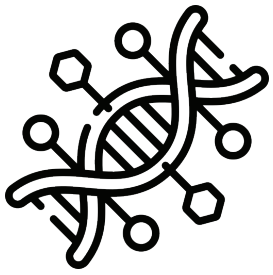
IIT JAM

JOINT ADMISSION TEST FOR MASTERS

BIOTECHNOLOGY



22 PREVIOUS YEARS
2005 TO 2026

TOPIC WISE SORTED QUESTIONS WITH DETAILED EXPLANATIONS

DR. KAILASH CHOUDHARY

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PREFACE

Every year, thousands of students begin their IIT JAM Biotechnology preparation wondering where to start. Previous year papers hold the answers — they reveal patterns, highlight recurring concepts, and show exactly how examiners think. This book was created to solve that problem.

It has been prepared with the aim of helping IIT JAM Biotechnology aspirants practice previous year questions in a more systematic and exam-focused manner. While preparing for competitive exams, students often need one reliable source where questions are not only collected but also properly arranged and explained. This idea became the main motivation behind creating this book.

FEATURES OF THIS BOOK

- ✓ **1. Includes Previous Year Questions from 2005 to 2026**
- ✓ **2. Provides detailed explanations for every question**
- ✓ **3. Arranged in topic-wise and subtopic-wise format**
- ✓ **4. Section-wise sorting into Biology, Mathematics, Physics, and Chemistry**
- ✓ **5. Includes a Questions Analysis Sheet for every topic**

The book is systematically organized with detailed, step-by-step solutions to help students understand concepts and problem-solving techniques. It will be valuable for IIT JAM Biotechnology as well as other M.Sc. entrance exams like GAT-B, CUET (PG), and TIFR.

We hope this book helps students understand exam trends, strengthen concepts, and prepare with better confidence.

All the very best for your Exam...!!

EXAM SCHEME

IIT JAM BT EXAM: From the Academic Session 2004-05, IITs started conducting a Joint Admission Test for M.Sc. (JAM). The objective of JAM is to provide admissions to M.Sc. (Two Years), Joint M.Sc.-Ph.D., M.Sc.-Ph.D. Dual Degree, and other Post-Bachelor Degree Programmes at the IITs and Integrated Ph.D. Degree Programmes at the IISc and to consolidate Science as a career option for bright students across the country. JAM has been established as a benchmark for undergraduate-level science education in the country. The Integrated Ph.D. Program at IISc, started in the early 1990s to enable students to directly join a Ph.D. Program after their B.Sc. Degree has flourished under JAM.

IIT JAM BT examination is an ONLINE Computer Based Test (CBT) the duration of the examination will be of 3 hours. The medium for all the test papers will be English only. There will be a total of 60 questions carrying a total of 100 marks. The entire paper will be divided into three sections, A, B, and C. All sections are compulsory.

Section–A contains a total of 30 Multiple Choice Questions (MCQs) involving 10 questions of one mark each and 20 questions of two marks each.

Section–B contains a total of 10 Multiple Select Questions (MSQs) carrying two marks each.

Section–C contains a total of 20 Numerical Answer Type (NAT) questions involving 10 questions of one mark each and 10 questions of two marks each.

IIT JAM BIOTECHNOLOGY PREVIOUS YEAR CUT OFF

Year	General	GEN EWS/OBC-NCL	SC/ST/PwD
2026	42.3	38.07	21.15
2025	24.46	22.01	12.23
2024	44.46	40.01	22.23
2023	33.06	29.75	16.53
2022	35.25	31.73	17.62
2021	34.13	31.72	17.07
2020	39.86	35.87	19.93
2019	22.93	20.64	11.46
2018	27.67	24.90	13.84
2017	26.67	24.00	13.34
2016	35.00	31.50	17.50

CONTENT

BIOSCIENCE

SECTION I - B I O L O G Y

BIOCHEMISTRY

1. Structure of Atoms, Molecules, Bonds, Interactions. 1
2. Acid, PH, Buffer & Solutions. 3
3. Thermodynamics. 6
4. Amino Acids. 10
5. Proteins. 13
6. Carbohydrates & Glycobiology. 16
7. Lipids. 19
8. Nucleotides & Nucleic Acids. 21
9. Enzymes. 24
10. Metabolism. 30
11. Vitamins. 41

CELL BIOLOGY

1. Prokaryotic, Archaea & Eukaryotic Cell Structure. 45
2. Biological Membranes / Plasma Membrane 46
3. Membrane Transport. 48
4. Protein Sorting. 50
5. Cell Organelles. 53
6. Genome Organization. 56
7. Cell Walls –Plant, Animal & Fungi. 57
8. The Cytoskelleton & Cell Movement. 58
9. The Cell Cycle. 61
10. Mitosis & Meiosis. 66

MOLECULAR BIOLOGY

1. Replication. 68
2. DNA Damage & Repair. 75
3. Transcription & RNA Splicing. 76
4. Translation. 78
5. The Genetic Code. 82
6. LAC, TRP Operon. 84
7. Regulatory RNAs. 87
8. Gene Regulation. 88

CELL SIGNALING

1. Cell Signaling. 90
2. Cell-Cell & Cell -Matrix Interactions. 94
3. Cancer. 95

IMMUNOLOGY

1. Innate Immunity. 97
2. Cell & Organs of Immune System. 98
3. Antigens. 99
4. Antibodies. 100
5. Antigen –Antibody Interaction. 103
6. VDJ Recombination. 105
7. Hybridoma Technology. 106
8. MHC. 107
9. Adaptive Immunity. 108
10. Immunity to Microbes. 109
11. Autoimmunity, Transplantation Immunology, Hypersensitivity Disorders, Congenital & Acquired Immunodeficiencies. 110
12. Vaccine. 112

DEVELOPMENTAL BIOLOGY

1. Developmental Biology. 114

PLANT PHYSIOLOGY

1. Photosynthesis: The Light Reactions. 117
2. Photosynthesis: C3, C2, C4 & Cam Cycle. 121
3. Nitrogen Metabolism & Nitrogen Fixation. 123
4. Water Balance of Plants, Mineral Nutrition & Solute Transport. 126
5. Stomatal Biology. 129
6. Plant Hormones. 130

7. Double Fertilization, Fruit, Seeds, Seed Dormancy Germination Embryogenesis, Seeding Establishment,. 133
8. Stress Physiology. 135

ANIMAL PHYSIOLOGY

1. General Physiology. 137
2. Muscle & Bones. 139
3. Circulatory System. 140
4. Respiration System 145
5. Kidney & Filtration. 146
6. Brain & Neurophysiology. 147
7. Gastrointestinal Physiology. 149
8. Endocrinology & Reproduction. 151

TAXONOMY

1. Principles of Taxonomy & Nomenclature. . 158
2. Classical & Quantitative Methods of Taxonomy. 159
3. Monera, Protista, Algae, Fungi Plant Classification. 160
4. Animal Classification. 161
5. Diversity of Life Forms 162

GENETICS

1. Mendelian Genetics. 164
2. Multiple Alleles. 169
3. Gene Interaction. 170
4. Extrachromosomal Inheritance. 171
5. Human Genetic Disorders. 172
6. Sex Linked Inheritance. 174
7. Molecular Markers. 175
8. Linkage. 176
9. Transformation, Conjugation, Transduction & Mapping of Genes. 177
10. Point Mutations, Gross Mutation and Transposable Elements. 179

ECOLOGY

1. Population Ecology 182
2. Ecological Succession. 184
3. Ecosystem: Structure & Function. 185
4. Species Interactions & Competition. 187

EVOLUTION

1. The Origin & Early Evolution of Life. 190
2. Genetic Drift, Hardy & Weinberg Equation, Population Genetics. 193
3. Speciation: Allopatricity & Sympatricity. ... 197
4. Convergent Evolution/Divergent Evolution. 198
5. Sexual Selection & Co-Evolution, Brain, Behavior & Evolution. 200

MICROBIOLOGY

1. Viruses & Other Acellular Agents (Prions, Viroids & Virusoid) & Viral Infection. 202
2. The Microbes. 204
3. Morphology & Physiology of Microorganisms Gram Staining & Other Staining Methods. 207
4. Microbial Nutrition. 211
5. Microbial Growth. 212
6. Microbes & Disease. 217
7. Plasmid. 223
8. Plaque Assay & MOI. 224
9. Sterilization Control of Microorganisms. ... 225
10. Antibiotics. 227
11. Fermentation. 229
12. Applied Microbiology & Industrial Microbiology. 230

TECHNIQUES

1. Animal Tissue Culture. 234
2. Plant Tissue Culture. 235
3. Microscopy 236
4. Techniques of Molecular Biology, Bioinformatics & Basic Techniques. 239
5. Recombinant DNA & Genetic Analysis 242
6. Immunochemical Techniques. 250
7. Protein/Enzyme Structure, Purification, Characterization & Function Analysis. 251

8. Protein/DNA Sequencing. 253
9. Mass Spectrometric & Spectroscopic Techniques. 255
10. Electrophoretic Techniques. 260
11. Chromatographic Techniques. 265
12. Radioisotope Techniques. 266
13. Drug Discovery & Development. 267
14. Biostatistics. 268

SECTION II - C H E M I S T R Y

1. Fundamental of Physical Chemistry. 271
2. Chemistry of Gaseous State. 273
3. Chemical Thermodynamics. 274
4. Electrochemistry. 278
5. Chemical Kinetics. 281
6. Nuclear Chemistry. 285
7. Photochemistry. 286
8. Analytical & Environmental Chemistry. 287
9. Atomic Structure & Fundamental of Inorganic Chemistry. 288
10. Chemical Periodicity. 290
11. Chemical Bonding & Theories of Bonding. . 292
12. Chemistry of Main Group Elements. 296
13. Chemistry of Transition Elements & Coordination Chemistry. 299
14. Organometallic Chemistry. 303
15. Chemistry of Inner Transition Elements. 304
16. Bioinorganic Chemistry. 305
17. General Organic Chemistry & Aromaticity. 306
18. Stereochemistry. 311
19. Reaction Intermediates, Mechanism & Named Reactions. 315
20. Organic Reagents. 321
21. Organic Spectroscopy. 325
22. Polymer Chemistry, Biochemistry & Chemistry of Natural Products. 330

SECTION III - P H Y S I C S

1. Unit & Measurements. 334
2. Kinematics. 337
3. Laws of Motion. 341
4. Work Power Energy. 344
5. Rotational Dynamics. 346
6. Gravitation. 348
7. Solid State & Mechanical Properties of Solids & Fluids. 350
8. Thermodynamics & Ktg. 352
9. Waves & Oscillations. 357
10. Electrostatics & Electricity. 359
11. Magnetostatics & Electromagnetic Induction. 364
12. EM Waves. 367
13. Ray Optics & Wave Optics. 368
14. Dual Nature of Radiation, Matter & Atom Nuclei. 373
15. Electronics & Principle of Communications. 379
16. Quantum Mechanics. 384

SECTION IV - M A T H E M A T I C S

1. Sets, Relations And Functions. 387
2. Limit. 391
3. Continuity. 393
4. Differentiation. 394
5. Integration. 397
6. Differential Equation. 400
7. Sequence & Series. 403
8. Complex Analysis. 405
9. Probability. 407
10. Binomial Theorem. 410
11. Trigonometry. 411
12. Algebra (Linear + Abstract). 414
13. Permutation & Combination. 417
14. Vector Algebra. 418
15. Geometry. 420
16. Theory of Equations. 427
17. General Aptitude. 429
18. Statistics. 430
19. L L P. 432
20. Advanced Calculus. 433

SECTION – I

BIOLOGY

BIOCHEMISTRY: NUMBER OF QUESTIONS ASKED IN IIT JAM EXAM (2005 to 2026)																							
	TOPIC	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
1	Structure of Atoms, molecules, bonds and interactions	-	-	-	-	-	-	-	-	-	2	-	1	-	-	-	-	-	2	-	-	1	-
2	Acid, pH, Buffer and Solution	-	-	-	-	-	-	1	1	-	1	1	-	1	-	-	-	2	-	-	1	1	-
3	Thermodynamics	-	-	2	1	1	1	1	-	1	2	-	-	-	-	1	-	1	-	-	3	1	1
4	Amino acids	1	3	1	1	2	-	1	1	-	-	-	1	-	1	-	-	-	-	1	-	-	1
5	Proteins	1	-	-	-	1	1	-	-	-	3	-	1	-	1	2	-	1	-	-	-	-	2
6	Carbohydrates and Glycobiology	1	2	1	2	2	-	2	1	-	-	-	-	-	-	1	1	1	1	-	-	-	1
7	Lipids	1	-	1	-	-	1	1	1	-	1	1	-	-	-	-	1	-	-	-	-	-	-
8	Nucleotides and Nucleic acids	1	-	-	-	1	-	-	1	-	3	-	1	-	1	-	1	1	1	-	1	-	-
9	Enzymes	3	1	2	1	1	-	2	2	2	4	3	1	3	2	1	1	-	1	-	-	-	-
10	Metabolism	3	3	5	4	4	2	6	1	2	3	-	1	3	2	2	2	2	3	-	-	2	1
11	Vitamins	1	1	1	-	1	1	-	1	-	1	-	-	-	1	-	1	-	-	-	-	-	2

CHAPTER-1
BIOCHEMISTRY

STRUCTURE OF ATOMS, MOLECULES, BONDS, INTERACTIONS

IIT JAM BT

PREVIOUS YEAR EXAM QUESTIONS

(IIT JAM BT - 2014)

1. Aqueous environment in a spherical endosome – a closed vesicle of 100 nm diameter, is at a pH 5.0, in order to denature and hydrolyze the material internalized by a cell. Assuming Avogadro's number to be 6×10^{23}, the number of free protons in an endosome is closest to
   (1) 24 (2) 3
   (3) 2400 (4) 300

(IIT JAM BT - 2014)

2. The number of water molecules present in a 300 residue soluble protein of spherical shape (diameter = 2nm) having 20% (V/V) water is closest to *Assume:* density of water = 1000 kg/m^3, Avogadro's number = 6×10^{23}
   (1) 224 (2) 9
   (3) 140 (4) 28

(IIT JAM BT - 2016)

3. Which of the following statements are TRUE for hydrogen bonds? Strength of hydrogen bond is
   (1) low in a solvent of high dielectric constant
   (2) low in a solvent of low dielectric constant
   (3) lower in water as compared to organic solvents
   (4) higher in water as compared to organic

(IIT JAM BT - 2022)

4. The correct statement/s for bimolecular nucleophilic substitution reactions is/are
   (1) It goes through a carbocation formation
   (2) There is an inversion of configuration if the reacting center is chiral
   (3) Reaction is enhanced when carried out in polar solvents
   (4) The reaction intermediate is trigonal bipyramidal

(IIT JAM BT - 2022)

5. What is the maximum number of hydrogen bonds that a water molecule can make in the liquid state?

(IIT JAM BT - 2025)

6. The correct order of electronegativity of the given elements is
   (1) B>C>N>O>F (2) F>0>N>C>B
   (3) F>N>O>C>B (4) O>F>N>C>B

Answer Key					
1	**2**	**3**	**4**	**5**	**6**
2	4	1,3	2,3	4	2

EXPLANATION

1. Explanation:-

Given that pH = 5

Hence concentration of H^+ ions = 10^{-5} mol L^{-1}

In order to find out the number of H+ ions, we must calculate the volume of vesicle

Volume of sphere = 4/3 πr^3 as r = 50 nm = 5 x 10^{-8} m

So, volume = 4/3 x 22/7 x 125 x 10^{-24} m^3 = 5.2381 x 10^{-22} m^3

Consider the environment as aqueous, (so 1 m^3 = 1000 Litre)

Hence, 5.2381 x 10^{-22} m^3 = 5.2381 x 10 -19 moles

Number of moles of H^+ inside a vesicle

= concentration x volume

= 10^{-5} x 5.2381 x 10^{-19}

= 5.2381 x 10^{-24} moles

No. of protons = 6 x 10^{23} x 5.2 x 10^{-24}

= 3.19 x 10^0

= 3 protons

2. Explanation:-

To calculate the number of water molecules present in the protein, we need to determine the volume of the protein and the volume of water in it.

Given:

Diameter of the protein = 2 nm

Volume fraction of water = 20% (V/V)

Density of water = 1000 kg/m^3

Avogadro's number = 6×10^{23}

First, let's calculate the volume of the protein.

Radius of the protein = Diameter / 2 = 2 nm / 2 = 1 nm

Volume of the protein

$= \left(\frac{4}{3}\right) \times \pi \times (radius^3) = (4/3) \times \pi \times (1\,nm)^3$

Now, let's calculate the volume of water in the protein.

Volume of water = Volume of the protein × Volume fraction of water = $[(4/3) \times \pi \times (1\,nm)^3] \times 0.2$

Next, let's convert the volume of water to cubic meters.

$1\,nm = 1 \times 10^{-9}\,m$

Volume of water (in m^3) = Volume of water (in nm^3) $\times (1 \times 10^{-9})^3 = [(4/3) \times \pi \times (1\,nm)^3] \times 0.2 \times (1 \times 10^{-9})^3$

Now, let's calculate the mass of the water present in the protein.

Mass of water = Volume of water (in m^3) × Density of water $= [(4/3) \times \pi \times (1\,nm)^3] \times 0.2 \times (1 \times 10^{-9})^3 \times 1000\,kg/m^3$

Now, let's convert the mass of water to the number of water molecules.

Mass of water (in grams)

$$= Mass\ of\ water\ (in\ kg) \times 1000$$
$$= [(4/3) \times \pi \times (1\,nm)^3] \times 0.2 \times (1 \times 10^{-9})^3 \times 1000 \times 1000\,grams$$

Number of water molecules = Mass of water (in grams) / (Molar mass of water × Avogadro's number) $= [(4/3) \times \pi \times (1\,nm)^3] \times 0.2 \times (1 \times 10^{-9})^3 \times 1000 \times 1000\,grams\ /\ (18\,grams/mole \times 6 \times 10^{23})$

Therefore, the number of water molecules present in the protein is closest to (4) 28.

3. Explanation:- Option 1 is correct because hydrogen bond is an ionic interaction. We know that ionic interactions are weak in polar solvent which has high dielectric constant.

Option 3 is correct because the strength of hydrogen bond is inversely proportional to the dielectric constant. The strength of hydrogen bond is low in water compared to organic solvents because water has higher dielectric constant than organic solvents.

4. Explanation:-

1) This option is not correct because in unimolecular nucleophilic substitution reaction carbocation is formed.
2) This option is correct because during replacement of ligand starts in a chiral centre is needed to occur an inversion of configuration.
3) This option is correct because sn2 reaction is favourable in polar aprotic solvents like acetone, DMSO, acetonitrile etc.
4) This option is incorrect because the reaction intermediate in a bimolecular nucleophilic substitution reaction is tetrahedral, not trigonal bipyramidal.

5. Explanation:- The maximum number of hydrogen bonds is 4 in a water molecule in a liquid state because it has two hydrogen bond donor and two hydrogen bond acceptor.

6. Explanation:- Electronegativity measures an atom's ability to attract electrons. it increases across a period from left to right and decreases down a group. Fluorine is the most electronegative (3.98), followed by oxygen (3.44), nitrogen (3.04), carbon (2.55), and boron (2.04). Thus, the correct order is F > O > N > C > B.

ACID, pH, BUFFER & SOLUTIONS

IIT JAM BT

PREVIOUS YEAR EXAM QUESTIONS

(IIT JAM BT - 2011)

1. An aqueous solution contains 0.01 mol of formic acid (pK_a = 3.8) and 0.1 mol of sodium formate. The pH of the solution is
   (1) 3.8 (2) 4.8
   (3) 2.8 (4) 1.8

(IIT JAM BT - 2012)

2. pK_a of acetic acid is 4.80. A 10mL of 1M solution of acetic acid is mixed with 5mL of 1M solution of NaOH. The *pH* of the resulting solution is
   (1) 3.2 (2) 7.0
   (3) 4.8 (4) 2.4

(IIT JAM BT - 2014)

3. The pH at the equivalence point when 50mL of 0.1M Acetic acid is titrated against 0.1M NaOH is closest to
   (1) 6.0 (2) 7.0
   (3) 8.0 (4) 9.0

(IIT JAM BT - 2015)

4. The pH of a 0.1M solution of monosodium succinate (pKa_1= 4.19 and pKa_2 = 5.57) is ___.

(IIT JAM BT - 2017)

5. The $[H^+]$ of 0.1 N acetic acid solution is 1.33×10^{-3}. The pH of the solution (correct to two decimal places) is_____.

(IIT JAM BT - 2021)

6. The molar concentration of water in pure water is _____ M (rounded -off to 1 decimal).

(IIT JAM BT - 2021)

7. 1.45 g of sucrose ($C_{12}H_{22}O_{11}$) is dissolved in 30.0 ml of water. Molality (rounded off to 3 decimals) of the resulting solution is _____ m.

(IIT JAM BT - 2024)

8. One molecule of the protein myoglobin contains one atom of iron. A myoglobin sample was found to contain 0.34% iron. The molecular weight of myoglobin is _____ $g\ mol^{-1}$ (rounded off to the nearest integer).
   (Use 55.9 $g\ mol^{-1}$ as atomic mass of iron)

(IIT JAM BT - 2025)

9. A buffer solution is composed of 0.1 M acetic acid and 0.15 M sodium acetate. The change in pH of 1 L buffer solution upon addition of 50 mL of 1.0 M NaOH is _____. (rounded off to 2 decimals)
   [K_a of acetic acid=1.75×10^{-5}]

Answer Key				
1	**2**	**3**	**4**	**5**
3	3	4	4.80-4.90	2.86-2.89
6	**7**	**8**	**9**	
55.7	0.141	16441.18	0.42	

EXPLANATION

1. Explanation:- The formic acid and sodium formate will react to form a buffer solution. The pH of a buffer solution is given by the Henderson-Hasselbalch equation:

$$pH = pKa + log([A-] / [HA])$$

where [A-] is the concentration of the conjugate base, [HA] is the concentration of the acid, and pKa is the acid's pKa.

In this case, the pKa of formic acid is 3.8, the concentration of the conjugate base is 0.1 mol, and the concentration of the acid is 0.01 mol. Plugging these values into the Henderson-Hasselbalch equation,

we get: pH = 3.8 + log(0.1 / 0.01) = 2.8

Therefore, the pH of the solution is 2.8.

2. Explanation:- The acetic acid and NaOH will react to form sodium acetate, a salt. The pH of a solution of a salt of a weak acid and a strong base is equal to the pKa of the weak acid.

In this case, the pKa of acetic acid is 4.8, so the pH of the resulting solution will be 4.8.

Calculate the moles of acetic acid and NaOH:

Moles of acetic acid = 10 mL * 1 M = 10 mmol

Moles of NaOH = 5 mL * 1 M = 5 mmol

Calculate the moles of excess acetic acid:

Moles of excess acetic acid = 10 mmol - 5 mmol = 5 mmol

Calculate the pH of the solution:

pH = pKa + log([A-] / [HA])

[A-] = moles of NaOH / total volume = 5 mmol / 15 mL = 0.333 M

[HA] = moles of acetic acid / total volume = 5 mmol / 15 mL = 0.333 M

pH = 4.8 + log(0.333 / 0.333) = 4.8

Therefore, the pH of the resulting solution is 4.8.

3. Explanation:- Initial moles of acetic acid = 50mL * 0.1M = 5 mmol

Initial moles of NaOH = 50mL * 0.1M = 5 mmol

Moles of NaOH added = 5 mmol
Moles of acetic acid neutralized = 5 mmol
Moles of acetate formed = 5 mmol
Total volume = 50mL + 50mL = 100mL
[Acetate] = 5 mmol / 100mL = 0.05M
pH = 14 - pKa - log([Acetate])
pH = 14 - 4.8 - log(0.05)
pH = 10.5 which is closest to 9.0

4. Explanation:-
pKa1 = 4.19
pKa2 = 5.57
[HA2-] = 0.1M
[HA] = 0.1M - 0.1M = 0
pH = pKa2 + log([A2-] / [HA])
pH = 5.57 + log(0.1 / 0)
pH = 5.57
The pH of the solution is 5.57. However, this is the pH of the solution after the first dissociation of monosodium succinate. The second dissociation of monosodium succinate will also contribute to the pH of the solution, so the pH will be slightly lower than 5.57.
The exact pH of the solution will depend on the relative concentrations of the first and second dissociated forms of monosodium succinate.
pKa2 = 5.57
[A2-] = 0.1M
[HA] = 0.1M - 0.01 = 0.09
pH = pKa2 + log([A2-] / [HA])
pH = 5.57 + log(0.1 / 0.09)
pH = 4.88

5. Explanation:-
To determine the pH of the acetic acid solution, we can use the equation relating pH and the concentration of hydrogen ions ([H+]):
pH = -log[H+]
Given that the [H+] of the 0.1 N (normal) acetic acid solution is 1.33×10^{-3} M, we can substitute this value into the equation:
pH = -log(1.33×10^{-3})
Using a calculator, we find:
pH ≈ 2.88
Therefore, the pH of the 0.1 N acetic acid solution is approximately 2.88.

6. Explanation:-
The molar concentration of water in pure water can be calculated using the fact that water has a density of 1 g/cm³, which is equivalent to 1000 kg/m³. The molar mass of water (H_2O) is approximately 18.015 g/mol.
The molar concentration (C) can be calculated using the formula:
C = density / molar mass
Substituting the values, we have:
C = 1000 kg/m³ / 18.015 g/mol
Converting the units to match (1 g = 0.001 kg, 1 mol = 6.022×10^{23} molecules), we get:
C = (1000 kg/m³ / 18.015 g/mol) × (1 mol / 1000 g) × (6.022×10^{23} molecules / 1 mol)
C ≈ 55.56 mol/m³
Rounding off to one decimal place, the molar concentration of water in pure water is approximately 55.6 M.

7. Explanation:-
To calculate the molality of the resulting solution, we need to determine the number of moles of sucrose ($C_{12}H_{22}O_{11}$) and the mass of water.
The molar mass of sucrose ($C_{12}H_{22}O_{11}$) can be calculated as follows: 12(12.01 g/mol) + 22(1.008 g/mol) + 11(16.00 g/mol) = 342.34 g/mol
Given that 1.45 g of sucrose is dissolved, we can calculate the number of moles of sucrose: moles of sucrose = mass of sucrose / molar mass of sucrose = 1.45 g / 342.34 g/mol ≈ 0.00424 mol
The mass of water is given as 30.0 mL, which we need to convert to grams using the density of water (1 g/mL): mass of water = volume of water × density of water = 30.0 mL × 1 g/mL = 30.0 g
Now we can calculate the molality (m) of the solution: molality = moles of solute / mass of solvent (in kg) = 0.00424 mol / (30.0 g / 1000) = 0.1413 mol/kg
Rounding off to three decimal places, the molality of the resulting solution is approximately 0.141 m.

8. Explanation:
To calculate the molecular weight of myoglobin based on it containing 0.34% iron, we use the given information:
Atomic mass of iron (M_{Fe}) = 55.9 g mol^{-1}
Percentage of iron in myoglobin = 0.34%
The formula to calculate the molecular weight of myoglobin ($M_{Myoglobin}$) is rearranged from the proportion of iron in myoglobin:
Percentage of iron= $\frac{M_{Fe}}{M_{Myoglobin}} \times 100\%$
Substituting the values: $M_{Myoglobin} = \frac{55.9}{0.34} \times 100$
$M_{Myoglobin}$= 16441.18$g\ mol^{-1}$

9. Explanation:-
i. **Initial pH:** Use the Henderson-Hasselbalch equation:
pH = pKa + log ($\frac{[A^-]}{[HA]}$)
Where: **pKa** = -log(Ka) = -log(1.75×10^{-5}) ≈ 4.76 , **$[A^-]$** = concentration of acetate (0.15 M) , **[HA]** = concentration of acetic acid (0.1 M)

pH (initial) = 4.76 + log ($\frac{0.15}{0.1}$)

= 4.76 + 0.18 = 4.94

ii. **Moles of reactants:**
Moles of acetic acid (HA): 0.1 mol/L x 1 L = 0.1 mol
Moles of acetate (A^-): 0.15 mol/L x 1 L = 0.15 mol
Moles of NaOH added: 1.0 mol/L x 0.05 L = 0.05 mol

iii. **Reaction:** NaOH reacts with acetic acid: $HA + OH^- \rightarrow A^- + H_2O$

iv. **New concentrations:**
Moles of HA remaining: 0.1 mol - 0.05 mol = 0.05 mol
Moles of A^- formed: 0.15 mol + 0.05 mol = 0.2 mol
New concentrations (in 1.05 L):
[HA] = $\frac{0.05\ mol}{1.05\ L}$ = 0.0476 M
[A^-] = $\frac{0.2\ mol}{1.05\ L}$ = 0.1905 M

v. **Final pH:** Use the Henderson-Hasselbalch equation again:
pH (final) = 4.76 + log ($\frac{0.1905}{0.0476}$)
= 4.76 + 0.60 = 5.36

vi. **Change in pH:**
ΔpH = pH (final) – pH (initial) = 5.36 - 4.94 = 0.42

∴ Change in pH approximately **0.42**.

CHAPTER-9
CELL BIOLOGY

THE CELL CYCLE

IIT JAM BT

PREVIOUS YEAR EXAM QUESTIONS

(IIT JAM BT 2005)

1. Which of the following four is involved in cell cycle control?
   (1) Proteolysis of cyclins
   (2) Phosphorylation of cyclins
   (3) Proteolysis of cyclin-dependent kinase
   (4) Dephosphorylation of cyclins

(IIT JAM BT 2007)

2. The G_0 phase of the animal cell cycle can occur
   (1) Just before the G_1 phase
   (2) Just before the mitotic (M) phase
   (3) During the G_2 phase
   (4) Late in the G_1 phase

(IIT JAM BT 2010)

3. M Phase promoting factor (MPF) facilitates cells to move from G2 to M phase during the cell cycle. The sudden decline in MPF at the end of the M Phase is due to
   (1) Degradation of CDKs
   (2) Degradation of cyclins
   (3) The reduced expression of cyclins
   (4) An increase in the ratio of cell volume and genome

(IIT JAM BT 2010)

4. Spindle fibers, formed during the cell division, are composed of
   (1) Actin (2) collagen
   (3) Myosin (4) tubulin

(IIT JAM BT 2011)

5. Which one of the following statements is *incorrect*?
   (1) Mer B is a bacterial protein similar to eukaryotic actin
   (2) FtsZ protein found in most of the bacteria is a tubulin homologue
   (3) AmiC hydrolyzes peptidoglycan to separate daughter cells
   (4) FtsZ is an inhibitor of Z ring assembly

(IIT JAM BT 2013)

6. Mammalian cells in the S phase can be monitored by incorporating which one of the following in the cell culture medium?
   (1) ^{35}S Methionine (2) ^{32}P-ATP
   (3) ^{3}[H] Thymine (4) ^{3}[H] Thymidine

(IIT JAM BT 2013)

7. DNA was isolated from three samples of normal human cells. In each of these samples, cells were at different stages of cell division
   Sample 1: Cells were in G2 phase
   Sample 2: Cells were in anaphase
   Sample 3: Cells were in telophase
   DNA isolated from which of these samples conforms to Chargaff's rules?
   (1) Only samples 1 and 2
   (2) Only Samples 1 and 3
   (3) Only samples 2 and 3
   (4) Samples 1, 2 and 3

(IIT JAM BT 2013)

8. Cell A is in S phase of cell division. Cell B is in G1 phase of cell division. If cell A and cell B were to be fused then the nucleus of the cell B in the heterokaryon
   (1) Continues to be in the G_1 phase
   (2) Enters the S phase
   (3) Enters the M phase
   (4) Enters the G_2 phase

(IIT JAM BT 2014)

9. A toxin which causes accumulation of twice the normal amount of DNA in a dividing mammalian cell, most likely blocks the cell cycle
   (1) During G_0 phase (2) after G_1 phase
   (3) After M phase (4) during G_2 phase

(IIT JAM BT 2016)

10. During mitosis, disappearance of the nucleolus is a hallmark of
    (1) Metaphase (2) prophase
    (3) Anaphase (4) telophase

(IIT JAM BT 2016)

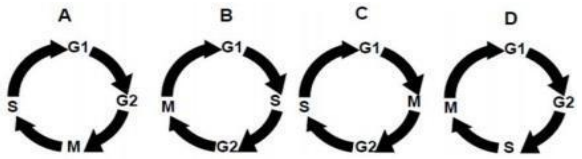
11. Two mammalian cell lines with doubling times of 12h and 36h were cultured with radioactive thymidine for 8h. The cells were further cultured without the radioactive thymidine for 72h. Incorporated radioactivity was measured in equal number of cells in each culture, which revealed that
    (1) Both the cell lines had the same amount of radioactivity
    (2) The fast growing cells had more radioactivity
    (3) The slow growing cells had more radioactivity
    (4) Neither of the cells had any radioactivity

(IIT JAM BT 2017)

12. During eukaryotic cell division, the amount of DNA doubles
    (1) Between prophase and anaphase of mitosis
    (2) Between prophase I and prophase II of meiosis
    (3) Between the G1 and G2 phases of the cell cycle
    (4) During the M phase of the cell cycle

(IIT JAM BT 2019)

13. Which one of the following figures represents the correct sequence of phases in adult eukaryotic cell cycle?



(IIT JAM BT 2019)

14. Which one of the following statements is a correct description of modes of action of taxol and colchicine?
    (1) Taxol causes DNA damage and colchicine prevents microtubule formation
    (2) Taxol stabilizes microtubules and colchicine inhibits protein synthesis
    (3) Taxol destabilizes microtubules and colchicine promotes microtubule formation
    (4) Taxol stabilizes microtubules and colchicine prevents microtubule formation

(IIT JAM BT 2020)

15. The CORRECT sequence of phases during mitosis is
    (1) Prophase, metaphase, anaphase, telophase
    (2) Prophase, anaphase, metaphase, telophase
    (3) Anaphase, prophase, metaphase, telophase
    (4) Anaphase, metaphase, prophase, telophase

(IIT JAM BT 2023)

16. Which of the following statement(s) is/are correct about telophase?
    (1) Division of cytoplasm begins
    (2) Daughter chromosomes are yet to form
    (3) Nuclear membrane disappears
    (4) New nuclear envelop starts to reassemble

(IIT JAM BT - 2024)

17. Chromosome duplication during the cell cycle occurs in
    (1) G_1 phase (2) G_2 phase
    (3) M phase (4) S phase

(IIT JAM BT - 2025)

18. Which of the following represents the CORRECT order of events in the eukaryotic cell cycle?
    (1) G1→S→G2→M (2) S→G1→M→G2
    (3) G1→S→M→G2 (4) S→G1→G2→M

(IIT JAM BT 2026)

19. Which one of the following is a characteristic of apoptosis?
    (1) Endocytosis
    (2) DNA fragmentation
    (3) Cell migration
    (4) Uncontrolled cell proliferation

Answer Key									
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
1	1	2	4	4	4	4	2	4	2
11	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	
3	3	2	4	1	1,4	4	1	2	

EXPLANATIONS

1. Explanation: During the cell cycle, the levels of cyclin proteins fluctuate, and their degradation is crucial for cell cycle control. Cyclins regulate the activity of cyclin-dependent kinases (CDKs), which are enzymes responsible for driving cell cycle progression. The proteolysis of cyclins, specifically their degradation through the ubiquitin-proteasome system, plays a key role in regulating the activity of CDKs and controlling the cell cycle.

2. Explanation: The G0 phase of the cell cycle is a resting or quiescent phase in which cells temporarily exit the active cell cycle. It occurs just before the G1 phase, which is the first phase of the cell cycle. Cells in the G0 phase are not actively dividing but can re-enter the cell cycle if they receive appropriate signals or stimuli.

3. Explanation: M Phase promoting factor (MPF) is a complex composed of cyclin-dependent kinase (CDK) and cyclin proteins. It plays a crucial role in facilitating the transition from the G2 phase to the M phase of the cell cycle. MPF promotes entry into mitosis and the events associated with cell division. At the end of the M phase, there is a sudden decline in MPF activity. This decline is primarily due to the degradation of cyclin proteins. Cyclins are regulatory proteins that control the activity of CDKs. The degradation of cyclins through the ubiquitin-proteasome system leads to the inactivation of MPF and allows the cell cycle to progress beyond the M phase.
Therefore, the correct answer is (2) Degradation of cyclins.

4. Explanation: Spindle fibers, also known as microtubules, are composed of the protein tubulin. Tubulin is a globular protein that polymerizes to form long, filamentous structures called microtubules. These microtubules play a critical role in cell division by forming the spindle apparatus,

which is responsible for separating chromosomes during mitosis and meiosis.

Actin is another cytoskeletal protein that forms microfilaments and is involved in various cellular processes, but it is not the primary component of spindle fibers. Collagen is a fibrous protein found in the extracellular matrix, providing structural support to tissues, but it is not involved in the formation of spindle fibers.

Myosin is a motor protein that interacts with actin to generate force and is mainly involved in muscle contraction, cell movement, and other cellular processes, but it is not a component of spindle fibers.

Therefore, the correct answer is (4) Tubulin.

5. Explanation: FtsZ is a bacterial protein that plays a central role in cell division. It forms a ring-like structure called the Z ring at the site of cell division, which is crucial for initiating cytokinesis. FtsZ is not an inhibitor of Z ring assembly; rather, it is the key protein involved in the assembly of the Z ring.

The other statements are correct:

(1) Mer B is a bacterial protein similar to eukaryotic actin. Mer B is a protein found in bacteria that shares structural and functional similarities with eukaryotic actin.

(2) FtsZ protein found in most bacteria is a tubulin homologue. FtsZ is a bacterial protein that shows homology to tubulin, the protein involved in microtubule formation in eukaryotes.

(3) AmiC hydrolyzes peptidoglycan to separate daughter cells. AmiC is an enzyme found in bacteria that hydrolyzes peptidoglycan, a major component of the bacterial cell wall, to facilitate cell separation during cell division.

Therefore, the correct answer is (4) FtsZ is an inhibitor of Z ring assembly.

6. Explanation: During the S phase of the cell cycle, DNA replication occurs. Thymidine is a nucleoside that is specifically incorporated into newly synthesized DNA strands during replication. By adding a radioactive isotope of hydrogen, 3[H] thymidine, to the cell culture medium, the newly synthesized DNA in the S phase cells can be labeled and detected. This allows researchers to monitor and study the progression of cells through the S phase.

7. Explanation: Chargaff's rules state that in DNA, the amount of adenine (A) is equal to thymine (T), and the amount of guanine (G) is equal to cytosine (C). Based on this, we can determine which samples conform to Chargaff's rules:

Sample 1: Cells in G2 phase During the G2 phase, DNA replication has already occurred, and the amount of DNA in the cell is doubled. However, the base pairing rule is still maintained, so the DNA isolated from cells in G2 phase should conform to Chargaff's rules.

Sample 2: Cells in anaphase Anaphase is the stage during which sister chromatids are separated and pulled to opposite ends of the cell. DNA replication is complete at this stage, and the DNA should still conform to Chargaff's rules.

Sample 3: Cells in telophase Telophase is the final stage of cell division when the cell is almost divided into two daughter cells. The DNA has already undergone replication and segregation, so the DNA in telophase cells should also conform to Chargaff's rules.

Based on this analysis, the DNA isolated from all three samples (1, 2, and 3) should conform to Chargaff's rules. Therefore, the correct answer is (4) Samples 1, 2, and 3.

8. Explanation: The presence of a cell in the S phase indicates that DNA synthesis is ongoing, and the cell is actively replicating its DNA. When the nucleus of cell B in the heterokaryon fuses with cell A, which is in the S phase, the factors and signals present in the S phase nucleus can induce DNA synthesis in the fused nucleus. As a result, the nucleus of cell B in the heterokaryon would enter the S phase and initiate DNA replication.

9. Explanation: If a toxin causes accumulation of twice the normal amount of DNA in a dividing mammalian cell, it most likely blocks the cell cycle during G2 phase.

During the G2 phase, the cell prepares for mitosis by synthesizing proteins and organelles required for cell division. It is also a checkpoint phase where the cell checks for DNA damage and ensures proper DNA replication before entering mitosis.

If a toxin blocks the cell cycle during the G2 phase, it can disrupt the processes involved in DNA replication and cell division, leading to the accumulation of twice the normal amount of DNA in the cell.

Therefore, the correct answer is (4) during the G2 phase.

10. Explanation: During prophase, the chromatin condenses and becomes visible as distinct chromosomes. The nuclear envelope begins to break down, and the nucleolus, which is responsible for ribosome synthesis and assembly, starts to

disappear. This is because the nucleolus is primarily involved in interphase activities and becomes inactive during mitosis.
Therefore, the correct answer is (2) prophase.

11. Explanation: In this scenario, radioactive thymidine was incorporated into the DNA of both cell lines during the initial 8-hour culture period. After that, both cell lines were cultured without radioactive thymidine for 72 hours.
Since thymidine is specifically incorporated into DNA during DNA synthesis (S phase), the amount of radioactivity measured in the cells reflects their DNA replication activity during the initial 8-hour period.
The cell line with a doubling time of 12 hours is faster growing and has a shorter cell cycle. Therefore, a significant portion of its cells would have undergone DNA replication and incorporated radioactive thymidine during the 8-hour culture period.
On the other hand, the cell line with a doubling time of 36 hours is slower growing and has a longer cell cycle. As a result, a smaller proportion of its cells would have undergone DNA replication and incorporated radioactive thymidine during the same 8-hour culture period.
During the subsequent 72-hour period without radioactive thymidine, both cell lines would continue to grow and divide, but only the initially labeled DNA would retain the radioactivity.
Therefore, when the radioactivity is measured in equal numbers of cells from each culture, the slow growing cells (with a longer cell cycle) would have more radioactivity because a higher proportion of their cells would have retained the labeled DNA.
Hence, the correct answer is (3) The slow growing cells had more radioactivity.

12. Explanation: During the cell cycle of eukaryotic cells, the amount of DNA doubles during the S phase (Synthesis phase). In the S phase, DNA replication takes place, resulting in the synthesis of two identical copies of the genome. Each copy, known as a sister chromatid, is held together at the centromere.
After DNA replication in the S phase, the cell progresses to the G2 phase (Gap 2 phase). During the G2 phase, the cell prepares for cell division by undergoing further growth, synthesizing proteins, and ensuring that all the replicated DNA is intact and ready for segregation.
So, between the G1 and G2 phases of the cell cycle, the amount of DNA doubles due to DNA replication in the S phase.
Therefore, the correct answer is (3) Between the G1 and G2 phases of the cell cycle.

13. Explanation: Cell cycle is a process by which cells maintain their number, following different phases of cell cycle Interphase and Division phase.

- Interphase: A phase of cell cycle by which the cells prepare for division, it contains G1-Phase, S-phase, and G2-phase.
- G1 phase: Active in most metabolically active, organelle duplication.
- S phase: DNA duplication, Histone protein synthesis, Centriole synthesis.
- G2 phase: Tubulin synthesis, Centriole division
- Division phase: This is the final division phase of the cell by which cells either divide by Mitosis or Meiosis.

14. Explanation: Taxol and colchicine are both drugs that affect the dynamics of microtubules, which are important components of the cytoskeleton involved in various cellular processes, including cell division.
Taxol (also known as paclitaxel) stabilizes microtubules by binding to them and preventing their depolymerization. This leads to the stabilization of microtubule structures, inhibiting their dynamic behavior and interfering with processes that rely on microtubule dynamics, such as mitosis.
On the other hand, colchicine disrupts microtubule formation by binding to tubulin subunits, preventing their polymerization into microtubules. As a result, colchicine inhibits microtubule assembly and disrupts the normal organization and function of the cytoskeleton.
Therefore, the correct statement is that taxol stabilizes microtubules and colchicine prevents microtubule formation (option 4).

15. Explanation: During mitosis, which is a process of cell division, the cell undergoes several distinct phases:
Prophase: This is the first phase of mitosis. During prophase, the chromatin condenses into visible chromosomes, the nuclear membrane disintegrates, and the mitotic spindle begins to form.
Metaphase: In metaphase, the chromosomes line up along the equatorial plane of the cell, forming a structure called the metaphase plate. The mitotic spindle fibers attach to the centromeres of the chromosomes.
Anaphase: Anaphase is the phase in which the sister chromatids separate and move towards opposite poles of the cell. This separation is facilitated by the shortening of the spindle fibers.

Telophase: Telophase is the final phase of mitosis. During telophase, the chromosomes reach the opposite poles of the cell, and the nuclear membranes start to reform around each set of chromosomes. The chromatin begins to decondense, and cytokinesis, the division of the cytoplasm, usually begins.
Therefore, the correct sequence is (1) Prophase, metaphase, anaphase, telophase.

16. **Explanation:** During telophase, several events occur as part of the cell division process.
The statements that accurately describe these events are:
(1) Division of cytoplasm begins: Telophase marks the beginning of cytokinesis, the physical division of the cytoplasm, which leads to the formation of two separate daughter cells.
(4) New nuclear envelop starts to reassemble: As telophase progresses, the nuclear membrane, which had previously disassembled during prophase and metaphase, starts to reassemble around the separated sets of daughter chromosomes. This process is essential for the formation of two distinct nuclei in the newly formed daughter cells.
Statement (2) is incorrect. During telophase, the daughter chromosomes have already migrated to opposite poles of the cell and are starting to decondense, forming chromatin. The formation of daughter chromosomes occurs during anaphase.
Statement (3) is also incorrect. In telophase, the nuclear membrane reappears, rather than disappearing. The nuclear membrane disassembles during prophase and metaphase, allowing the chromosomes to interact with the spindle apparatus. However, during telophase, the nuclear membrane starts to reform around the decondensing daughter chromosomes.

17. **Explanation:** During mitosis, the duplicated chromosomes are separated and distributed equally to the daughter cells. No chromosome duplication happens in M phase.Therefore, the only phase where chromosome duplication occurs is the S phase (Synthesis phase). During this phase, specialized enzymes and proteins work together to create an exact copy of each chromosome, ensuring accurate transmission of genetic information to the next generation of cells.

18. **Explanation:-** The eukaryotic cell cycle progresses in the order G1 → S → G2 → M. G1 involves cell growth and preparation, S is DNA replication, G2 is further growth and mitosis preparation, and M is cell division. This order ensures controlled duplication and prevents errors.

19. **Explanation: DNA fragmentation** is a hallmark of **apoptosis**, where the cell's DNA is cleaved into small, regular fragments, often visualized as a "DNA ladder" during gel electrophoresis. This process is facilitated by endonucleases such as **caspase-activated DNase (CAD)**. DNA fragmentation is a critical step in apoptosis, distinguishing it from other forms of cell death.

MITOSIS & MEIOSIS

IIT JAM BT

PREVIOUS YEAR EXAM QUESTIONS

(IIT JAM BT 2021)

1. The difference between mitosis and meiosis I is
   (1) The DNA is double helical in meiosis I but not in mitosis
   (2) Sister chromatids separate in mitosis, whereas homologous chromosomes separate in meiosis I
   (3) Unlike in mitotic metaphase, chromosomes do not align at the equatorial plate in meiosis I
   (4) The nuclear membrane is absent during mitotic metaphase, but not in meiotic metaphase

(IIT JAM BT 2025)

2. Which of the following statements about eukaryotic asymmetric cell division is NOT correct?
   (1) Chromosomes are unequally distributed in the daughter cells
   (2) Chromosomes are equally distributed in the daughter cells
   (3) RNA and proteins are unequally distributed in the daughter cells
   (4) Cytoplasmic contents are unequally distributed in the daughter cells

Answer Key	
1	**2**
2	1

EXPLANATION

1. Explanation: Mitosis is a type of cell division that produces two identical daughter cells. During mitosis, the DNA in the nucleus is replicated, and the two identical copies of DNA (sister chromatids) are separated into two daughter cells.

Meiosis is a type of cell division that produces four daughter cells, each with half the number of chromosomes as the parent cell. During meiosis, the DNA in the nucleus is replicated, but the homologous chromosomes (pairs of chromosomes that are similar but not identical) are separated into two daughter cells.

Therefore, the main difference between mitosis and meiosis is that in mitosis, sister chromatids separate, while in meiosis, homologous chromosomes separate.

The other options are incorrect:

Option (1) is incorrect because the DNA is double helical in both mitosis and meiosis.

Option (3) is incorrect because chromosomes do align at the equatorial plate in meiosis I.

Option (4) is incorrect because the nuclear membrane is absent during both mitotic metaphase and meiotic metaphase.

2. Explanation:- In asymmetric cell division, chromosomes are usually equally distributed, but RNA, proteins, and cytoplasmic contents are unequally shared, leading to differences in the daughter cells' function and fate.

MOLECULAR BIOLOGY: NUMBER OF QUESTIONS ASKED IN IIT JAM EXAM (2005 to 2026)																							
	TOPIC	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
1	Replication	2	1	-	1	1	3	1	2	3	1	1	1	-	2	1	-	1	3	2	2	1	1
2	DNA Damage & Repair	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-
3	Transcription and RNA Splicing	1	-	-	1	-	-	-	-	-	1	-	-	-	-	-	-	-	-	3	3	1	-
4	Translation	2	2	-	2	1	3	-	1	-	1	1	-	2	-	-	-	-	1	1	-	1	1
5	Genetic code	-	-	-	2	1	-	-	1	-	1	-	-	1	-	-	-	1	-	-	-	-	-
6	Lac, Trp Operon	-	-	1	-	1	1	1	1	1	1	1	-	1	1	1	1	-	-	-	-	1	-
7	Regulatory RNA's	1	-	-	-	-	-	1	-	-	1	-	-	-	-	-	1	-	-	-	-	-	-
8	Gene regulation	-	-	-	1	-	-	-	-	-	-	-	-	-	-	1		1	-	-	-	-	-

CHAPTER-5
TECHNIQUES

RECOMBINANT DNA & GENETIC ANALYSIS

IIT JAM BY

PREVIOUS YEAR EXAM QUESTIONS

(IIT JAM BT 2005)

1. Baculovirus vectors are used to transfer genes into
   (1) Mammalian cells (2) Plant cells
   (3) Insect cell (4) Bacterial cells

(IIT JAM BT 2006)

2. The DNA restrictions site recognized by the enzyme *Hind* III is - $\frac{AAGCTT}{TTCGAA}$. Which of the following sequence contained in a double stranded DNA is cut by *Hind* III?
   (P) ATGCCTTAAGATGC
   (Q) ATGCTTCGAAATGC
   (R) ATGCAAGCTTATGC
   (S) ATGCGAATTCATGC
   (1) Only Q (2) Both Q and R
   (3) Only R (4) All of them

(IIT JAM BT 2006)

3. Pure plasmid DNA was isolated from a bacterium. Restriction enzyme digestion of this plasmid with either *Bam* HI or *Eco* RI resulted in two DNA fragments. A double digestion of the same plasmid with both these enzymes resulted in three DNA fragments. From this we can conclude that the isolated plasmid DNA is
   (1) Double stranded and linear
   (2) double stranded and circular
   (3) Single stranded and linear
   (4) Single stranded and circular

(IIT JAM BT 2006)

4. Which of the following can be used for transferring the DNA into the host cells?
   P. Transformation
   Q. Sonication
   R. Transfection
   S. Electroporation
   (1) Only P can be used
   (2) Only Q and R can be used
   (3) Only Q, R and S can be used
   (4) Only P, R and S can be used

(IIT JAM BT 2007)

5. Which one of the following can be used to transfect DNA into mammalian cells?
   P. Liposomes
   Q. Cholesterol
   R. $CaCl_2$ + HEPES buffer (calcium phosphate)
   S. Magnesium chloride
   (1) Only P (2) P and Q
   (3) P and R (4) P and S

(IIT JAM BT 2007)

6. The enzyme that is used to make the first strand cDNA from mRNA is
   (1) Reverse transcriptase
   (2) Restriction endonuclease
   (3) DNA polymerase
   (4) T4 DNA ligase

(IIT JAM BT 2007)

7. Which one of the following elements NEED NOT be present in an expression vector?
   (1) Selection marker to select for host cells containing the vector
   (2) Two different origins of replication
   (3) Promoter sequence upstream of the cloned gene
   (4) Unique restriction enzyme sites for insertional cloning

(IIT JAM BT 2008)

8. Which of the following statements are FALSE about Palindromes?
   P. DNA which reads the same sequence from both directions but in antiparallel orientation
   Q. DNA which reads the same sequence from both directions but in parallel orientation
   R. It is recognized by a specific restriction endonuclease and causes specific cleavage
   S. It is recognized by exonucleases and causes non-specific cleavage.
   (1) P and R (2) P and S
   (3) Q and R (4) Q and S

(IIT JAM BT 2008)

9. Which of the following techniques are used for transfer of a gene into the cells?
   P. Electroporation Q. Electroelution
   R. Particle bombardment S. Microinjection
   (1) Q, R, S (2) P, Q, R
   (3) P, R, S (4) P, Q, S

(IIT JAM BT 2009)

10. Which of the following elements must be present in a plasmid cloning vector?
    P. Origin of replication
    Q. Selectable marker
    R. Unique restriction sites
    S. Promoter element upstream of the unique restriction site

(1) S and P (2) Q and R
(3) R and S (4) P and Q

(IIT JAM BT 2009)

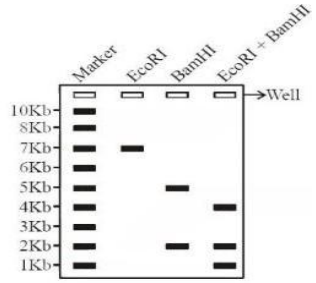
11. Which of the following pairs of protocols is used before ligating two DNA molecules incompatible 5' overhangs?
P. Filling in with a Klenow fragment
Q. S1 nuclease digestion
R. Dephosphorylation of 5' phosphate
S. Phosphorylation of 3' hydroxyl group
(1) P and Q (2) Q and R
(3) R and S (4) S and P

(IIT JAM BT 2010)

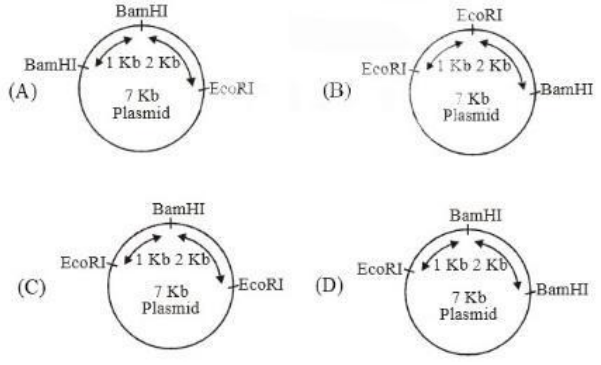
12. Which of the following are used as reporter genes?
P. β -glucuronidase gene
Q. ampicillin-resistance gene
R. Gal4 gene
S. luciferasegene
(1) P and S (2) P and Q
(3) R and S (4) Q and R

(IIT JAM BT 2011)

13. A 7kb circular plasmid was completely digested with either EcoRI or BamHI or both. The digestion pattern is shown below.



Which one of the following is the *correct* restriction map of the plasmid?



(IIT JAM BT 2012)

14. Which of the following statements regarding techniques and their applications is NOT correct?
(1) Recombinant DNA Technology: cloning genes and expression for proteins
(2) Enzyme Linked Immuno Sorbent Assay: recognize antigen and antibody interactions
(3) Polymerase Chain Reaction: amplify specific DNA sequences
(4) Western Blot: detect DNA is given samples

(IIT JAM BT 2012)

15. Which one of the following processes allows introduction of gene of interest to a target site in genome?
(1) Somatic embryogenesis (2) Organogenesis
(3) Gene cloning (4) Southern blotting

(IIT JAM BT 2013)

16. The following experiment was performed with a double stranded DNA sample S of size 1 kb:
Step 1: The two strands were separated
Step 2: The separated strands were annealed
Step 3: Treated the double stranded DNA from Step 2 with 3'→5' exonuclease
From agarose gel electrophoresis, it was found that the DNA from Step 3 is less than 1 kb. The most probable reason for not getting a 1kb DNA in Step 3 is that the DNA in sample S
(1) Is palindromic
(2) Has sequence repeats
(3) Has sequence inversion
(4) Has strands, each of which has self-complementary sequence

(IIT JAM BT 2013)

17. A human gene was PCR amplified from a cDNA library, cloned into an expression vector and transformed into *E. coil*. However, the expression of this gene was poor. This is probably because of
(1) The presence of introns
(2) The modifications of the mRNA that are unique to eukaryotes
(3) The incompatibility of the mRNA with *E. coli* ribosome
(4) A shortage of tRNA for certain codons used in the human gene

(IIT JAM BT 2013)

18. A student wanted to clone a gene G (size ~ 1.6kb) in a vector V (size ~5kb).
The vector has sites for restriction enzymes RE1, RE2 and RE3 in its multiple cloning site. The site for RE2 is located in between the sites for RE1 and RE3. The student carried out the following steps for cloning:
Step 1: Cut the gene G with restriction enzymes RE1 and RE3.
Step 2: Cut the vector V with restriction enzymes RE1 and RE3.
Step 3: Ligated G and V from Steps 1 and 2, transformed into *E. coli* and isolated plasmid L from the transformants. The plasmid L was cut with RE2, which gave a band of size ~6.6kb. The following three reasons were given to explain this observation:
P: Plasmid L is same as the vector V, since *E. coli* got transformed only with uncut V.

Q: Gene G has a site for RE2.
R: RE1 and RE2 are isoschizomers
Which of the above three reasons are possible?
(1) P alone, neither Q nor R
(2) R alone, neither P nor Q
(3) Either Q or R, but not P
(4) Q alone, neither P nor R

(IIT JAM BT 2014)

19. Bt toxin, produced by Bacillus thuringiensis, does NOT kill the bacteria itself because the toxin is
(1) Isolated in a special intracellular sac
(2) In an inactive form inside the bacteria cell
(3) Active only against eukaryotic ribosomes
(4) Produced in very small quantities

(IIT JAM BT 2015)

20. Choose the option that lists the correct sequence of steps involved in gene therapy
P. Injection of expression vector into patient
Q. Wild-type gene is inserted into expression vector
R. Wild-type gene is isolated and cloned
S. Wild-type gene is transcribed and translated in the patient
(1) Q, S, P, R (2) Q, P, R, S
(3) R, P, Q, S (4) R, Q, P, S

(IIT JAM BT 2017)

21. A linear DNA contains five restriction sites for EcoRI and three restriction sites for BamHI. The number of fragments that will be generated after digestion with EcoRI is _____.

(IIT JAM BT 2022)

22. Transfer of plasmids into animal cells can be achieved by
(1) Electroporation
(2) Liposome-mediated process
(3) Calcium chloride treatment
(4) Sucrose treatment

(IIT JAM 2023)

23. Match the recombinant DNA products in Group I with its application in Group II

Group I	Group II
P) Tissue plasminogen activator	1) Emergency treatment of heart attack
Q) Erythropoietin	2) Treatment of anemia
R) Superoxide dismutase	3) Prevents tissue damage
S) Interferon	4) Stimulates cells to inhibit viral replication

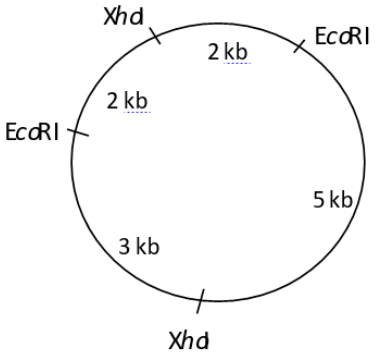
(1) P-1, Q-2, R-3, S-4 (2) P-4, Q-3, R-1, S-2
(3) P-3, Q-1, R-4, S-2 (4) P-1, Q-3, R-4, S-2

(IIT JAM BT - 2024)

24. Which color of light excites a natural GFP to emit green fluorescence?
(1) Blue (2) Green
(3) Infrared (4) Red

(IIT JAM BT - 2024)

25. The restriction map of a circular plasmid is shown below, along with the indicated distances between the restriction sites.



The plasmid was completely digested with EcoRI, and XhoI. The products were analysed by agarose gel electrophoresis followed by ethidium bromide staining. The number of bands that will be visible in the gel when exposed to UV light is _____.

(IIT JAM BT 2025)

26. Bacterial cloning vectors and bacterial expression vectors are differentiated by the presence of
(1) antibiotic resistance gene cassette
(2) origin of replication
(3) promoter and ribosome-binding site
(4) unique restriction sites

(IIT JAM BT 2025)

27. Which one of the following statements is CORRECT about Agrobacterium tumefaciens-mediated plant transformation?
(1) The marker gene for the selection of plant transformant is located outside the T-DNA segment of the transformation plasmid
(2) The marker gene for the selection of bacterial transformant is located within the T-DNA segment of the transformation plasmid
(3) Two T-DNA border sequences (left and right) are essential to design a binary vector system
(4) In binary vector system, the vir genes and two T-DNA border sequences (left and right) are present in the same transformation plasmid

(IIT JAM BT 2025)

28. The vector, shown in the figure, has promoter and RBS sequences in the 300 bp region between the restriction sites for enzymes X and Y. There are no other sites for X and Y in the vector. The promoter is directed towards the Y site. The insert containing only an ORF provides 3 fragments after digestion with both enzymes X and Y. The ORF is cloned in the correct orientation in the vector using the single restriction enzyme Y. The size of the largest fragment of the recombinant plasmid expressing the ORF upon digestion with enzyme X is _____ bp. (answer in integer)

Answer Key									
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
3	2	1	4	3	1	2	4	3	4
11	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**
3	1	4	4	3	4	3	4	2	4
21	**22**	**23**	**24**	**25**	**26**	**27**	**28**		
6-6	1, 2, 3	1	1	3	3	3	3400		

EXPLANATIONS

1. Explanation: Correct answer is 3:
Baculovirus vectors are primarily used to transfer genes into insect cells. Baculoviruses are a family of viruses that naturally infect insects, particularly insects from the order Lepidoptera (such as moths and butterflies). These viruses have been extensively studied and engineered for use as gene delivery vectors in insect cell cultures.

2. Explanation: Correct answer is 2:
The DNA restriction site recognized by the enzyme Hind III is AAGCTT. It is a palindromic sequence that reads the same from both directions.
Among the given sequences, Q and R sequence contains the Hind III recognition site (AAGCTT) and will be cut by Hind III.

3. Explanation: Correct answer is 1:
When the plasmid DNA is digested with either Bam HI or Eco RI, it results in two DNA fragments. This indicates that the plasmid is double stranded, as both enzymes would cut the DNA at specific recognition sites, resulting in two fragments.
When the plasmid DNA is double digested with both Bam HI and Eco RI, it results in three DNA fragments. This suggests that the plasmid is linear, as the double digestion by both enzymes would create three fragments with two cuts.
Therefore, the isolated plasmid DNA is double stranded and linear.

4. Explanation: Correct answer is 4:
P. Transformation: Transformation involves the uptake of exogenous DNA by bacterial cells. It is commonly used in bacterial genetic engineering.
R. Transfection: Transfection refers to the introduction of exogenous DNA into eukaryotic cells. It is commonly used in mammalian cell culture and genetic engineering.
S. Electroporation: Electroporation is a technique that uses electrical pulses to create temporary pores in the cell membrane, allowing for the uptake of DNA by both bacterial and eukaryotic cells.
Q. Sonication is not typically used for transferring DNA into host cells. Sonication is a method used to disrupt cells or break down cellular components, but it is not a direct method for DNA transfer

5. Explanation: Correct answer is 3:
P. Liposomes: Liposomes are lipid-based vesicles that can encapsulate DNA and facilitate its delivery into mammalian cells. They fuse with the cell membrane, allowing the DNA to enter the cell.
R. CaCl2 + HEPES buffer (calcium phosphate): This method, known as calcium phosphate transfection, involves mixing DNA with calcium chloride and HEPES buffer to form a precipitate. The precipitate is then added to the cells, where the DNA is taken up by endocytosis.
Q. Cholesterol and S. Magnesium chloride are not commonly used for transfecting DNA into mammalian cells.

6. Explanation: Correct option is 1:
Reverse transcriptase is an enzyme used to make the first strand cDNA (complementary DNA) from mRNA. It catalyzes the synthesis of DNA using an RNA template. This process is called reverse transcription because it involves the synthesis of DNA from an RNA template, which is the opposite direction of the normal transcription process. Reverse transcriptase is commonly used in molecular biology techniques such as reverse transcription polymerase chain reaction (RT-PCR) and cDNA library construction.

7. Explanation: Correct answer is 2:
An expression vector is a type of plasmid or other DNA molecule that is designed for the expression of a gene of interest in a host cell. It typically contains certain essential elements, but the presence of two different origins of replication is not necessary for an expression vector.
The elements that are commonly required in an expression vector include:
(1) Selection marker to select for host cells containing the vector: This allows for the identification and selection of cells that have successfully taken up and retained the vector.
(3) Promoter sequence upstream of the cloned gene: This is necessary to drive the transcription of the gene of interest and initiate gene expression.
(4) Unique restriction enzyme sites for insertional cloning: These sites allow for the insertion of the gene of interest into the vector at specific locations, facilitating the construction of recombinant DNA.

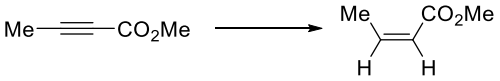
CHAPTER-20 ORGANIC REAGENTS

IIT JAM BT

PREVIOUS YEAR EXAM QUESTIONS

(IIT JAM BT 2005)

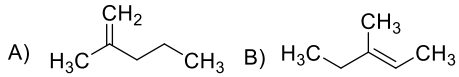
1. The following reduction is best achieved by



(1) H_2/Pd-C (2) H_2/Lindlar catalyst
(3) $LiAlH_4$ (4) Na/liq. NH_3

(IIT JAM BT 2010)

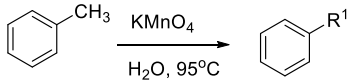
2. Which one of the following compounds gives acetone as one of the products when treated sequentially with (i) O_3 and (ii) Me_2S? ____

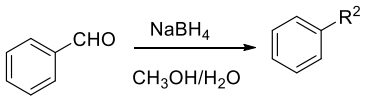


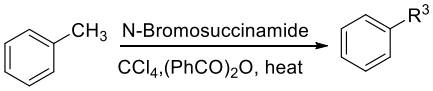


(IIT JAM BT 2010)

3. In the following transformations, the groups R^1, R^2 and R^3 are



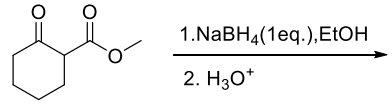


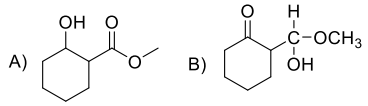


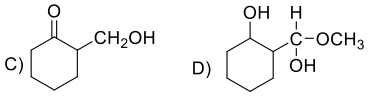
(1) $R^1 = CH_2OH$, $R^2 = CH_2Br$ and $R^3 = COOH$
(2) $R^1 = COOH$, $R^2 = CH_2Br$ and $R^3 = CH_2OH$
(3) $R^1 = COOH$, $R^2 = CH_2OH$ and $R^3 = CH_2Br$
(4) $R^1 = CH_2Br$, $R^2 = COOH$ and $R^3 = CH_2OH$

(IIT JAM BT 2014)

4. The major product, Z, obtained in the reaction ___

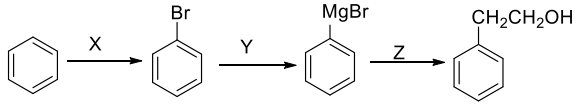






(IIT JAM BT 2014)

5. In the reaction sequence below, X, Y and Z, respectively, are ____

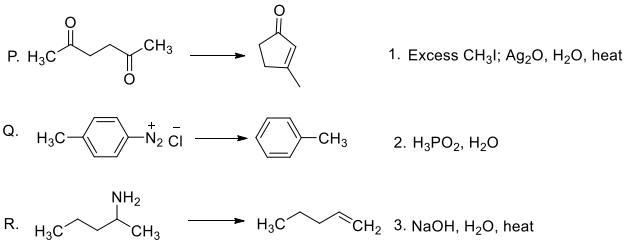


(A) Br_2, $FeBr_3$; $MgCl_2$; CH_2O, H^+ (B) HBr; $HgCl_2$; CH_3CHO, H^+
(C) Br_2, hv, $MgCl_2$; CH_2O, H^+ (D) Br_2, $FeBr_3$; Mg, THF, 

(IIT JAM BT 2011)

6. Correlate the reactions in Group I with the reagent (s) and condition (s) in Group II:

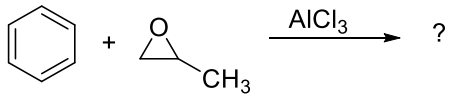
Group-I Group-II

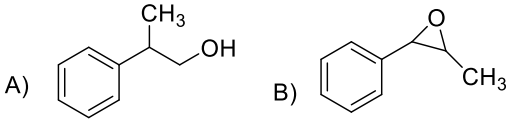


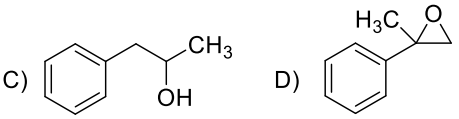
(1) P–4, Q–3, R–2 (2) P–3, Q–1, R–4
(3) P–4, Q–3, R–1 (4) P–3, Q–2, R–1

(IIT JAM BT 2011)

7. Identify the major product of the following reaction_____

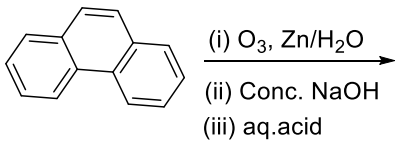


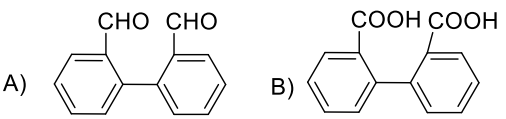


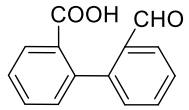


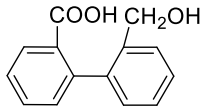
(IIT JAM BT 2012)

8. The major product of the following reaction sequence, is _____





C) 

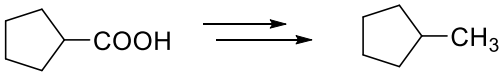
D) 

(IIT JAM BT 2012)

9. 2-Butyne can be selectively reduced to *cis*-2-butene using
   (1) H_2, Pd/C
   (2) H_2, Pd/$CaCO_3$, quinoline
   (3) $LiAlH_4$
   (4) Na/liq. NH_3

(IIT JAM BT 2013)

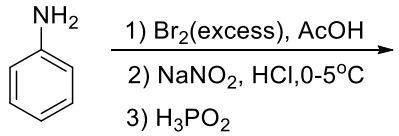
10. The condition under which the following transformation is carried out is____

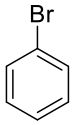


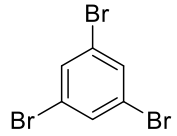
   (1) (i) $LiAlH_4$ (ii)H_3O^+ (iii)$SOCl_2$ (iv) Mg in ether (v) H_2O
   (2) (i) $SOCl_2$ (ii) $LiAlH_4$ (iii) H_3O^+ (iv)$NaNH_2$, KOH
   (3) (i) $NaNH_2$, KOH (ii) $SOCl_2$ (iii) Mg in ether (iv) H_2O
   (4) (i) CH_3Li (ii) H_3O^+

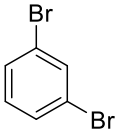
(IIT JAM BT 2013)

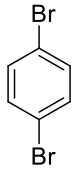
11. Identify the major product formed in the following transformation: _____



A) 

B) 

C) 

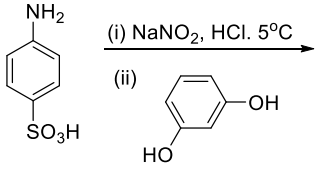
D) 

(IIT JAM BT 2015)

12. The compound meso 2, 3-dibromobutane is obtained by
   (1) electrophilic addition of HBr to (*E*)-1-bromobut-2-ene
   (2) electrophilic addition of Br_2 to (*E*)-2-butene
   (3) electrophilic addition of Br_2 to (*Z*)-2-butene
   (4) nucleophilic addition of Br_2 to (*Z*)-1-bromobut-2-ene

(IIT JAM BT 2016)

13. Which one is the major product of the following reaction? _____

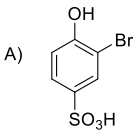


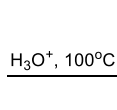
(IIT JAM BT 2017)

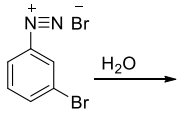
14. Fehling's solution
   (1) contains a copper complex of tartaric acid
   (2) forms a brick-red precipitate with glucose
   (3) forms a white precipitate with aldehydes
   (4) is used as a test reagent for reducing sugars

IIT JAM BT 2017)

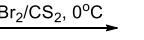
15. The reaction that produces *o*-bromophenol as the major product is _____

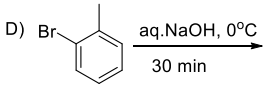
A) 



B) 

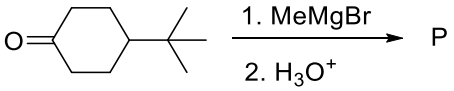
C) 



D) 

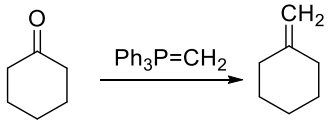
(IIT JAM BT 2018)

16. The number of axial C-H bond(s) in the major product (P) of the given reaction is_____.



(IIT JAM BT 2018)

17. The mechanism of the following reaction involves the formation of a _____ membered ring

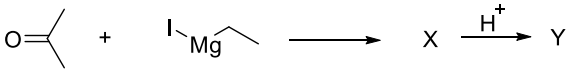


(IIT JAM BT 2018)

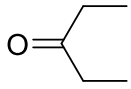
18. Which of the following pairs of compounds can be distinguished by iodoform test performed in ammonium hydroxide?
   (1) CH_3COCH_3 and C_2H_5OH
   (2) C_2H_5OH and CH_3OH
   (3) CH_3COCH_3 and $C_6H_5COCH_3$
   (4) $C_6H_5COCH_3$ and C_2H_5OH

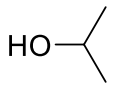
(IIT JAM BT 2020)

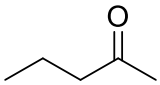
19. In the following reaction, X is an intermediate and Y is one of the end products.

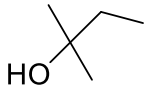


Which one of the following compounds is the end product Y? _____

A) 

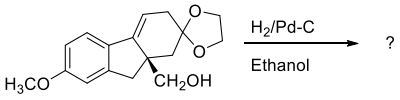
B) 

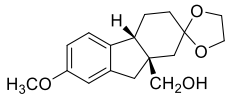
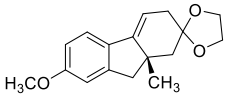
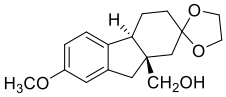
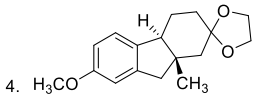
C) 

D) 

(IIT JAM BT 2021)

20. Which one of the following is the major product of the hydrogenation reaction given below? _____

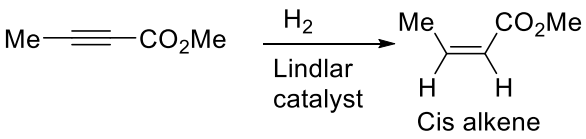


1. 
3. 
2. 
4. 

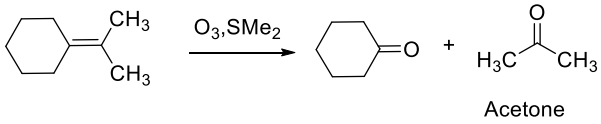
Answer Key									
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
2	4	3	1	4	1	1	3	2	1
11	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**
2	2	3	1,2,4	1	5	4	1	4	1

EXPLANATIONS

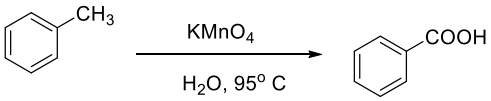
1. **Explanation:**

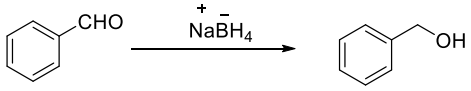


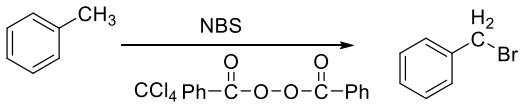
2. **Explanation:**



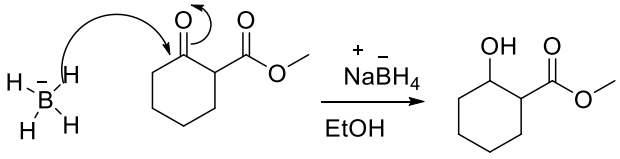
3. **Explanation:**



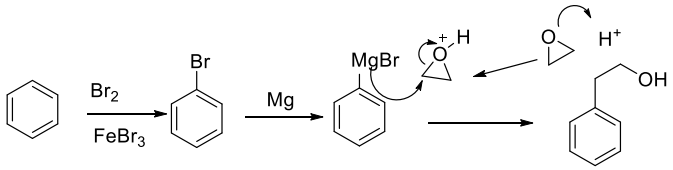




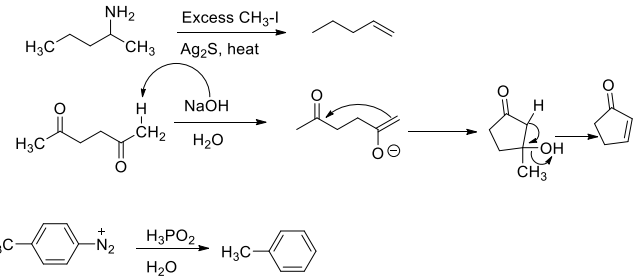
4. **Explanation:**



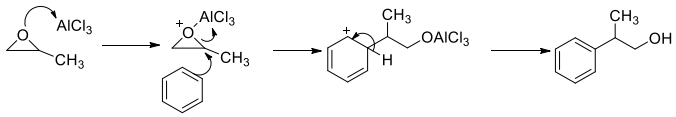
5. **Explanation:**



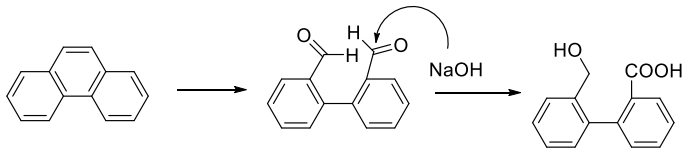
6. **Explanation:**



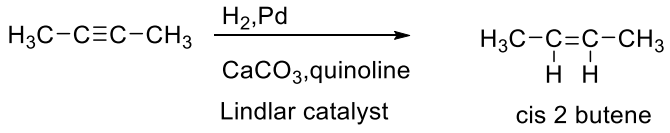
7. **Explanation:**



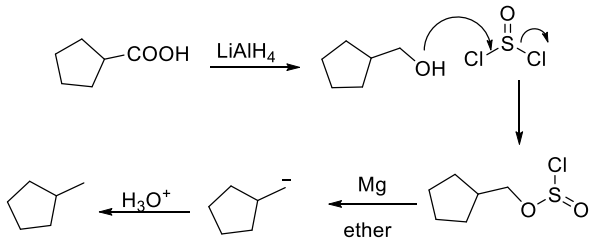
8. **Explanation:**



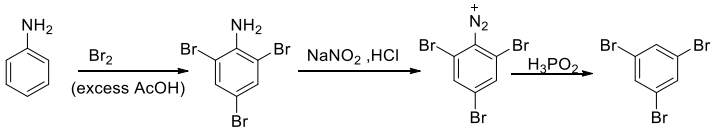
9. **Explanation:**



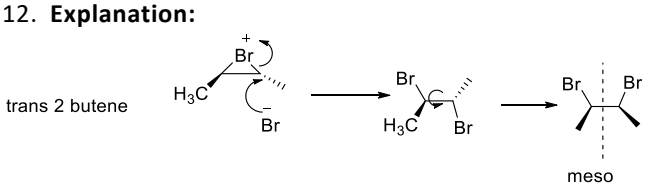
10. **Explanation:**



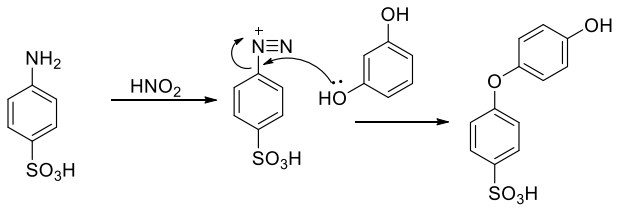
11. **Explanation:**



12. **Explanation:**

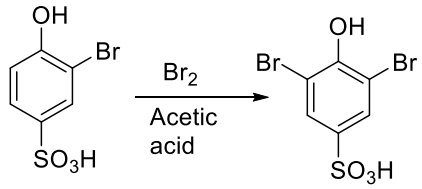


13. **Explanation:**

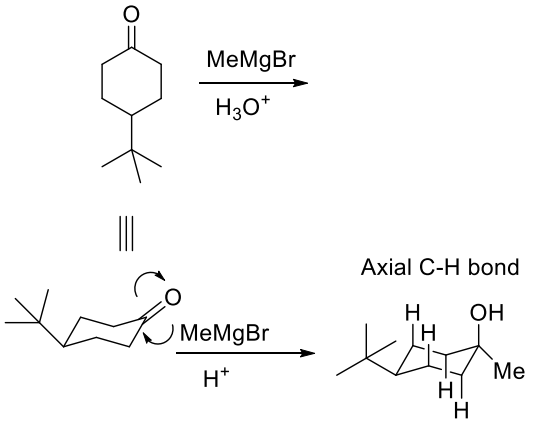


14. **Explanation:** Fehling's solution is a chemical solution is a deep blue alkaline solution which is used to identify the presence of aldehydes or groups that contain any aldehyde functional group $-CHO$ & in addition will reagent to differentiate between reducing & non reducing sugars.

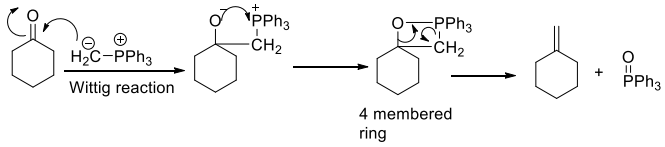
15. **Explanation:**



16. **Explanation:**



17. **Explanation:**

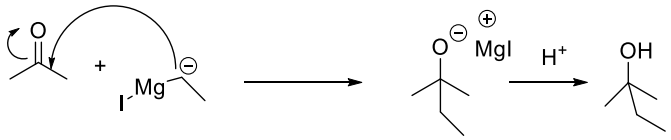


18. **Explanation:** Iodoform test: It is used to check the presence of carbonyl compounds with the structure $R-C-CH_3$ or alcohols with the structure.

$$R-\overset{O}{\overset{\|}{C}}-CH_3$$

So, $CH_3-\overset{O}{\overset{\|}{C}}-CH_3$ & CH_3-CH_3-OH can be distinguished by iodoform test performed in Ammonium Hydroxide.

19. **Explanation:**



20. **Explanation:**

