment; biotic environment; biotic and abiotic interactions.
- B. Habitat and niche :** Concept of habitat and niche; niche width and overlap; fundamental and realized niche; resource partitioning; character displacement.
- C. Population ecology :** Characteristics of a population; population growth curves; population regulation; life history strategies (*r* and *K* selection); concept of metapopulation – demes and dispersal, interdemec extinctions, age structured populations.
- D. Species interactions :** Types of interactions, interspecific competition, herbivory, carnivory, pollination, symbiosis.
- E. Community ecology :** Nature of communities; community structure and attributes; levels of species diversity and its measurement; edges and ecotones.
- F. Ecological succession :** Types; mechanisms; changes involved in succession; concept of climax.
- G. Ecosystem ecology :** Structure and function; energy flow and mineral cycling (CNP); primary production and decomposition; structure and function of some Indian ecosystems : terrestrial (forest, grassland) and aquatic (fresh water, marine, eustarine).
- H. Biogeography :** Major terrestrial biomes; theory of island biogeography; biogeographical zones of India.
- I. Applied ecology :** Environmental pollution; global environmental change; biodiversity – status, monitoring and documentation; major drivers of biodiversity change; biodiversity management approaches.
- J. Conservation biology :** Principles of conservation, major approaches to management, Indian case studies on conservation/management strategy (Project Tiger, Biosphere reserves).

11. EVOLUTION AND BEHAVIOUR

- A. Emergence of evolutionary thoughts :** Lamarck; Darwin – concepts of variation, adaptation, struggle, fitness and natural selection; Mendelism; spontaneity of mutations; the evolutionary synthesis.
- B. Origin of cells and unicellular evolution :** Origin of basic biological molecules; abiotic synthesis of organic monomers and polymers; concept of Oparin and Haldane; experiment of Miller (1953); the first cell; evolution of prokaryotes; origin of eukaryotic cells; evolution of unicellular eukaryotes; anaerobic metabolism, photosynthesis and aerobic metabolism.
- C. Paleontology and evolutionary history :** The evolutionary time scale; eras, periods and epoch; major events in the evolutionary time scale; origins of unicellular and multicellular organisms; major groups of plants and animals; stages in primate evolution including Homo.
- D. Molecular evolution :** Concepts of neutral evolution, molecular divergence and molecular clocks; molecular tools in phylogeny, classification and identification; protein and nucleotide sequence analysis; origin of new genes and proteins; gene duplication and divergence.
- E. The mechanisms :** Population genetics – populations, gene pool, gene frequency; Hardy-Weinberg law; concepts and rate of change in gene frequency through natural selection, migration and random genetic drift; adaptive radiation; isolating mechanisms; speciation; allopatricity and sympatricity; convergent evolution; sexual selection; co-evolution.
- F. Brain, behaviour and evolution :** Approaches and methods in study of behaviour; proximate and ultimate causation; altruism and evolution – group selection, kin selection, reciprocal altruism; neural basis of learning, memory, cognition, sleep and arousal; biological clocks; development of behaviour; social communication; social dominance; use of space and territoriality; mating systems, parental investment and reproductive success; parental care; aggressive behaviour; habitat selection and optimality in foraging; migration, orientation and

navigation; domestication and behavioural changes.

12. APPLIED BIOLOGY

- A. Microbial fermentation and production of small and macro molecules.
- B. Application of immunological principles (vaccines, diagnostics). Tissue and cell culture methods for plants and animals.
- C. Transgenic animals and plants, molecular approaches to diagnosis and strain identification.
- D. Genomics and its application to health and agriculture, including gene therapy.
- E. Bioresource and uses of biodiversity.
- F. Breeding in plants and animals, including marker – assisted selection.
- G. Bioremediation and phytoremediation.
- H. Biosensors.

13. METHODS IN BIOLOGY

- A. **Molecular biology and recombinant DNA methods** : Isolation and purification of RNA , DNA (genomic and plasmid) and proteins, different separation methods; analysis of RNA, DNA and proteins by one and two dimensional gel electrophoresis, isoelectric focusing gels; molecular cloning of DNA or RNA fragments in bacterial and eukaryotic systems; expression of recombinant proteins using bacterial, animal and plant vectors; isolation of specific nucleic acid sequences; generation of genomic and cDNA libraries in plasmid, phage, cosmid, BAC and YAC vectors; in vitro mutagenesis and deletion techniques, gene knock out in bacterial and eukaryotic organisms; protein sequencing methods, detection of post-translation modification of proteins; DNA sequencing methods, strategies for genome sequencing; methods for analysis of gene expression at RNA and protein level, large scale expression analysis, such as micro array based techniques; isolation, separation and analysis of carbohydrate and lipid molecules; RFLP, RAPD and AFLP techniques.
- B. **Histochemical and immunotechniques** : Antibody generation, detection of molecules using ELISA, RIA, western blot,

immunoprecipitation, flow cytometry and immunofluorescence microscopy, detection of molecules in living cells, *in situ* localization by techniques such as FISH and GISH.

- C. **Biophysical methods** : Molecular analysis using UV/visible, fluorescence, circular dichroism, NMR and ESR spectroscopy, molecular structure determination using X-ray diffraction and NMR; molecular analysis using light scattering, different types of mass spectrometry and surface plasma resonance methods.
 - D. **Statistical methods** : Measures of central tendency and dispersal; probability distributions (Binomial, Poisson and normal); sampling distribution; difference between parametric and non-parametric statistics; confidence interval; errors; levels of significance; regression and correlation; *t*-test; analysis of variance; χ^2 test; basic introduction to Multivariate statistics, etc.
 - E. **Radiolabelling techniques** : Properties of different types of radioisotopes normally used in biology, their detection and measurement; incorporation of radioisotopes in biological tissues and cells, molecular imaging of radioactive material, safety guidelines.
 - F. **Microscopic techniques** : Visualization of cells and subcellular components by light microscopy, resolving powers of different microscopes, microscopy of living cells, scanning and transmission microscopes, different fixation and staining techniques for EM, freeze-etch and freeze-fracture methods for EM, image processing methods in microscopy.
 - G. **Electrophysiological methods** : Single neuron recording, patch-clamp recording, ECG, Brain activity recording, lesion and stimulation of brain, pharmacological testing, PET, MRI, fMRI, CAT.
 - H. **Methods in field biology** : Methods of estimating population density of animals and plants, ranging patterns through direct, indirect and remote observations, sampling methods in the study of behaviour, habitat characterization-ground and remote sensing methods.
-

CSIR-UGC NET/JRF Exam. December 2014 Solved Paper Life Sciences

PART-A

1. What is the 94th term of the following sequence ?

1, 1, 2, 2, 2, 2, 3, 3, 3, 3, 3, 3, 4, 4, 4, 4, 4, 4, 4, 4,

- (A) 8 (B) 9
(C) 10 (D) 11

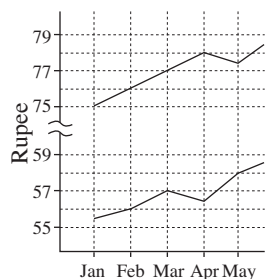
2. Which of the following numbers is a perfect square ?

- (A) 1022121 (B) 2042122
(C) 3063126 (D) 4083128

3. The equation $m^2 - 33n + 1 = 0$, where m & n are integers, has —

- (A) no solution
(B) exactly one solution
(C) exactly two solutions
(D) infinitely many solutions

4. The following graphs depict variation in the value of Dollar and Euro in terms of the Rupee over six months.



Which of the following statements is true ?

- (A) Values of Dollar and Euro rose steadily from January to June
(B) Values of Dollar and Euro rose by equal rate between January to March

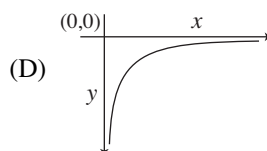
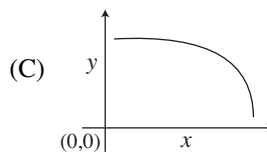
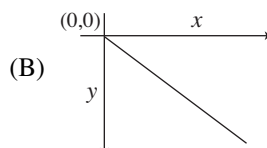
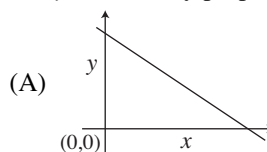
- (C) The rise in the value of Dollar from April to May is three times the fall in Euro during the same period

- (D) Values of Dollar and Euro rose equally between May and June

5. What is the maximum number of whole laddoos having diameter of 6 cm that can be packed in a box whose inner dimensions are $24 \times 18 \times 17 \text{ cm}^3$?

- (A) 24 (B) 30
(C) 33 (D) 36

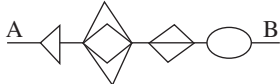
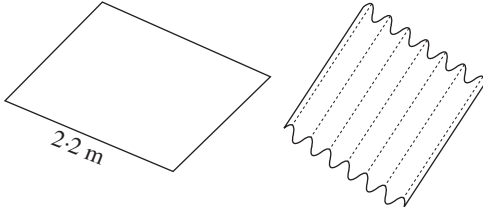
6. Which of the following figures best shows that y is inversely proportional to x ?



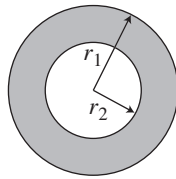
7. What is the next term in the following sequence ?

7, 11, 13, 17, 19, 23, 29,

- (A) 37 (B) 35
(C) 31 (D) 33

8. What is the area of the triangle bounded by the lines $y = 2x$, $y = -2x$ and $y = 6$?
 (A) 36 (B) 18
 (C) 12 (D) 24
9. Three volumes of a Hindi book, identical in shape and size, are next to each other in a shelf, all upright, so that their spines are visible, left to right : I, II and III. A worm starts eating from the outside front cover of volume I, and eats its way horizontally to the outside back cover of volume III. What is the distance travelled by the worm, if each volume is 6 cm thick ?
 (A) 6 cm
 (B) 12 cm
 (C) 18 cm
 (D) a little more than 18 cm
10. A cubical piece of wood was filed to make it into the largest possible sphere. What fraction of the original volume was removed ?
 (A) More than $3/4$
 (B) $1/2$
 (C) Slightly less than $1/2$
 (D) Slightly more than $1/2$
11. Two platforms are separated horizontally by distance A and vertically by distance B . They are to be connected by a staircase having identical steps. If the minimum permissible step length is a , and the maximum permissible step height is b , the number of steps the staircase can have is—
 (A) $\geq B/b$ (B) $\leq A/a$
 (C) $\geq B/b$ and $\leq A/a$ (D) $\leq B/b$ and $\geq A/a$
12. Ajay, Bunty, Chinu and Deb were agent, baker, compounder and designer, but not necessarily in the order. Deb told the baker that Chinu is on his way. Ajay is sitting across the designer and next to the compounder. The designer didn't say anything. What is each person's occupation ?
 (A) Ajay-compounder; Bunty-designer; Chinu-baker; Deb-agent
 (B) Ajay-compounder; Bunty-baker; Chinu-agent; Deb-designer
 (C) Ajay-baker; Bunty-agent; Chinu-designer; Deb-compounder
 (D) Ajay-baker; Bunty-designer; Chinu agent; Deb-compounder
13. Every month the price of a particular commodity falls in this order—
 1024, 640, 400, 250,
 What is the next value ?
 (A) 156.25
 (B) Approximately 39
 (C) 64
 (D) 40
14. We define a function $f(N)$ = sum of digits of N , expressed as decimal number. *e.g.* $f(137) = 1 + 3 + 7 = 11$. Evaluate $f(2^7 3^5 5^6)$ —
 (A) 10 (B) 18
 (C) 28 (D) 11
15. A certain day, which is x days before 17th August, is such that 50 days prior to that day, it was $4x$ days since March 30th of the same year. What is x ?
 (A) 18 (B) 30
 (C) 22 (D) 16
16. A mouse has to go from point A to B without retracing any part of the path, and never moving backwards. What is the total number of distinct paths that the mouse may take to go from A to B ?

 (A) 11 (B) 48
 (C) 72 (D) 24
17. The sum of first n natural numbers with one of them missed is 42. What is the number that was missed ?
 (A) 1 (B) 2
 (C) 3 (D) 4
18. A 2.2 m wide rectangular steel plate is corrugated as shown in the diagram. Each corrugation is a semicircle in cross section having a diameter of 7 cm. What will be the width of steel sheet after it is corrugated ?

 (A) 1.4 m (B) 1.6 m
 (C) 0.7 m (D) 1.1 m

19. If N, E and T are distinct positive integers such that $N \times E \times T = 2013$, then which of the following is the maximum possible sum of N, E and T ?
 (A) 39 (B) 2015
 (C) 675 (D) 671
20. The areas of the inner circle and the shaded ring are equal. The radii r_1 and r_2 are related by—



- (A) $r_1 = r_2$ (B) $r_1 = r_2\sqrt{2}$
 (C) $r_1 = r_2\sqrt{3}$ (D) $r_1 = 2r_2$

PART-B

21. Reaction products inhibit catalysis in enzymes by—
 (A) covalently binding to the enzyme
 (B) altering the enzyme structure
 (C) occupying the active site
 (D) from a complex with the substrate
22. Chirality of DNA is due to—
 (A) the bases
 (B) base stacking
 (C) hydrogen bonds between bases
 (D) deoxyribose
23. Which of the following statements regarding membrane transport is false ?
 (A) Polar and charged solutes will not cross cell membranes effectively without specific protein carriers
 (B) Each protein carrier will only bind and transport one (or a few very similar) type of solute
 (C) Sugars such as glucose are always transported by active transport rather than by facilitated diffusion carriers
 (D) Ions are typically transported by special proteins that form membrane channels
24. What will happen if histones are depleted from a metaphase chromosome and viewed under a transmission electron microscope ?
 (A) 30 nm chromatin fibres will be observed
 (B) 10 nm chromatin fibres will be observed
 (C) A scaffold and a huge number of loops of DNA fibres will be observed
 (D) A huge number of loops of DNA fibres without scaffold will be observed
25. In proteins, hydrogen bonds form as follows : Donor (D)-H... Acceptor (A). Hydrogen bond is more favourable if the angle between D-H and A is—
 (A) $< 90^\circ$ (B) 180°
 (C) $> 180^\circ$ (D) 120°
26. Leader sequence in some of the protozoan parasites is transcribed elsewhere in the parasite genome and gets joined with several transcripts to make the functional RNA. The joining of the two transcripts occur by the process of—
 (A) alternate splicing (B) trans splicing
 (C) ligation (D) RNA editing
27. Small nuclear RNAs used to process and chemically modify rRNAs are called—
 (A) Sca RNAs (B) Si RNAs
 (C) Sno RNAs (D) Sn RNAs
28. Proton motive force during oxidative phosphorylation is generated in mitochondria by—
 (A) Exchanging protons for sodium ions
 (B) pumping protons out into intermembrane space
 (C) pumping hydroxyl ions into the mitochondria
 (D) hydrolysis of ATP
29. During replication, the RNA primer is degraded by the 5' – 3' exonuclease activity of—
 (A) RNase H1 (ribonuclease H1)
 (B) FEN-1 (flap endonuclease 1)
 (C) Topoisomerase II B
 (D) DNA polymerase γ
30. Which one of the following statements about eukaryotic translation is not true ?
 In eukaryotic translation,
 (A) ribosome binding site on mRNA is called Kozak consensus sequences

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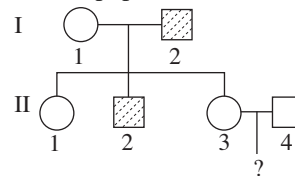
- (B) initiator tRNA is $tRNA_i^{f-met}$
 (C) initiator amino acid is methionine
 (D) translocation factor is eEF2
31. A patient with ER⁺/PR⁺ breast cancer was cured with a drug 'T', whereas a second patient did not respond to 'T'. Which one of the following is the best therapy that you should suggest for the second patient ?
 (A) Surgery, followed by HER-2/neu targeted drugs
 (B) A drug that targets triple negative (ER⁻/PR⁻/HER-2⁻) breast cancer.
 (C) Radiation, followed by drug 'T'.
 (D) Surgery, followed by radiation only
32. If you run a pentavalent IgM through SDS-polyacrylamide gel electrophoresis, how many bands you are supposed to get by Western blotting using alkaline phosphatase conjugated secondary antibody ?
 (A) Five (B) Four
 (C) Three (D) One
33. The splitting or migration of one sheet of cells into two sheets as seen during hypoblast formation in bird embryogenesis is termed as—
 (A) delamination (B) ingression
 (C) involution (D) invagination
34. Which of the following statements about meiosis is not true ?
 (A) Kinetochores of sister chromatids attach to opposite poles in Meiosis I
 (B) Kinetochores of sister chromatids attach to opposite poles in Meiosis II
 (C) Chiasma is formed in Prophase I
 (D) Homologous chromosomes are segregated in Meiosis I
35. In chloroplast, the site of coupled oxidation-reduction reactions is the—
 (A) outer membrane (B) inner membrane
 (C) thylakoid space (D) stromal space
36. Lens formation requires sequential events whereby the anterior neural plate signals the anterior ectoderm to promote secretion of Pax 6, which renders the anterior ectoderm more receptive to secretions from the optic vesicle. The above can be best explained by which of the following phenomenon ?
 (A) Instructive interactions only
 (B) Epithelial-Mesenchymal interactions
 (C) Permissive interactions
 (D) Induction and competence
37. The group of cells of amphibian blastula capable of inducing the organizer is called as—
 (A) Hensen's node
 (B) Nieuwkoop centre
 (C) Dorsal blastopore lip
 (D) Hypoblast
38. Glycosaminoglycans are usually linked to proteins to form proteoglycans. Which of the following is not a proteoglycan ?
 (A) Hyaluronan (B) Aggrecan
 (C) Betaglycan (D) Syndecan-1
39. Which one of the following statements regarding seed germination of a wild type plant is not correct ?
 (A) Low ABA and high bioactive GA can break seed dormancy
 (B) Light accompanied with high temperature can break seed dormancy
 (C) GA induces synthesis of hydrolytic enzymes in cereal grains
 (D) Degradation of carbohydrates and storage proteins provide nourishment and energy to support seedling growth
40. Some T lymphocytes respond to antigenic stimulation by synthesizing a growth factor that causes T cell proliferation thereby increasing the responsive T lymphocytes resulting in amplification of the immune response. This is an example of—
 (A) endocrine signaling
 (B) paracrine signaling
 (C) autocrine signaling
 (D) cyclic signaling
41. Light is the dominant environmental signal that controls stomatal movement in leaves of well-watered plants grown in natural environment. Which one of the following wavelengths of light is responsible for such regulation ?
 (A) Red light (B) Blue light
 (C) Green light (D) Far-red light

42. Which one of the following is not the main factor that contributes to water potential during plant growth under normal conditions ?
 (A) Solute potential
 (B) Hydrostatic pressure
 (C) Gravity
 (D) Temperature
43. Which one of the following cells in the renal corpuscle can influence Glomerular filtration by its contraction ?
 (A) Podocytes
 (B) Endothelial cells of glomerular capillaries
 (C) Parietal epithelial cells of Bowman's capsule
 (D) Mesangial cells
44. Production of excessive amount of corticotropin (ACTH) occurs in which one of the following—
 (A) Graves' disease
 (B) Cushing's syndrome
 (C) Grieg's syndrome
 (D) Alport's syndrome
45. The plant hormone indole-3-acetic acid (IAA) is present in most plants. The structure of this hormone is related to which one of the following amino acids ?
 (A) Glutamic acid (B) Aspartic acid
 (C) Lysine (D) Tryptophan
46. The type-I glomus cells present in the carotid bodies contain granules which release some substances during hypoxia. Which one of the following is released in hypoxia ?
 (A) Serotonin (B) GABA
 (C) Dopamine (D) IL 8
47. Individuals with greater mass have a smaller surface area to volume ratio, which helps to conserve heat. This is known as—
 (A) Leibig's rule (B) Cope's rule
 (C) Gloger's rule (D) Bergmann's rule
48. Which one of the following is not a characteristic property of carotenoids ?
 (A) They possess complex porphyrin ring
 (B) They are integral constituent of thylakoid membrane

- (C) They are also called accessory pigments
 (D) They protect plants from damages caused by light

49. 5-Bromouracil is a base analog that can cause mutation when incorporated into DNA. Which of the following is the most likely change that 5-Bromouracil induces—
 (A) T : A to C : G (B) T : A to A : T
 (C) G : C to T : A (D) C : G to A : T

50. The following pedigree shows the inheritance of a common phenotype controlled by an autosomal recessive allele. The probability of carriers in the population is $1/3$ —



Which is the probability that a child from parents II-3 and II-4 will show the phenotype?

- (A) $1/16$ (B) $1/18$
 (C) $1/36$ (D) $3/16$

51. An interrupted mating experiment was performed between $Hfr\ Str^S\ a^+ b^+ c^+$ and $F^- Str^r\ a^- b^- c^-$ strains. The genotype of majority of streptomycin resistant (Str^r) exconjugant after 10, 20 and 30 minutes of interrupted mating is given below—

10 min	$a^+ b^- c^-$
20 min	$a^+ b^- c^+$
30 min	$a^+ b^+ c^+$

The most probable gene order would be—

- (A) $a b c$ (B) $c a b$
 (C) $b a c$ (D) $a c b$

52. Which one of the following functions is not served by the plasma proteins ?

- (A) Blood clotting
 (B) O_2 transport
 (C) Hormone binding and transport
 (D) Buffering capacity of blood

53. Two plants with white flowers are crossed. White flowers arise due to recessive mutation. All F_1 progeny have red flowers. When the F_1 plants are selfed, both red and white flowered

- progeny are observed. In what ratio will red-flowered plants and white-flowered plants occur ?
- (A) 1 : 1 (B) 3 : 1
(C) 9 : 7 (D) 15 : 1
54. The population density of an insect species increases from 40 to 46 in one month. If the birth rate during that period is 0.4 what is the death rate ?
- (A) 0.25 (B) 0.15
(C) 0.87 (D) 0.40
55. Two 18-residue helical peptides A and B are enantiomers. They can be distinguished by—
- (A) recording their MALDI mass spectrum
(B) hydrolysis followed by amino acid analysis
(C) sequencing by Edman's method
(D) examining their circular dichroism spectra
56. Schizocoelous coelom formation, mouth formation from embryonic blastopore, spiral and determinate cleavage are characteristics of—
- (A) deuterostomes
(B) pseudocoelomates
(C) protists
(D) protostomes
57. Which species concept utilizes morphological and molecular characters to distinguish between species ?
- (A) Evolutionary (B) Ecological
(C) Biological (D) Phylogenetic
58. Worker bees, instead of themselves reproducing, help the queen reproduce. This behaviour is explained as an example of—
- (A) kin selection (B) group selection
(C) sexual selection (D) natural selection
59. Which of the following is a correct match of the animal with its taxonomic group ?
- (A) Hirudinea-Leech; Chelicerata-Horse shoe crab; Cestoda-Tapeworm Echinoidea-Sea urchins; Cephalopoda-Octopus; Oligochaeta-Earthworm
(B) Hirudinea-Earthworm; Chelicerata-Horse shoe crab; Cestoda-Octopus; Echinoidea-Tapeworm; Cephalopoda-Earthworm; Oligochaeta-Leech
(C) Hirudinea-Tapeworm; Chelicerata-Leech; Cestoda-Tapeworm. Echinoidea-Horse shoe crab; Cephalopoda-Earthworm; Oligochaeta-Octopus
(D) Hirudinea-Leech; Chelicerata-Tapeworm; Cestoda-Earthworm Echinoidea-Sea urchins; Cephalopoda-Octopus, Oligochaeta-Horse shoe crab
60. The wings of insects and the wings of bats represent a case of—
- (A) divergent evolution
(B) convergent evolution
(C) parallel evolution
(D) neutral evolution
61. The degree of genetic relatedness between the offspring and their parents is—
- (A) higher than that between sister and brother
(B) lower than that between sister and brother
(C) the same as that between sister and brother
(D) dependent on the number of siblings
62. You want to purify a recombinant protein of your interest. You can use affinity chromatography to purify as you have nickel columns available in the laboratory. With what molecule will you tag the protein to purify using those columns ?
- (A) GST (B) Histidine
(C) Histamine (D) Proline
63. During which geological period was there an explosive increase in the number of many marine invertebrate phyla ?
- (A) Ordovician (B) Devonian
(C) Permian (D) Cambrian
64. An example of the species interaction called commensalism is—
- (A) nitrogen-fixing bacteria in association with legume plant roots
(B) microbes in living human gut
(C) female mosquito deriving nourishment from human blood
(D) orchid plant growing on the trunk of a mango tree

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