GATE 2021 BT Solutions

General Aptitude (GA)

Q.1 Q.5 Multiple Choice Question (MCQ), carry ONE mark each (for each wrong answer: 1/3).

Q.1 The ratio of boys to girls in a class is 7 to 3. Among the options below, an acceptable value for the total number of students in the class is:

(A) 21

(B) 37

(C) 50

(D) 73

Solution. (C) 50, The ratio of boys to girls in a class is 7 to 3. So, the total number of students must be a multiple of 7+3 = 10. Among the given options, only 50 is a multiple of 10. Therefore, the acceptable value for the total number of students in the class is 50. So, the answer is (C).

Q.3 Consider the following sentences:

(i) Everybody in the class is prepared for the exam.

(ii) Babu invited Danish to his home because he enjoys playing chess.

Which of the following is the CORRECT observation about the above two sentences?

(A) (i) is grammatically correct and (ii) is unambiguous

(B) (i) is grammatically incorrect and (ii) is unambiguous

(C) (i) is grammatically correct and (ii) is ambiguous

(D) (i) is grammatically incorrect and (ii) is ambiguous

Solution. (C) (i) is grammatically correct and (ii) is ambiguous
Explanation Sentence (i): "Everybody in the class is prepared for the exam" is grammatically correct. The subject "Everybody" takes a singular verb, "is". Sentence (ii): "Babu invited Danish to his home because he enjoys playing chess" is ambiguous. It remains ambiguous which "he" refers toBabu or Danish. This ambiguity makes the sentence ambiguous.

Q.5 Graduate Aptitude Test in Engineering 2021 Organising Institute IIT Bombay Biotechnology (BT) is to surgery as writer is to Which one of the following options maintains a similar logical relation in the above sentence?

(A) Plan, outline

(B) Hospital, library

(C) Doctor, book

(D) Medicine, grammar

Solution. (B) Hospital, Explanation: The analogy compares fields or professions to the places or contexts they are most associated with."Biotechnology (BT) is to surgery" compares a field of study to its practical application.Similarly, "writer is to library" compares a profession to a place associated with writing.It follows the same logical relationship, both examples matching a profession or field to a space that holds an association with it.

Q.8 There are five bags each containing identical sets of ten distinct chocolates. One chocolate is picked from each bag. The probability that at least two chocolates are identical is

(A) 0.3024

(B) 0.4235

(C) 0.6976

(D) 0.8125

Solution. (C) 0.6976 , Total Number of Ways to Choose Chocolates

Since we're choosing one chocolate from each sack, the total ways of choosing chocolates is: 10 10 10 10 10 = 10^5

Probability No Chocolates are the Same

So, the probability that no chocolates are the same is:

(10 90 80 70 60) / (10^5) ≈ 0.3024

Probability More Than Two Chocolates are the Same

Conclusion

Thus, the probability that at least two chocolates are identical is approximately 0.6976. Hence, the correct answer is (C).

Q.9 Given below are two statements 1 and 2, and two conclusions I and II. Statement 1: All bacteria are microorganisms. Statement 2: All pathogens are microorganisms. Conclusion I: Some pathogens are bacteria. Conclusion II: All pathogens are not bacteria. Based on the above statements and conclusions, which one of the following options is logically CORRECT?

(A) Only conclusion I is correct

(B) Only conclusion II is correct

(C) Either conclusion I or II is correct.

(D) Neither conclusion I nor II is correct.

Solution. (B) Only conclusion II is correct , Explanation : Statement 1: It means that bacteria are microorganisms because all bacteria fall under the category of microorganisms.

Statement 2: Explaining the implication, ‘All pathogens are microorganisms’ it will simply tell us that pathogens are part of the microorganisms.

Now, let's analyze the conclusions:Conclusion I: One has to note that the statements do not directly link the paths with bacteria and therefore ‘some pathogens are bacteria’ is not true.

Conclusion II: “All pathogens aren’t bacteria” is another statement which makes perfect sense logically, because it is true that all pathogens are not bacteria. Hence, pathogens may be a virus, fungi or something else.

Finally, following the analysis as laid out in this paper Conclusion II is proven to be true.

Q.10 3 Some people suggest antiobesity measures (AOM) such as displaying calorie information in restaurant menus. Such measures sidestep addressing the core problems that cause obesity: poverty and income inequality. Which one of the following statements summarizes the passage?

(A) The proposed AOM addresses the core problems that cause obesity.

(B) If obesity reduces, poverty will naturally reduce, since obesity causes poverty.

(C) AOM are addressing the core problems and are likely to succeed.

(D) AOM are addressing the problem superficially.

Solution.(D) AOM are addressing the problem superficially.

Explanation: The same passage points out that antiobesity measures (AOM), including nonsensical tactics like posting calorie information, fail to address the actual obesity determinants: poverty and income inequality. These measures are but only symptomatic, hence do not address the root of the problem. Thus, it is correct to state that AOM are solving the problem on the surface.

Biotechnology (BT)

Q.1 Q.17 Multiple Choice Question (MCQ), carry ONE mark each (for each wrong answer: 1/3).

Q.1 Coronavirus genome consists of

(A) doublestranded DNA

(B) doublestranded RNA

(C) negativesense singlestranded RNA

(D) positivesense singlestranded RNA

Solution. (D) positivesense singlestranded RNA Explanation: SARSCoV2 and other coronaviruses are armed with light positive strand single stranded RNA genome. This means that once inside a host cell their RNA acts as mRNA for synthesizing proteins, which makes it easy for a virus to replicate. The other choices such as the doublestranded DNA, or RNA, do not describe the genome in coronaviruses.

Q.2 The enzyme that transcribes the eukaryotic genes encoding precursor ribosomal RNAs (prerRNAs) of 28S, 18S and 5.8S rRNAs is
(A) RNA polymerase I

(B) RNA polymerase II

(C) RNA polymerase III

(D) RNA polymerase IV

Solution. (A) RNA polymerase I.

Explanation: In eukaryotic cells synthesis of the precursor ribosomal RNAs (prerRNAs), such as 28S, 18S and 5.8S rRNA is by RNA polymerase I. These rRNAs are involved in structure and function of the ribosome that is involved in protein synthesis. RNA polymerase II synthesizes mRNA, RNA polymerase III synthesizes tRNA and 5S rRNA thus RNA polymerase I is solely responsible for the synthesis of rRNA.

Q.3 Number of unrooted trees in a phylogeny of five sequences is

(A) 3

(B) 15

(C) 105

(D) 945

Solution.(C) 105 , Calculate of Number of Unrooted Trees

The formula to calculate the number of unrooted trees for a given number of sequences is:

(2n 3)! / (2^(n2) (n2)!)

where n is the number of sequences.

Here, n = 5

Substituting in the above formula:

(25 3)! / (2^(52) (52)!)

= 7! / (2^3 3!)

= 5040 / (8 6)

= 105

Q.4 Which one of the following methods is used to test the significance of a predicted phylogeny?

(A) Bootstrap

(B) Maximum likelihood

(C) Maximum parsimony

(D) Minimum evolution

Solution. (A) Bootstrap. Explanation: The bootstrap method is widely utilised as a means for investigating the reliability and significance of a given phylogeny prediction. It comprises repetition of the data and then making new samples and then formulating phylogenies from these samples. The number of trees in which a specific branch occurs determines the level of support in this case, statistical. Concerning that, the bootstrap method cannot be used for building trees, although maximum likelihood and maximum parsimony methods can, while the bootstrap is applied to the trees' phylogeny impeachment.

Q.5 The Cartesian coordinates (x, y) of a point A with polar coordinates (4,7/4) is

(A) (√3,2√2)

(B) (2,2√3)

(C) (2√2,√3)

(D) (2√2,2√2)

Solution. (D) (2√2,2√2), Given the polar coordinates (4, 7/4), we have:

$r = 4, \theta = 7/4$

Substituting these values into the formulas:

$x = 4 \cos(7/4) \approx 2\sqrt{2}$

$y = 4 \sin(7/4) \approx 2\sqrt{2}$

Therefore, the Cartesian coordinates of the point A are $(2\sqrt{2}, 2\sqrt{2})$.

So, the correct answer is (D).

Q.7 Which one of the following statements is INCORRECT about hybridoma production?

(A) Hybridoma cells can use hypoxanthine and thymidine

(B) DNA synthesis in myeloma cells is blocked by aminopterin

(C) Hybridoma cells are made to produce polyclonal antibodies

(D) Polyethylene glycol is used to fuse myeloma cells to Bcells

Solution. (C) Hybridoma cells are made to produce polyclonal antibodies.

Explanation: Hybridoma cells are specifically designed to produce monoclonal antibodies, not polyclonal antibodies. Monoclonal antibodies are derived from a single Bcell clone and target one specific epitope.

Q.9 Which one of the following techniques/tools is NOT used for inserting a foreign gene into a cell?

(A) DNA microarray

(B) Electroporation

(C) Gene gun

(D) Microinjection

Solution.(A) DNA microarray. Explanation:DNA microarray is a technique that is employed for gene expression profiling and in identification of specific DNA sequences but it is not applied to introduce foreign genes into cells.

Q.11 CRISPRCas system is associated with

(A) adaptive immunity in eukaryotes

(B) adaptive immunity in prokaryotes

(C) innate immunity in eukaryotes

(D) innate immunity in prokaryotes

Solution. (B) adaptive immunity in prokaryotes, Explanation:The CRISPRCas system is a defense mechanism found in prokaryotes (bacteria and archaea) that provides adaptive immunity. It works by capturing snippets of viral DNA and incorporating them into the bacteria's genome. If the virus attacks again, the system recognizes and cuts the viral DNA, preventing infection. This process is adaptive because it "remembers" past invaders, similar to adaptive immunity in higher organisms.

Q.12 The process by which intracellular macromolecules are supplied for lysosomal degradation during nutrient starvation is

(A) apoptosis

(B) autophagy

(C) phagocytosis

(D) pinocytosis

Solution.(B) autophagy. Explanation: Selfconsumption is the process in which damaged cell components and intracellular macromolecules that are under nutrient stress are taken to lysosomes for degradation. To balance energy the cell is capable of degrading some of its components in order to recycle nutrients. When the conditions which can cause nutrient starvation exist it helps in protecting the survival of the cell.

Q.15 The enzyme which adds phosphate group to the free 5' terminus of a DNA sequence is

(A) adenosine kinase

(B) alkaline phosphatase

(C) polynucleotide kinase

(D) terminal deoxynucleotidyl transferase

Solution. (C) polynucleotide kinase, Explanation: Polynucleotide kinase (PNK) is the enzyme that can add a phosphate moiety to the 5’ end of a DNA or RNA molecule. This is an essential reaction in DNA repair as well as molecular biology assays including ligation, where the 5’ end has to be phosphorylated for correct annealing with other DNA molecules.Adenosine kinase is associated with phosphorylation of adenosine.Alkaline phosphatase will strip off phosphate groups of DNA or RNA.Terminal deoxynucleotidyl transferase will only add nucleotides at the 3’ end not at 5’ end. Therefore, by limitation that is left with the polynucleotide kinase is adding a phosphate group at 5’ end.

Q.16 Which one of the following is CORRECT about microbial growth medium?

(A) LuriaBertani broth is a synthetic medium

(B) Nutrient broth is a defined medium

(C) Sabouraud dextrose agar is a differential medium

(D) Trypticase soy agar is a complex medium

Solution. (D) Trypticase soy agar is a complex medium

Explanation:The following are brief explanations for the above answers Trypticase soy agar (TSA) is a complex medium, meaning it contains a mixture of nutrients, such as digested proteins (trypticase), which provide a rich environment for a wide variety of microbial growth. It is TSA is thus correctly placed under the heading of a complex medium.

Q.17 The cellular process which utilizes RNAinduced silencing complex to block gene expression is

(A) RNA editing

(B) RNA interference

(C) RNA polyadenylation

(D) RNA splicing

Solution. (**B) RNA interference.**

Explanation: RNA interference (RNAi): It is a cellular mechanism that involves the RNAinduced silencing complex (RISC) to suppress gene expression. In this process, small RNA molecules, which can be siRNA or miRNA, guide the RISC complex to complementary mRNA sequences so that they are either degraded or their translation cannot take place, effectively silencing the gene.It is a form of RNA editing: This entails alteration of the RNA sequence after transcription.It is associated with RNA polyadenylation: Involves adding a polyA tail to the mRNA end.The process of RNA splicing removes the introns from premRNA.RNA interference is a process that involves RISC in inducing silence of gene expression.

Q.18Q.19 Multiple Select Question (MSQ), carry ONE mark each (no negative marks).

Q.18 Which of the following layer(s) is/are formed from the inner cell mass of the blastocyst?

(A) Ectoderm

(B) Endoderm

(C) Mesoderm

(D) Trophectoderm

Solution. (A) Ectoderm, (B) Endoderm, and (C) Mesoderm.

Explanation:The inner cell mass (ICM) of the blastocyst develops into the three primary germ layers during embryogenesis:Ectoderm: This layer progress into development of skin, nervous system and other body formations.Endoderm: This is the layer that makes internal organs such as digestive and respiratory system.Mesoderm: This layer progresses into muscles,bones, circulatory system among others.

Q.19 Which of the following cell organelle(s) is/are surrounded by a single phospholipid membrane?

(A) Golgi apparatus

(B) Lysosome

(C) Mitochondria

(D) Nucleus

Solution. (B) Lysosome.

Explanation: From all the given options, only the lysosome is contained within a single phospholipid membrane.

Golgi apparatus: Made of stacked membranebound sacs, but actually it is a doublemembrane structure, but it is considered one organelle.Mitochondria: Double membraned, meaning that it has inner and outer membranes.Nucleus: Is a doublemembraned, as it is covered by the nuclear envelope.Hence, from all the above options, the organelle enclosed in a single phospholipid membrane is the lysosome.

Q.27 Match enzymes in Group I with their corresponding industrial application in Group II.

Group I	Group II
P. Amylase	1. Laundry detergent
Q. Invertase	2. Fruit juice clarification
R. Pectinase	3. Liquefaction of sucrose
S. Xylanase	4. Pulp and paper processing

(A) P2, Q3, R4, S1

(B) P1, Q3, R2, S4

(C) P1, Q2, R3, S4

(D) P1, Q4, R2, S3

Solution. (B) P1, Q3, R2, and S4.

Explanation:P. Amylase: A starchbreaking enzyme included in laundry detergent that aids in stain removal.Q. Invertase: Used to liquefy sucrose (3) by turning it into glucose and fructose.R. Pectinase: A fruit juice clarity enzyme that breaks down pectin and helps clear liquids.S. Xylanase An enzyme used in processing pulp and paper which break xylan, making wood pulp easier to process.Thus, the right matches are: P1, Q3, R2 and S4.

Q.28 Match separation methods in Group I with associated properties in Group II.

Group I	Group II
P. Centrifugation	1. Density
Q. Dialysis	2. Diffusivity
R. Solvent extraction	3. Size
S. Ultrafiltration	4. Solubility

(A) P4, Q2, R1, S3

(B) P3, Q1, R2, S4

(C) P1, Q3, R2, S4

(D) P1, Q2, R4, S3

Solution. (C) P1, Q3, R2, S4.

Explanation:This is how each separation technique corresponds to its corresponding property:P. Centrifugation: This is separation by density (1). It separates a sample in a centrifuge based on different densities of particles. The denser the particles, the bottom they go; more light, the higher they stay.Q. Dialysis : Separates by size (3). It is the separation of molecules by allowing smaller molecules to permeate through a semipermeable membrane while retaining larger ones. P. Chromatography: Separation is adsorptionbased on stationary phases (1). Q. Dialysis: Separation relies on diffusivity (4); the smaller the particles, the greater the diffusivity, so that those will pass through a membrane while bigger particles are retained. R. Solvent extraction: Separation is based on the solubility (2) of compounds in different solvents. S. Ultrafiltration: Separation is based on diffusivity (4); let us assume number 4.Hence, the right matches are: P1, Q3, R2, S4.

Q.29 Match the autoimmune diseases in Group I with the corresponding primarily affected organ in Group II.

Group I	**Group II**
P. Hashimoto's disease	**1. Brain**
Q. Juvenile diabetes	**2. Pancreas**
R. Multiple sclerosis	**3. Skeletal muscle**
S. Myasthenia gravis	**4. Thyroid**

(A) P1, Q2, R3, S4

(B) P3, Q1, R2, S4

(C) P4, Q2, R1, S3

(D) P1, Q2, R4, S3

Solution. (C) P4, Q2, R1, S3.

Explanation:Here’s how each autoimmune disease matches with its primarily affected organ:

P. Hashimoto's disease: Primarily affects the thyroid (4), leading to hypothyroidism.Q. Juvenile diabetes (also known as Type 1 diabetes): Primarily affects the pancreas (2), where the immune system attacks insulinproducing beta cells.R. Multiple sclerosis: Primarily affects the brain (1), specifically targeting the central nervous system and causing demyelination.S. Myasthenia gravis: Primarily affects skeletal muscle (3) by interfering with the communication between nerves and muscles.

Q.30 Match hypersensitivity types in Group I with their corresponding condition in Group II.

Group I	Group II
P. Type	1. Erythroblastosis fetalis
Q. Type II	2. Host reaction to bee venom
R.Type III	3. Systemic lupus erythematosus

S.Type IV	**4. Tuberculin reaction**

(A) P2, Q3, R1, S4

(B) P3, Q1, R4, S2

(C) P2, Q3, R4, S1

(D) P2, Q1, R3, S4

Solution. (A) P2, Q3, R1, S4. Explanation:Here's how each hypersensitivity type matches with its corresponding condition:P. Type I: Matches with host response to bee sting (2), where an individual is colon that reacts immediately involving allergy.Q. Type II: Correlates with erythroblastosis fetalis (1) which is when antibodies produced by the mother aggregate the fetal red blood cell.R. This one is linked to systemic lupus erythematosus Systemic lupus erythematosus accounts for most of the cases relating to this antibody type (3). It is an autoimmune condition that is occasioned by deposition of immune complexes in tissues with subsequent inflammation.S. This one is related to tuberculin reaction (4), which is a typical form of delayed hypersensitivity that involve Tcells. the correct matches are: P2, Q3, R1, S4.

Q.31 Which of the following combinations of plant hormones and their associated function are CORRECT?

Hormone	**Function**
P. Abscisic	**Breaks seed dormancy**

Q. Auxin	**Induces cell division**
R. Ethylene	**Stimulates ripening of fruits**
S. Gibberellin	**Promotes seed dormancy**

(A) P and R only

(B) P and S only

(C) Q and R only

(D) Q and S only

Solution.(A) P and R only.

Explanation:P. Abscisic acid: This hormone is associated with the farm land that overrides seed dormancy (it actually promotes seed dormancy).

Q. Auxin: It is important to note that this hormone is credited for promoting cell division (erroneously; the hormone only helps to elongate and increase the size of cells).

R. Ethylene: This hormone encourage fruiting and ripening (correct).

S. Gibberellin: This hormone enhance seed dormancy (untrue; rather exists to break dormancy and enhance germination).Therefore, only for two hormones: Abscisic acid the function is wrong; Ethylene the sign is right. Consequently, the answer should be adapted as the judges of parallels have to pay their attention to the correctly matching functions. The most correct combination is R only (though for some reason the options have P with R as true statements it seems a bit tricky).

Q.32 Which one of the following tools is used to compare all the possible sixopen reading frames of a given nucleotide query sequence with all the available sixopen reading frames of the nucleotide sequence database?

(A) BLASTN

(B) BLASTX

(C) TBLASTN

(D) TBLASTX

Solution.(B) BLASTX.

Explanation: BLASTX: This one is a bioinformatics tool used to search for homologous alignments between the six reading frames translation of a given nucleotide query sequence compared to a protein database. For this, it can convert the nucleotide sequence into their equivalent protein sequences taking into account the six frames on two chains and look for this translated sequence into the protein sequences in the database thus giving the possible protein coding regions.

Q.33 In Neurospora crassa, a mutation in the poky gene results in a slow growth phenotype (poky). The results of four crosses are given below.
(1) wildtype wildtype → All progeny are wildtype
(2) wildtype poky→ All progeny are wildtype
(3) poky wildtype → All progeny are poky
(4) poky poky→ All progeny are poky
Which one of the following explains the inheritance mode of poky? (A) Episomal inheritance
(B) Mendelian inheritance
(C) Mitochondrial inheritance
(D) Xlinked inheritance

Solution. (C) Mitochondrial inheritance.
Explanation:Neurospora crassa: The poky phenotype appears to be linked to mitochondrial genes. Results of the crosses are as follows:
First cross (wildtype x wildtype): All the progeny are wildtype. That means wildtype is dominant.
Second cross (wildtype x poky): All the progeny are wildtype. The wildtype is dominant over the poky phenotype.
In the third cross (poky x wildtype), all progeny are poky meaning the traits are maternal, as all the progeny inherit mitochondria from the poky parent.
In the fourth cross of (poky x poky) all the progeny are poky, which further reinforces the premise that the phenotype is maternally inherited.
These findings are typical for mitochondrial inheritance in which the traits are transferred from mother through their mitochondrion's DNA.

Q.34 Tertiary structure of a protein consisting of ahelices and ßstrands can be determined by
(A) circular dichroism spectroscopy
(B) mass spectrometry
(C) nuclear magnetic resonance spectroscopy
(D) UV spectroscopy

Solution.(C) nuclear magnetic resonance spectroscopy
Explanation: Nuclear Magnetic Resonance (NMR) spectroscopy is a very effective way of determining protein tertiary structure, particularly if the protein recalcitrant consists of structures of αhelices and βstrands. NMR give us distances which are actually between atoms in the protein to build our three dimensional structure of the protein in solution.

In employment of CD spectroscopy in analysis, it is used to recognize secondary structures of the protein structure including αhelices and βsheets, although the more detailed tertiary structures are not well defined. In addition to the calculation of mass and composition, mass spectrometry does not have structural characteristics of proteins.

In general, UV spectroscopy is employed for the determination of proteins as well as nucleic acids. They do not refer to any certain aspect of structure construction.

Q.35 Which of the following statement(s) is/are CORRECT about Agrobacterium tumefaciens?
(A) It contains tumor inducing plasmid
(B) It causes crown gall disease in dicotyledonous plants
(C) It is a Grampositive soil bacterium
(D) It is used in generating transgenic plants

Solution.(A) It contains tumor inducing plasmid ,(B) It causes crown gall disease in dicotyledonous plants ,(D) It is used in generating transgenic plants
Explanation
(A) It carries tumorinducing plasmid: Correct. Agrobacterium tumefaciens carries a plasmid called the Ti or tumorinducing plasmid, which mediates the transfer of DNA into plant cells.

(B) It causes crown gall disease in dicotyledonous plants: Correct. This bacterium causes crown gall disease characterized by the formation of tumors on the stems and roots of dicot plants.

(D) It is used in generating transgenic plants: True. In biotechnology, it is used due to its natural ability to transfer DNA for creating transgenic plants.

So the correct statements are (A), (B), and (D).
Q.36 Which of the following antimicrobial agent(s) is/are growth factor analog(s)?
(A) 5Fluorouracil
(B) Isoniazid
(C) Sulfanilamide
(D) Tetracycline

Solution.(C) Sulfanilamide.

Explanation:

.(A) 5Fluorouracil This is an antimetabolite that acts like uracil but doesn't act as a growth factor analog.

.(B) Isoniazid This is an antimicrobial particularly used against Mycobacterium tuberculosis through inhibition of synthesis of cell walls and does not act as a growth factor analog.

(C) Sulfanilamide: This is a classic example of a growth factor analog. It serves as a mimic for paraaminobenzoic acid (PABA), a precursor that bacteria use in the synthesis of folic acid, so utilization is blocked and bacterial growth is completely inhibited.

(D) Tetracycline: This is an antibiotic that inhibits protein synthesis and is not a growth factor analog.

So the only antimicrobial agent that is a growth factor analog is (C) Sulfanilamide.

Q.37 Which of the following chemical messenger(s) is/are derivative(s) of tryptophan?
(A) yamino butyric acid
(B) Indole acetic acid
(C) Melatonin
(D) Serotonin

Solution. The correct answers are (C) Melatonin and (D) Serotonin.

Explanation:

(A) γAmino butyric acid (GABA): This is not a derivative of tryptophan; it is derived from glutamic acid.

(B) Indole acetic acid: This is a plant hormone (auxin) derived from tryptophan, but it is more commonly associated with plant physiology rather than being a typical chemical messenger in animals.

(C) Melatonin: This hormone is synthesized from serotonin, which is a derivative of tryptophan. Therefore, it is considered a derivative of tryptophan.

(D) Serotonin: This neurotransmitter is directly synthesized from tryptophan and is a wellknown derivative.

Thus, the correct chemical messengers that are derivatives of tryptophan are (C) Melatonin and (D) Serotonin.