BB101 Mid-Sem Examination

MCB Module

Prof. Sanjeeva Srivastava

Feb 26, 2024

Total 30 marks

Exam Duration: 2 hours

Student name _____

Roll number_____

Hall room number_____

Tutorial Batch_____

General Instructions

1. Use only black or blue ballpoint pen. Do not use pencil.
2. Calculators or digital devices are not permitted during the exam.
3. Questions in **Section-A** are multiple-choice questions. Attempt any 40 out of the total 45. Each correct answer carries 0.5 marks. MCQs are to be marked in the question paper itself, properly with pen. If there is any overwriting, it will be considered wrong.
4. Questions in **Section-B** are short answer type questions. Attempt any 10 out of the total 12. Each question carries 1 mark. Write the answers for these questions in the answer booklet provided to you. Ensure that the answers are short and to the point to maximize clarity and efficiency.
5. Questions are designed to be self-explanatory. No queries or clarifications will be entertained during the exam.
6. Rough sheets are included. Utilize them for any necessary rough work.
7. Aim to complete the exam within the allocated time frame.

SECTION-A

Multiple Choice Questions

Que. A1. Which of the following pairs of base sequences could form a short stretch of a normal double helix of DNA?

a. 5′-AGCT-3′ with 5′-TCGA-3′
b. 5′-GCGC-3′ with 5′-TATA-3′
c. 5′-ATGC-3′ with 5′-GCAT-3′
d. All of these pairs are correct.

Que. A2. In an experiment, two variations of genetically modified bacteriophages were utilized to infect E. coli bacteria. One type of bacteriophage was labeled with fluorescent tags (GFP) targeting its coat protein, while the other type was labeled with fluorescent tags (DAPI) specific to its DNA. Following the infection, the bacteria underwent vigorous shaking and were subsequently subjected to centrifugation. Identify the correct statements from the following options with regards to where the fluorescent signal will come from after centrifugation. Select all the statements that are CORRECT.

a. DAPI signal from Cell pellet and GFP signal from supernatant because viral bacteriophage coat protein infects the cell.
b. GFP signal from the supernatant and DAPI signal from cell pellet because viral DNA infects the cell.
c. DAPI signal from Cell pellet and GFP signal from supernatant because DNA is labelled with DAPI
d. GFP signal from supernatant and DAPI signal from cell pellet because all bacteriophage coat protein will remain in the supernatant

Que. A3. Which of the following statements regarding Plasmids is true:

a. Plasmids are artificial pieces of DNA made by scientists for the purpose of cloning and do not exist naturally
b. Replication of plasmid happens independent of the chromosomal DNA replication and it doesn't need to get integrated with the chromosomal DNA to get replicated
c. Most of the naturally occurring plasmids are linear in nature
d. Unlike chromosomal DNA, Plasmid remains as single stranded DNA inside bacteria

Que. A4. What accounts for peptide bond planarity within a polypeptide?

a. Electronegativity differences between nitrogen and carbon
b. Hydrogen bonding between amino acid side chains and water
c. Partial double bond character of the peptide bond
d. The peptide bond is not planar, it can actually rotate relatively freely
e. The fully double-bonded peptide bond

Que. A5. Ongoing space exploration teams searching for life beyond Earth have surprisingly found two new life forms, one on Mars and another on Jupiter. Upon analyzing these new life forms, scientists found that both follow a similar kind of central dogma like us on Earth. Though the genetic material on Mars (analogous to our DNA or RNA) has 4 types of nucleotides, their functional units (proteins) consist of 90 different amino acids. Which one could be a possible codon type used by this life form?

a. Doublet (2-letter codon)
b. Triplet (3-letter codon)
c. Quadruplet (4-letter codon)
d. None of the above

Que. A6. Which of the following is an example of a structural protein?

a. Insulin
b. Collagen
c. Adrenaline
d. Amylase

Que. A7. Which is/are the energy currency for our cells?

a. ATP
b. cAMP
c. Glucose
d. NADH

Que. A8. Which compound acts as a connecting link between glycolysis and Krebs's cycle?

a. Pyruvate
b. Acetyl CoA
c. Citrate
d. GAPDH

a
b

Que. A9. A brewery industry wants to produce ethanol from anaerobic bacterial cells by utilizing glucose. What is the biochemical process expected to play a major role here?

a. Krebs's cycle
b. Chemiosmosis
c. Fermentation
d. Both I & II

Que. A10. A sprinter experiences muscle cramp in his legs due to lack of oxygen in muscle. This is due to conversion of pyruvate to ---------- ?

a. Acetic acid
b. Carbon dioxide
c. Citric acid
d. Lactic acid

Que. A11. The process of photosynthesis which leads to formation of glucose from CO_2 and H_2O is an example of:

a. Oxidation
b. Reduction
c. Condensation
d. Fixation

a
a, b
a — α

Que. A12. Suppose that a scientist is simultaneously measuring both the amount of oxygen and the amount of glucose that is being used by cells. If a chemical was added that inhibited the electron transport chain, what would be expected to happen to the consumption of oxygen and glucose?

a. Both oxygen and glucose consumption increase

b. Oxygen consumption increases while glucose consumption decreases
c. Both oxygen and glucose consumption decrease
d. Oxygen consumption decreases while glucose consumption increases

Que. A13. In analyzing the number of different bases in a DNA sample, which result would be consistent with the base-pairing rules?
a. A=G b. A+G=C+T c. A+T=G+C d. A=C

Que. A14. There are two organisms of the same size and volume. One is a large singular cell (organism A) whereas the other one is composed of multiple cells (organism B). Which of the following option(s) are correct?
a. Organisms A and B have the same surface area to volume ratio
b. If there is damage to both organisms, organism B has more chance of survival and recovery.
c. As organism A grows large its surface area to volume ratio increases.
d. Organism B is more efficient at exchange of energy and matter compared to organism A.

Que. A15. Cyanide binds to at least one molecule involved in producing ATP. If a cell is exposed to cyanide, most of the cyanide will be found within the:
a. mitochondria b. peroxisomes
c. ribosomes d. lysosomes

Que. A16. Which of the following is present in a prokaryotic cell?
a. Mitochondrion b. Nuclear envelope
c. Ribosome d. Chloroplast

Que. A17. Red-green color blindness is caused by a sex-linked recessive allele. Sharma who is colorblind and marries Swapna with normal vision, whose father was color blind. What is the probability that they will have a color-blind daughter? What is the probability that their first son will be color-blind?
a. 1/2, 1/2 b. 0, 1/2 c. 1/2, 0 d. 1, 0

Que. A18. What was the result of breeding a white-eye male fly and a red eye female fly in the F1 generation according to Morgan's experiment?
a. All offspring had white eyes
b. All offspring had red eyes
c. Half had white eyes and half had red eyes
d. All offspring were male

X^eX X^eY

Que. A19. A white-eyed female Drosophila was mated with a red-eyed (wild-type) male, the reciprocal cross of the one mentioned the previous question. What phenotypes do you predict for the offspring?

a. All male offspring had white eyes
b. All male offspring had red eyes
c. Half female offspring had white eyes and half had red eyes
d. Half male offspring had white eyes and half had red eyes

Que. A20. A woman with a carrier gene for color-blindness marries a normal man. They are expecting their first child. What is the probability for the child being a boy and not to be color-blind?

a. 0% b.100% c. 50% d. 25%

$X^cX \quad XY$

$X^cX \quad X^cY \quad XX \quad XY$

Que. A21. From Mendelian genetics, consider a dihybrid cross occurs between YyRr heterozygotes. What will be the probability that F2 genotype is yyrr?

a. ¼ b. 1/8 c. 1/16 d. 1/32

$\frac{1}{4} \times \frac{1}{4} =$

Que. A22. In Africa, the percentage of the population that is susceptible to malaria is depicted by Hh. If the frequency of the gene pool is 0.19 (H) and 0.81 (h), what would be the percentage of heterozygous individuals?

a. 51 b. 55 c. 31 d. 20

$\frac{1}{2} \times \frac{1}{2}$

$= \frac{1}{4}$

Que. A23. Darwin proposed a mechanism for the evolutionary process, "natural selection". Which of the following statements is INCORRECT regarding natural selection?

a. A process in which individuals that have certain heritable traits survive and reproduce at a higher rate than other individuals because of those traits
b. Over time, natural selection can increase the match between organisms and their environment
c. If an environment changes or if individuals move to a new environment, natural selection may result in adaptation to these new conditions,
d. Natural selection weeds out the adapted population

Que. A24. Forelimbs of Bat, Cat, Human, and Whale are a classic example of which of the following?

a. Convergent b. Divergent c. Not known d. None of these

Que. A25. Darwin reported regarding beak variation in finches of various regions of Galapagos Island. What did he hypothesize for the beaks of finches?

a. Birds are not of the same species
b. Birds have different beaks according to the food availability
c. Birds don't need a variety of beak for eating different food types

d. None of these

Que. A26. Arabidopsis thaliana population has a gene with two alleles, R1 and R2. Population analysis showed that the R1 allele has a frequency of 40%. Assuming that the population is in Hardy-Weinberg equilibrium, what will be the proportion of heterozygous plants?

a. 0.12 b. 0.42 c. 0.36 d. 0.48

Que. A27. In the model for endosymbiotic origin, the inner membrane of mitochondria and chloroplasts is derived from which of the following?

a. Archaeal Origin b. Eukaryotic origin

c. Nucleus d. Prokaryotic origin

Que. A28. In a population, 210 have a genotype of DD for black hair, 245 have genotype Dd for gray hair and 45 have white hair dd. Using Hardy-Weinberg law can you find out the frequency of the dominant allele?

a. 0.7 b. 0.8 c. 0.9 d. 1

Que. A29. Which of the following statements about endosymbiotic origin is TRUE?

a. Ancestor eukaryotic cell engulfed non-photosynthetic prokaryotic cell which finally became a chloroplast

b. Ancestor prokaryotic cell engulfed non-photosynthetic eukaryotic cell which finally became a chloroplast

c. Ancestor eukaryotic cell engulfed non-photosynthetic prokaryotic cell which finally became a mitochondrion

d. Ancestor prokaryotic cell engulfed non-photosynthetic eukaryotic cell which finally became a mitochondrion

Que. A30. The ability of a pygmy sea horse to camouflage with its environment is an example of _____ adaptation.

a. Growth b. Evolutionary adaptation

c.Reproduction d. Development

Que. A31. Which of the following scientists made the path-breaking discoveries for the immense amount of diversity of life and chronicled in a famous book, The Origin of Species?

a. Arthur Conan Doyle b. Lamarck

c. Darwin d. Watson and Crick

Que. A32. To test for the mutations from an unborn child, which of the following best describes the correct procedure?

a. Check for the parent's genomic profile

b. Check for the mutations from amniotic fluid
c. Check parental karyotyping
d. All of the above

Que. A33. Arrange the steps for the IVF procedure –
i. Both types of gametes are extracted
ii. Sperm is to be injected into egg
iii. Implant the zygote in the uterus
iv. Incubated zygote to divide up to the 8-cell stage

The possible sequence is –
a. iii, ii, i, iv b. iii, i, iv, ii c. i, ii, iv, iii d. iii, ii, iv, i

Que. A34. A researcher performed an experiment of cloning in humans using nuclear transplantation. However, he forgot to remove the nucleus of the egg. Assume that the egg accepted the somatic nucleus resulting in a new zygote. What will be the ploidy of the embryo?
a. Haploid b. Diploid c. Triploid d. Tetraploid

Que. A35. Which of the following is NOT a reliable way of detecting a recombinant clone?
a. Polymerase Chain Reaction b. Cell morphology
c. Sequencing d. Restriction digestion

Que. A36. Down's syndrome is due to abnormality of which of the following chromosomes?
a. Trisomy at 22 b. Trisomy at 21 c. Trisomy at 17 d. Trisomy at 11

Que. A37. Which of the following experiments is/are closest to the In Vitro Fertilization (IVF) technique which is revolutionizing reproductive biology for couples who cannot reproduce by natural means?
a. Gordon's experiments on Frog metamorphogenesis
b. Identification of DNA's semi-conservative replication by Messelson & Stahl
c. Cloning of 'Dolly' the sheep by Ian Wilmut
d. All of the above

a, c
c
a X

Que. A38. Griffith did experiments on pneumonia-causing bacteria and mice and made observations. Which of the following statements is/are CORRECT for Griffith's experiment?
a. S cells are non-virulent while R cells are virulent.
b. R cells get transformed when mixed with S cells.
c. Mouse dies when infected with R cells.

d. R cell becomes virulent when gains a virulent gene.

Que. A39. What did Watson and Crick suggest to be significant about the base pairing found in the helix?

a. It allowed DNA to twist in a helix
b. DNA could be circular
c. It was a mechanism for copying
d. All of the above

Que. A40. Consider a hypothetical situation in which Cdk is absent in G1 phase, but is suddenly available during the S phase of cell division and afterward. What would be the effect of this type of situation on the whole process? Select all the options that are INCORRECT option(s).

a. There would be no effect of this situation on the cell cycle.
b. Cyclin is synthesized in the S phase and accumulated in the G2 phase.
c. Cyclin is synthesized in the M phase and accumulated in the G2 phase.
d. If Cdk is expressed from the S phase onwards, the complex will form in its usual way.

Que. A41. The cyclins and cyclin-dependent kinases play an important role in driving the cell cycle. The decline of a protein (M-phase-promoting factor) activity at the end of mitosis could be due to which of the following reason(s)? Select all the options that are correct.

a. The destruction of the protein kinase Cdk
b. decreased synthesis of Cdk
c. The degradation of cyclin
d. the accumulation of cyclin

Que. A42. During which stage of mitosis do the centromeres split?

a. Prophase
b. Interphase
c. Anaphase
d. Telophase

Que. A43. A diploid organism has 78 chromosomes, what will be the number of chromosomes per cell, if meiosis takes place –

a. 37
b. 156
c. 39
d. 78

Que. A44. A person gets a deep wound, which type of cell division can help in wound healing?

a. Mitotic
b. Meiotic
c. Both
d. None

Que. A45. Which technique can be used to separate DNA fragments of various sizes?

a. Agarose gel electrophoresis
b. SDS-PAGE
c. Western Blotting
d. All of the above

SECTION-B

Short Answer Type Question

Total 12 questions are given in this section. You can solve any 10 questions. If you solve all the questions, only Q1-10 will be checked for marking. Write short answers to these questions in the answer book.

Que. B1. A researcher conducts experiments similar to Griffith's to identify the genetic material. The transforming principle was partially purified from the S strain of *Streptococcus pneumoniae* bacteria to determine which macromolecule of S strain cells transformed R strain into S strain cells. She treated the extracts of heat-killed S strains with protein-, RNA-, and DNA-degrading enzymes respectively in different tubes. After the treatment, live R strain cells were introduced to each tube and the mixture was used to infect mice. According to your knowledge about the genetic material, what would be the expected outcome in each case with respect to whether the mice will survive or die. (1 marks)

Tube A: Treating the mixture with protein-degrading enzyme and injecting it into mice.

Expected Outcome: Mice Dies

Tube B: Treating the mixture with RNA-degrading enzyme and injecting it into mice.

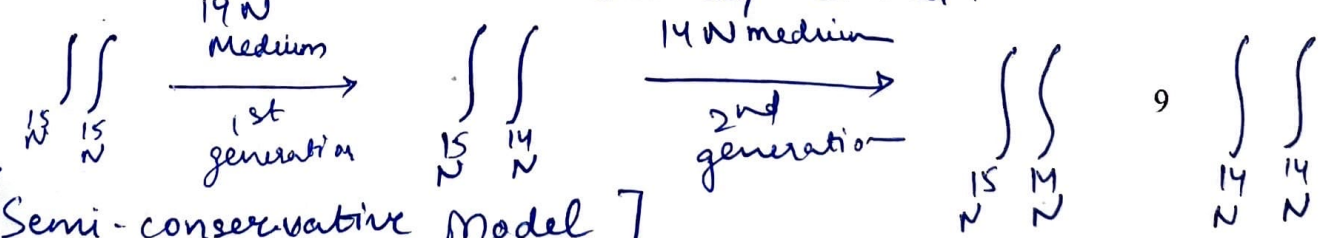
Expected Outcome: Mice Dies

Tube C: Treating the mixture with DNA-degrading enzyme and injecting it into mice.

Expected Outcome: Mice Survives

Que. B2. You have discovered an alien species and seek to elucidate its mode of DNA replication. To achieve this, you repeated the Meselson-Stahl experiment. The alien species was grown on ^{15}N medium for several generations and then transferred to ^{14}N medium and allowed to grow for two more generations (two rounds of DNA replication). DNA extracted from its cells is centrifuged. You find out that this species follows the same mode of DNA replication as *E. coli*. What density distribution of DNA did you find in this experiment? Explain with the help of a diagram. What is this model of DNA replication called? (0.5 X 2 = 1 marks)

one low density & one intermediate density band.



[Semi-conservative Model]

Que. B3.

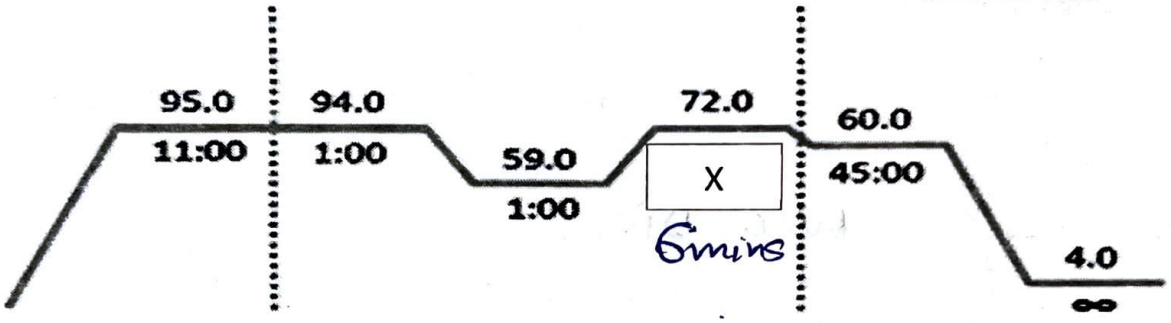
A. Suppose you have cloned a gene ('wg' for wingless), which plays an important role in the embryonic development of Drosophila. The first thing you might want to know that which embryonic cells express the gene and where in embryo the corresponding mRNA is found. To detect the mRNA, you have to synthesize the single-stranded DNA probe. If mRNA sequence of "wg" is given below:

5'...CUCAUCACCGGC...3'

What would be the sequence of single-stranded DNA probe? **(0.5 marks)**

3' — GIAGTAGTGGCCG — 5'

B. Now you want to set up a PCR reaction to amplify a gene which is 3 kilo base pairs long. You are using a DNA polymerase which is known to amplify 500 base pairs per minute. The reaction parameters are given in the table. Fill in the reaction time (X) for the amplification step in minutes. **(0.5 marks)**



Que. B4. You are particularly interested in one gene named BPAD. BPAD codes for a protein – Bisphenoldegradase – that can degrade the synthetic chemical – bisphenol A (BPA) which is used to make plastic. The genetic sequence of BPAD is the following:

>NW_006766950.1:Bisphenoldegradase

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1  ATGGCTTTCAAGTGGTCGTCCATCCTCGCCCTCGTCACCCTCGCTACGTTGGCGAGTGCTGCGCCAACTC
2  AGTCAACAGTCACCTGTTCCGACGGCACCGTAGTTCCAGACTCAGTGTGCTGCGAGTTCATTCCGGTAGG
3  TCGTGGTTGCGCTACGCTGTGATATGCTCGACACTCAAATGACATGCCATGTAGCTCAGGGAGGCACTCA
4  ACGACCAGGTCATCCAGAGCGATTGTGGTGAAGATGGTAGGTCGATTGTATGTGATAGTAATGATCACGG
5  TCTCACGCTCTACTACTCCAGCTCACGAGCTTCTCCGTCTCACTTTCCGTAAGCCCTCTGCATTCGTACA
6  GCGTCGGTGAGGTACTAAACATACTGCGCAGACGATGCCATTGCCATCTCGCAGAGCTTGGGTCCCTCGG
7  CGTGAGTAGCAGCCAAGCTCTATGACAAGTCCGGAGCTGATCACAATTGATATGCAGTGGTGGAGGAGCT
8  GACGGTTCGATGCTCCTGTTCCCAACCGTCGAGCCGGCCTTCTTCGCCAATCTCGGTATCGCCGACAGTG
9  TCAACAACCTGATCCCGTTCATGTCGCAGTTCCCCAACATCTCCCCCGGTGATCTCGTCCAGTTCGCAGG
10 TGCTGTCGCCATCACTAACTGCCCTGTGCGTACATACCGTTCTTCTCACACCACGTGACTTGCCGTGCTA
11 ATGACTTTTCTTCATTAGGGTGCACCTCAGCTCGAATTCCTTGCCGGTCGTCCCAACGGTACCGCCCCCG
12 CCATCGACGGCCTCATCCCAGAGCCCCAGGACAGCATCGACGACATTCTGGCCCGCTTCGACGATGCAGG
13 AGGCTTCACGCCCTTCGAGGTCGTCTCCCTCCTCGCTTCGCACACCGTCGCCCGTGCGGACCACGTCGAC
14 CCCACGCTCGACGCTGCGCCCTTCGACAGTGTGAGTAACGTGATCTCCTTTGTTCGAAATGCTCTCTAAG
15 GTCATACCCTCCCAGACGCCCTTCACTTTTGACACCCAGATCTTCCTGGAGGTCCTTCTCAAGGGTACCG
16 GCTTCCCCGGAACGGACAACAACACCGGCGAGGTCGCCTCTCCTATCCCCGTCACGAACGGCACCGACGT
17 TGGCGAGCTCCGCCTCCAATCTGACTTCGGCCTCGCCCACGACTCGCGCACCGCGTGCTTCTGGCAGGGC
18 TTCGTCAACCAGCAGGACTTCATGGCCCAGTCCTTCAAGGCTGCCATGGCCAAGCTCGCCGTCCTCGGCC
19 ACAACGCCGCGGACCTCGTCAACTGCTCCGCCGTCATCCCCACGCCCCTGCCCGCCACCGGAAAGCCCGC
20 CACGTTCCCGGCTACCTTGGGCCCCGACGACCTCGAGCTCTCGTGCACGACCGAGCCGTTCCCGTCCCTC
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21 ACCACCGACCGTGAGTGTCATGGTTTCTGTTCGCGGTCGCCGTATCATGCAGTGGCGCTGACAGCGACTC
22 TTCCCTACAGCCGGTGCCCAGGAGACTCTCATCCCTCACTGCTCGGACGGCAGCATGGACTGCGAGTCCG
23 TCCAGTTCGACGGTCCTGCTACCAACTTCGGTGGCGACGACGACGACGACGACGACTCTTAG
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A. Based on the genetic sequence of BPAD, write down the first 10 and last 10 amino acids of the protein Bisphenoldegradase. You can refer to the genetic codon table given below. (0.5 mark)

First Base	Second Base: U	Second Base: C	Second Base: A	Second Base: G	Third Base
U	UUU, UUC — Phe	UCU, UCC, UCA, UCG — Ser	UAU, UAC — Tyr	UGU, UGC — Cys	U
	UUA, UUG — Leu		UAA, UAG — STOP	UGA — STOP	C
				UGG — Trp	A
					G
C	CUU, CUC, CUA, CUG — Leu	CCU, CCC, CCA, CCG — Pro	CAU, CAC — His	CGU, CGC, CGA, CGG — Arg	U
			CAA, CAG — Gln		C
					A
					G
A	AUU, AUC, AUA — Ile	ACU, ACC, ACA, ACG — Thr	AAU, AAC — Asn	AGU, AGC — Ser	U
	AUG — Met or Start		AAA, AAG — Lys	AGA, AGG — Arg	C
					A
					G
G	GUU, GUC, GUA, GUG — Val	GCU, GCC, GCA, GCG — Ala	GAU, GAC — Asp	GGU, GGC, GGA, GGG — Gly	U
			GAA, GAG — Glu		C
					A
					G

First 10 AA
-Met - Ala - Phe - Lys - Trp - Ser - Ser - Ile - Leu -

Last 10 AA
- Gly - Gly - Asp - Asp - Asp - Asp - Asp - Asp - Asp - Ser -

B. You want to clone this gene into a plasmid to produce the plastic-degrading protein as a solution to plastic pollution. In order to do that, you have to first amplify the desired gene by polymerase chain reaction (PCR). Write down the sequence of the forward and the reverse primer that you would design to amplify the gene. Make the primers 18 nucleotides long. (0.5 marks)

(FP) 5'- ATG GCT TTC AAG TGG TCG -3'

(RP) 5'- CTA AGA GTC GTC GTC GTC -3'

Que. B5. Based on the previous question (QB4), answer the following:

A. How many DNA copies will you get after 25 cycles of PCR. Assume that the initial number of DNA copies is 'x' and each PCR cycle is 60% efficient. (0.4 marks)

$(60/100 \times 2)^{25} x = (1.2)^{25} \times x$

B. You clone the PCR product, i.e., the BPAD gene, into a plasmid. You use this recombinant plasmid to transform E. coli cells for expression of the protein. The transformed E. coli cells will now express bisphenoldegradase. To purify the protein from the bacterial culture, you must use some chromatographic techniques. You know that your protein interacts with a chemically stable

analogue of bisphenol A such that you want to use this interaction to specifically pull down your protein. No other protein from the bacterial culture binds to this analogue. You prepare matrix beads chemically coupled to this analogue and use them to separate your protein from other proteins in the mixture. What is this type of chromatography called? (0.3 marks)

a. Size exclusion chromatography
b. Ion exchange chromatography
c. Affinity chromatography
d. Gel filtration chromatography

C. After purification, you test the protein for its function. To your disappointment, the protein lost its function. You realised that you have added a reducing agent - beta mercaptoethanol - to your buffer. Which structure of the protein is likely affected? (0.3 marks)

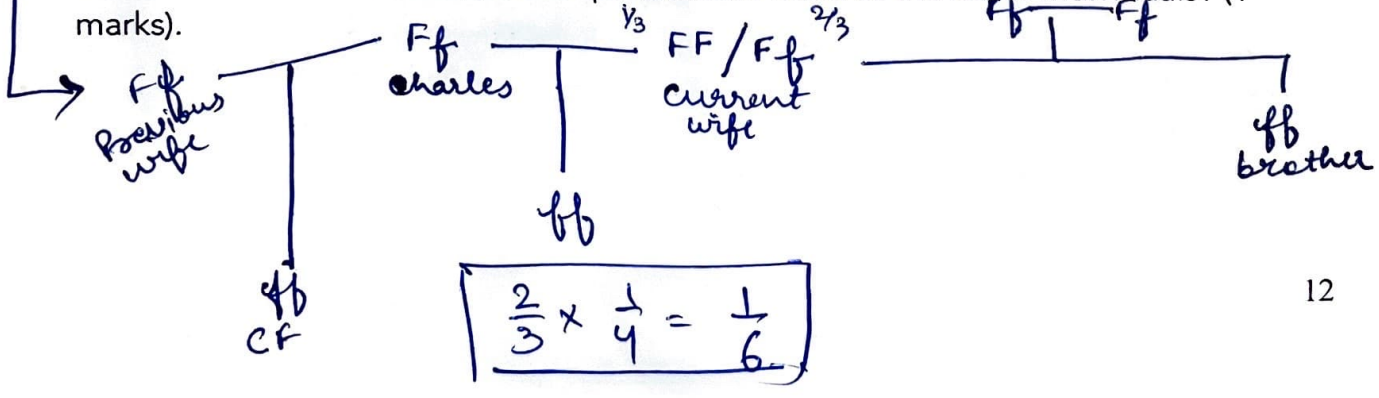
a. Primary
b. Secondary
c. Tertiary
d. Both b and c

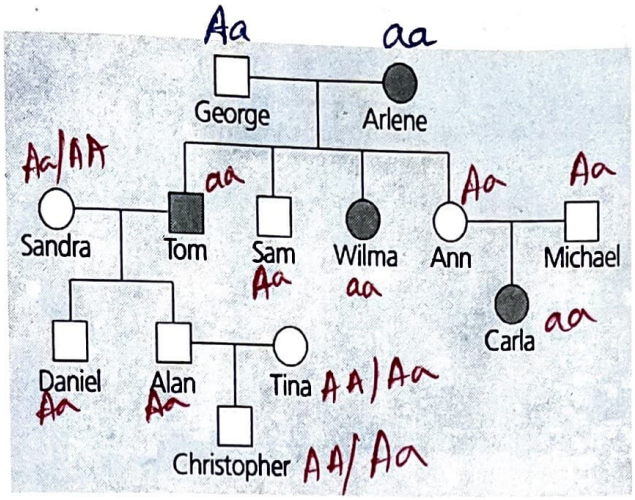
Que. B6. Imagine that you are a genetic counsellor, and a couple planning to start a family, comes to you for information. Charles was married once before, and he and his first wife had a child with cystic fibrosis. The brother of his current wife, Elaine, died of cystic fibrosis. What is the probability that Charles and Elaine will have a baby with cystic fibrosis? Explain with the help of a pedigree. (Neither Charles, Elaine, nor their parents have cystic fibrosis.) (1 marks).

Que. B7. What is the probability that each of the following pairs of parents will produce the indicated offspring? (Assume independent assortment of all gene pairs.) (1 mark)

a. AaBbCc*AaBbCc → AaBbCc $\frac{1}{2} \times \frac{1}{2} \times \frac{1}{2} = \frac{1}{8}$
b. aaBbCC * AABbcc → AaBbCc $1 \times \frac{1}{2} \times 1 = \frac{1}{2}$

Que. B8. The pedigree below traces the inheritance of alkaptonuria, a biochemical disorder. Affected individuals, indicated here by the coloured circles and squares, are unable to metabolize a substance called alkapton, which colours the urine and stains body tissues. Does alkaptonuria appear to be caused by a dominant allele or by a recessive allele? Fill in the genotypes of the individuals whose genotypes can be deduced. What genotypes are possible for each of the other individuals? (1 marks).





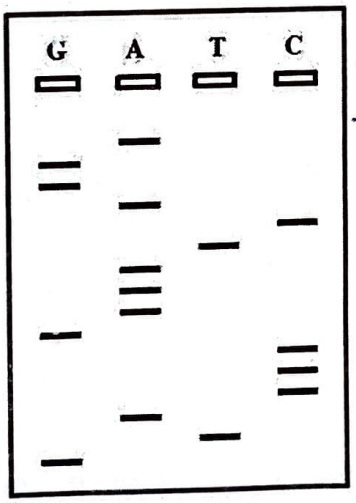
Tom - aa
Sam - Aa
Wilma - aa
Ann - Aa
Michael - Aa
Sandra - Aa/AA
Tina - AA/Aa
Carla - aa
Daniel - Aa
Alan - Aa
Christopher - AA/Aa.

Que. B9. A man with haemophilia (a recessive, sex-linked condition) has a daughter of normal phenotype. She marries a man who is normal for the trait. What is the probability that a daughter of this mating will have haemophilia? That a son will have haemophilia? If the couple has four sons, what is the probability that all four will be born with haemophilia? (1 marks).

Probability of daughter having hemophilia = 0
Probability of son having hemophilia = 1/2
Probability of all the 4 sons having hemophilia = $\frac{1}{2} \times \frac{1}{2} \times \frac{1}{2} \times \frac{1}{2} = \frac{1}{16}$

Que. B10.

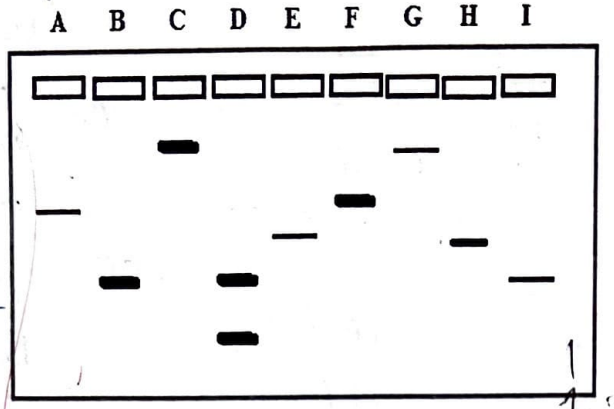
A. A student is working on 5'-labelled DNA for sequencing. He performed agarose gel electrophoresis and found following result (see image). Write the sequence in 5' to 3' direction. **(0.5 marks)**



5' —GTACCCGAAATCAGGA— 3'

B. This student further wants to study the gene expression profiling of C. *elegance* in its developmental stage. He performed RT-PCR and run a gel as shown in the figure below. What can be concluded by this result for gene expression? **(0.5 marks)**

Which genes are espressed more in during developmental stage in C. elegans.



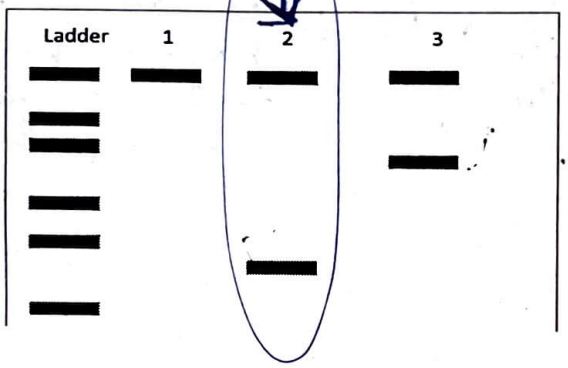
B, C, D, and F are espressed more &

A, E, G, H & I are espressed less.

0.5
0.75
1.25

Que. B11.

A. You are performing colony PCR to confirm the clone of your interest. You find the following pattern (a shown in gel image) post-digestion of your vector. Which lane indicates presence of both vector and correct size clone, and why? **(0.5 marks)**



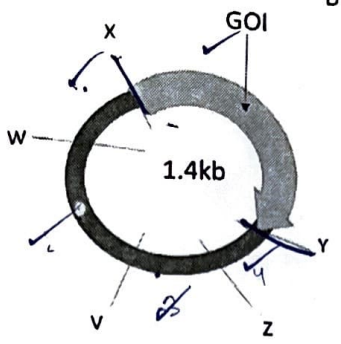
2

B. pBB101 is a 20kb plasmid. When digested with EcoR1, one linear fragment is obtained. Digestion with BamH1 results in in 3 fragments of the following sizes: 12kb, 2kb, and 6kb. A combination digest with EcoR1 and BamH1 resulted in 4 fragments: 8kb, 4kb, 2kb, and 6kb. Develop a map for the plasmid. **(0.5 marks)**

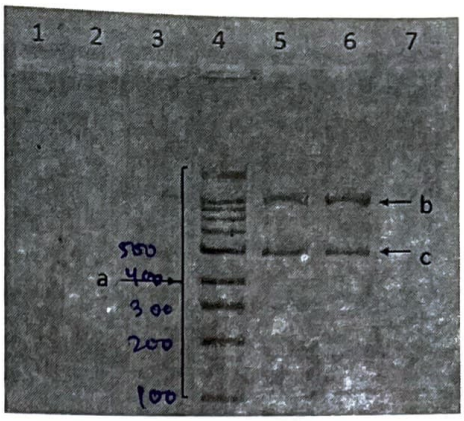
Que. B12.

Your vector with the gene of interest (GOI) is 1.4kb long (Figure A). On digesting it with two restriction enzymes, the vector linearizes and releases the gene of interest. The sample after digestion is loaded into 3 wells (lanes 4-6). Upon scanning the gel, the below image was observed (Figure B). Based on this, answer the following questions (Note: Vector not drawn to scale) **(1 marks)**

A



B



A. Name the following: a, b and c (0.3 marks) a → Ladder b → Plasmid c → Gene

B. If lowermost band on lane 4 is 100bp (and all the band sizes in lane a could be 200, 300 or so on), what is the size of the vector and insert (0.3 marks)

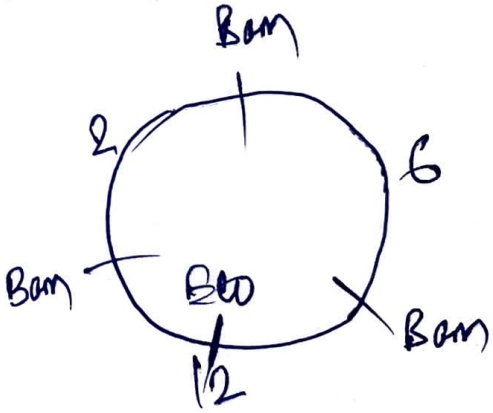
C. What are the two restriction enzymes used (from figure A) (0.2 marks)

D. How many bands would you observe if all 5 restriction enzymes (x, y, z, v, w) were used (0.2 marks) 5 bands

B) Insert → 500
Vector → 900

C) X and Y

D) 5



Eco → 20
Bam → 12, 2, 6
→ 8 4 2 6

11b)