

Genetic engineering

Long questions 7 marks

1. The cost and slow processing of Sanger sequencing has been overcome with more advanced technologies over the last few decades. Describe the various advances made in this technology with their individual underlying principle. (Internal, 2079)
2. Real-time PCR has several advantages over conventional PCR. One of the key advantages being its specificity on amplicon detection. Explain briefly on how this has been achieved with focus on its principle. A PCR needs to be carried out in a place where there is no electricity, and fire is used as primary source of heat. Illustrate with diagram the PCR that you can carry out here. (4+3) (Internal, 2079)
3. A scientist has established two cell lines, one of which is a cancerous cell line while the other is the normal counterpart. The scientist has created four different types of libraries from them. Elaborate these libraries and explain which of these would be best suited for studying about promoter and regulatory regions of the genome. (Preboard, 2079) | for studying transcriptome (Preboard, 2078)
4. A manuscript detailing over-expression of certain number of genes confirmed only by microarray data was submitted to a peer-reviewed journal; however, the editor rejected the paper at first glance. What was the reason? Write about any one of the experiments that should help the authors to reliably prove overexpression of genes. (Preboard, 2079)
5. Metagenomic and microbiome studies have really paved the way for understanding the prevalence and nature of non-culturable micro-organisms present in the environment. Next generation sequencing made all these possible – however, the human genome draft in 2003 or any of the prior whole genome sequencing was done using relatively simple technique. Write about basic working principle, advantages, and disadvantages of this simpler technique. (Preboard, 2079)
6. The cost of sequencing for the first whole human genome was approximately 3 billion USD. Today it has decreased to less than 1000 USD. Advancement in which of the technology made this possible? Mention in brief about the working principle of all the contributing techniques for this amazing feat. (Preboard, 2079)
7. Tissue sample from brain and liver was taken. Write three different ways by which changes in their DNA or RNA content can be determined either qualitatively or quantitatively. (Preboard, 2078)
8. A scientist aims to carry out metagenomic studies for soil sample from newly discovered island. Which technique is most feasible to carry out this in a huge scale? Write briefly about four different variants of this technique. (Preboard, 2078)
9. A PCR product with a length of about 1500 bp needs to be sequenced in a developing country that has no next generation sequencing machine. Describe the technique that would be most feasible for carrying out the sequencing. (Preboard, 2078)
10. The gene TRAP1 was to be over-expressed to see its effects on the overall division of mitochondria. Write down three strategies by which this over-expression can be confirmed. (Preboard Re, 2078)
11. Precision medicine, whereby, the treatment regimen for individual patients can be designed based on their genetic makeup has become one of the emerging strategies for treatment in advanced countries. Elaborate on the technologies that have made this possible. (Preboard Re, 2078)
12. Name various PCR types. Describe reverse transcription PCR. (Internal, 2072)
13. During the course of integrating a target gene into chromosomal DNA of host bacterium, a marker gene may also be inserted into chromosomal DNA. What strategy could be used to excise only the marker gene? (Internal, 2072)
14. Describe the strategies and procedure to prepare cDNA library. Differentiate between cDNA library and genomic DNA library. (4+3) (Internal, 2072)

15. Why is the next generation sequencing a revolutionary technique? Describe a basic technique of Sanger's dideoxy terminating sequence. Compare it with Next generation sequencing. (1+4+2) (Internal, 2072)
16. Define knockout mutation. Write down the strategy for making knockout mouse. (2+5) (Internal, 2072)
17. Why *Agrobacterium* is called *natural genetic engineer*? Describe the structure of Ti plasmid. Describe in brief the tricky method for Ti-plasmid mediated gene transfer in plant genome. (1+3+3) (Internal, 2072)

Short questions 2 marks

1. A segment of DNA has been treated with *Enzyme W* to produce *product A* with blunt ends. *A* was then treated with *Enzyme X* to attach nucleotides at its terminal ends, and give *product B* followed by treatment with *Enzyme Y* that dephosphorylated *B* to produce *C*. Finally, radioactive phosphate was attached to *product C* with the help of *enzyme Z*. What are *W*, *X*, *Y*, and *Z*. (Internal, 2079)
2. What would be the resulting color of *Escherichia coli* DH5 α colonies that have been transformed with a vector containing intact lacZ gene, when growing in a media containing X-gal and induced by IPTG? Why? (Preboard Re, 2078)
3. The problem with mutants is their non-specificity. How has this been overcome? (Internal, 2079)
4. A student conducts restriction digestion experiment for a plasmid and expects two clean bands in the gel – however, all he sees is a smear. What could be the possible reason for this? (Preboard, 2079)
5. A student performs restriction digestion for PCR products in two different tubes assuming two bands will be observed. After running gel electrophoresis, three bands were observed in one well while smear was observed in the other. Write down all the possible explanations for these results. (Preboard, 2078)
6. The color of maize kernels although primarily yellow, can have various colors despite undergoing no foreign gene modifications. What could be the internal factors responsible for these changes? (Preboard Re, 2078)
7. What would be the expected changes in a monocot plant's explant during tissue culture that has been transformed with a wild type Ti-plasmid?
8. Department of Food Technology and Quality Control (DFTQC) has banned the release of certain genetically modified plant product in Nepalese market citing presence of different antibiotic genes that had previously been used as markers for confirming transformation with foreign genes. The company is suffering loss of millions of rupees in revenue. Mention the ways on how you can remove these markers. (Preboard, 2079)
9. Two DNA segments – a larger circular unit *X* and a smaller linear unit *Y* obtained from amplification of a certain segment of the genome were treated with *A* resulting in generation of DNA segments with sticky ends. Following this, they were then treated with *B* resulting in generation of single unit *Z*. *Z* was then *C* in host *Escherichia coli* DH5 α for its amplification and preservation. What are *X*, *Y*, *Z*, *A*, *B*, and *C*? (Preboard, 2079)
10. A microparticle bombardment experiment was setup with iron as microcarriers of DNA for transformation of fully mature green leaf with yellowish patterns already showing up with 500mg of plasmid DNA. What would be your recommended changes for this experimental setup, and why? (Preboard, 2079)
11. How many copies of a gene present in X chromosome do you get after 30 cycles of PCR if you started with 100ng of a template DNA from a patient with Turner syndrome? [n copies give rise to n³² copies/ hint: weight of one human genome in a somatic cell = 7.18 pg DNA; weight of DNA content in X chromosome: 0.1 pg; Turner syndrome: XO chromosome (missing one X chromosome)] (Preboard, 2079)
12. How many copies of a gene present in chromosome 21 do you get after 30 cycles of PCR if you started with 100ng of template DNA from a patient with Down syndrome? [n copies give rise to n³² copies/ hint: weight of one human genome in a somatic cell = 7.18 pg DNA; weight of DNA content in one chromosome 21: 0.03 pg; Down syndrome: Trisomy chromosome 21] (Preboard, 2078)
13. Write the functions of T-DNA genes in Ti-plasmids of *Agrobacterium*. (Internal, 2072)
14. Define fusion protein. Write in brief about uses of fusion proteins. (Internal, 2072)
15. Write in brief about critical factors in designing PCR primers. (Internal, 2072)

16. Describe: a) palindromic sequence b) isochizomeres c) cohesive end (Internal, 2072)
17. Different factors influence the movement of nucleic acid in agarose gel electrophoresis. What are the factors? Write how they affect the movement of nucleic acid. (Internal, 2072)
18. What are inclusion bodies and how their formation can be avoided? (Internal, 2072)
19. Describe in brief about Nuclear Localization Signal (NLS) mediated gene transfer in eukaryotes. (Internal, 2072)
20. What is GFP gene? Describe how it is used as reporter gene. (Internal, 2072)
21. A piece of genome was obtained using [A]. These huge numbers of similar pieces were then reduced in size using [B] which produced sticky ends. This product was then joined with another sticky end using [C]. The total size which was now bigger was then confirmed in [D] which had expected size when compared with the ladder. What are [A], [B], [C], and [D]?
22. A patient has pathological development of autoimmune disorder. Which of the library would be best suited for in vitro production of antigen which has resulted in this disorder?
23. A protein with extensive glycosylation needs to be over-expressed. Which of the following host expression system would be best suited, and write their advantages and disadvantages?
 - a. *Escherichia coli*
 - b. *Saccharomyces cerevisiae*
 - c. Mammalian expression system

Very short questions 1 mark

1. A student mistakenly kept reverse primer twice while skipping forward primer during PCR setup. What would happen during PCR reaction? (Internal, 2079)
2. A student mistakenly kept only the forward primer during PCR setup. What would happen during PCR reaction? (Preboard Re, 2078)
3. Which vector would you choose to establish a human genome library, and why? (Internal, 2079)
4. Give an example of a marker with its working principle for the selection system that does not kill the non-transformed cells while helping in identification of transformed cells. (Preboard, 2079)
5. An organism undergoes fetal abortion when a particular gene is knocked out. Write about the alternative technique for studying the function of this gene. (Preboard, 2079)
6. There was an electrical spark while conducting an electroporation experiment. What happened? (Preboard, 2079)
7. How can a genome result in such variation of morphology in butterfly without undergoing changes in its sequence? (Preboard, 2079)
8. Illustrate technical replicate design for microarray experiment to be conducted for RNA of HEK293T cells. (Preboard, 2079)
9. A scientist has transformed both haploid and diploid yeast cells. Which one of them would likely reach the homozygous state earlier? (Preboard, 2079)
10. What do you mean by blue-white screening? (Internal, 2079)
11. What is star activity? (Internal, 2079)
12. Which method of electrophoresis is used to separate large molecules of DNA? (Internal, 2079)
13. What is degenerate primer? (Internal, 2079)
14. What are the applications of linkers and adapters? (Internal, 2079)
15. During gel electrophoresis of PCR amplicons, no bands including that of the ladder were visible. Elaborate. (Preboard Re, 2078)
16. What are the differences between DpnI, DpnII, MboI, and Sau3AI?
17. What is RACE? (Internal, 2072)

18. Why would you want to express a foreign protein on the surface of a bacterium or bacteriophage? (Internal, 2072)
19. What are the constraints associated with *Agrobacterium*-mediated gene transfer? (Internal, 2072)
20. Differentiate between Hot start PCR and Touch down PCR. (Internal, 2072)
21. Write the role of Magnesium chloride in PCR reaction. (Internal, 2072)
22. What is vent DNA polymerase? (Internal, 2072)
23. Compare the genomic changes brought by traditional breeding and genetic engineering. (Internal, 2072)
24. Differentiate between a plasmid and a phagemid. (Internal, 2072)
25. Compare differences on genomics, transcriptomics, and proteomics. (Internal, 2072)
26. How Taq-polymerase differs from Pfu-polymerase. (Internal, 2072)
27. Differentiate between transitions and transversions. (Internal, 2072)
28. What is a DNA chip? (Internal, 2072)
29. A gardener wishes to make a sterile flower since he does not wish any one to get hold of his unique strain of flower. Which of the genetic engineering technique could be employed? (Internal, 2072)
30. *E. coli* DH5 α is used as a cloning host while *E. coli* BL21 is used as an expression host. What ideal characters make the BL21 a suitable expression host?
31. A student conducted following replicate experiments for microarray:
 - a. Using same RNA sample three times
 - b. Using three different RNA samplesWhat are the technical terms for above replicates?
32. Is it possible to transform electro-competent cells using heat-shock method? Elaborate.
33. A deletion needs to be conducted for a gene using PCR. Illustrate how this can be achieved.

Long questions

1. Describe working principle of two types of vector systems in *Agrobacterium*-mediated gene transfer describing the vectors used and functions of different genes present in the vectors. Write the advantages/ disadvantages of the systems as well. (Preboard, 2079)
2. What is meant by dihaploid plant? How dihaploid plants can be produced in-vivo and in-vitro? Describe one common method of producing haploid plants in vitro. (Preboard, 2079)
3. Write with examples on different strategies followed for protein production in molecular farming to produce different valuable proteins to be used as enzymes, vaccines, and biopharmaceuticals. (Preboard, 2079)
4. During plant development, in one stage, the vegetative meristem is changed to floral meristem controlled by both environment and genetically (autonomous). Describe how environmental control in floral initiation and write about changes in expression of genes that lead to floral initiation. (Preboard, 2079)
5. Explain full mechanism of how *Agrobacterium* naturally infects plants. How have scientists utilized this mechanism to genetically modify plants with the help of co-integrate vector, binary vector, superbinary vector, and ternary vector systems, explain with diagrams. (3+4.5) (Internal, 2079)
6. How dihaploid plants are produced from anther culture? Describe. Write advantages of dihaploid plants.
7. The vegetative meristem changes to floral meristem so that the plant will produce flowers. The change in meristem is controlled by both environmental factors and genetically (autonomous). Describe how the environmental conditions and gene expression control floral initiation mentioning environmental conditions and genes involved in floral initiation.
8. What is micropropagation? Explain its major steps. (Preboard, 2077)
9. Define plant genetic engineering. Write direct gene transfer methods in plants in detail. (Preboard, 2077)
10. Describe different methods of virus elimination from plants. (Preboard, 2077)
11. Describe methods of protoplast fusion and its applications with reference to *Nicotiana glauca*. (Preboard, 2077)
12. Metabolic engineering is employed as main procedure for over-production of economically important product for molecular farming. Describe various strategies of metabolic engineering that can be taken for over-production of certain product. (Preboard, 2072)
13. The seedling development is controlled by light. Describe different seedling morphology shown when grown in light or dark. Write how the development is controlled genetically in *Arabidopsis*. (Preboard, 2072)
14. What is meant by somatic embryogenesis? How somatic embryos differ from gametic embryos? Describe basic principle of inducing embryogenesis in plant tissue culture with suitable example. Write how synthetic seeds are produced to use somatic embryos as propagules. (Preboard, 2072)
15. The only way of virus elimination in clonal propagation is by meristem culture. Write the principle behind it. Describe the steps taken in procedures to obtain virus-free plantlets taking a suitable example. (Preboard, 2072)
16. Describe the organization of shoot apical meristem (SAM). For the continuous growth of stem, the size of SAM should be maintained constant when the shoot is growing. Describe how SAM is maintained describing the role of various genes to keep the size of SAM constant. (Preboard)
17. What are the floral organs of a typical flower that are found in four whorls? Describe the role of different genes involved which are identified by analysis of various mutants. How these various floral organs are specified genetically during floral development of *Arabidopsis*? (Preboard)
18. Write the different strategies taken for engineering insect resistance in plant. Bacterial *cry* endotoxin gene transformation is one approach to develop such resistance in plant. Write the mode of action of this gene. Describe how insect resistant crop plants are produced using this gene. (Preboard)

19. Write the structural features of a binary cloning vector and a cointegrative vector used in *Agrobacterium*-mediated transformation. What are the similarities and differences in their working principle? List the advantages of two systems. (Preboard)
20. Describe different tissue culture techniques writing their major applications in plant biotechnology. (Preboard)
21. What is haploid culture? Describe different techniques of haploid culture and write its importance in plant breeding. (Preboard)

Short questions

1. What is meant by somatic hybridization? Discuss potential uses of somatic hybridization giving examples. (Preboard, 2079)
2. What is meant by antisense technology? Write with example how this technology can be used in improvement of crop yield/ quality? (Preboard, 2079)
3. What is micro propagation? Describe its various stages. Differentiate between direct and indirect morphogenesis. (Preboard, 2079)
4. What is self-incompatibility? Describe different types of self-incompatibility, their mechanism, and their effects in fertilization process of angiosperms. (Preboard, 2079)
5. For continuous growth of stem, the size of SAM should be maintained constant when the shoot is growing. What are the genes involved in maintenance of meristem and write their role in maintenance. (Preboard, 2079)
6. The seedling morphology is controlled by light. Describe different seedling morphology shown when grown in light or dark. (Preboard, 2079)
7. What are the marker and reporter genes used in plant gene transformation? Describe them with
8. Describe how chloroplast transformation is done with an example. (Internal, 2079)
9. What is callus? Describe how callus is induced from plant explants. Write with an example. (Internal, 2079)
10. *The formation of new primordium during growth is controlled by existing primordial which is formed earlier.* Explain with an example. (Internal, 2079)
11. Describe roles of auxin and cytokinin in plant tissue culture. (Preboard, 2077)
12. Describe embryo development in monocots. (Preboard, 2077)
13. Describe cybrid with an illustration. (Preboard, 2077)
14. What are the applications of transgenic/ GE plants for economic benefit? (Preboard, 2077)
15. Describe any three methods of plant transformation. (Preboard, 2077)
16. Give characteristics of two model plants used for transformation. (Preboard, 2077)
17. Describe techniques of anther culture. (Preboard, 2077)
18. Describe the production of transgenic protein through oleosin system. Write the advantages of this system.
19. Describe the specific problems encountered during tissue culture of woody plant.
20. Describe t-DNA writing the genes found and functions of their products
21. Write the principle of gene transformation by particle bombardment. Describe different steps followed in plant genetic transformation using particle bombardment.
22. What is model plant? What are its uses? Write why *Arabidopsis* is considered a model plant in plant genetic transformation.
23. What is meant by protoplast and protoplast culture? Write its importance. (Preboard, 2072)
24. What is meant by mobilization of reserve foods? Write the role of gibberellin in control of mobilization of reserve food in seed during germination of monocot seed. (Preboard, 2072)
25. Describe in brief how herbicides kill plants and how it can be prevented by using transgenic approaches with an example of any one non-selective herbicide. (Preboard, 2072)
26. What is GFP gene? Describe how it works and how it is used in genetic transformation. (Preboard, 2072)

27. Describe in brief about factors that affect the flow of transgenes from GMOs to the environment. What strategies can be taken to reduce the flow of transgenes? (Preboard, 2072)
28. Describe the role of ABA and Gibberellin in transition of embryogenesis and germination. (Preboard)
29. What are the advantages of producing product of economic importance in chloroplast? Describe how poly hydroxyl butyrate (PHB) can be produced in cytosol or chloroplast of plant cell. (Preboard)

Very short questions

1. What is virus-induced gene editing (VIGE)? (Internal, 2079)
2. Name three common sources of contamination in plant tissue culture. (Internal, 2079)
3. What type of plant explant is used to produce virus-free plants? Why? (Internal, 2079)
4. What is the role of shoot meristemless (STM) in meristem maintenance? (Internal, 2079)
5. What is meant by radial patterning? What are the results of radial patterning? (Internal, 2079)
6. Give examples of industrial products and pharmaceuticals extracted from plants. (Preboard, 2077)
7. What are the strategies of plant gene expression? (Preboard, 2077)
8. Mention steps for successful *Agrobacterium* DNA transfer in plants. (Preboard, 2077)
9. Give three examples of chemical agents used for surface sterilization of plant explants. (Preboard, 2077)
10. Draw a labeled diagram of female gametophyte of plant. (Preboard, 2077)
11. What are batch and continuous cultures? (Preboard, 2077)
12. What is somatic hybridization? (Preboard, 2077)
13. Give examples of primary and secondary meristems. (Preboard, 2077)
14. What is meant by macroelement? What are the macroelements needed for plant growth?
15. What are the applications of haploid culture?
16. What is biotransformation? Give one example.
17. What is somaclonal variation? Write its application.
18. What is Ti plasmid? Describe its major components and write their functions.
19. What are reporter and marker genes? Compare the action of two genes.
20. What is cryoprotectant? Where is it used?
21. Write the disadvantages of using plants for molecular pharming.
22. What are the precautions that should be taken if novel products are planned to be produced in plant?
23. Two plant species both flower when exposed to 15 hour light and 9 hour dark cycle. One is short day plant whereas other is long day plant, write how it is possible.
24. What is meant by zone of differentiation? Draw a diagram of root tip showing position of differentiation zone in root tip.
25. What are the characteristics of seedling of plant growing in dark compared to that growing in the light?
26. What is the role of synergid cells in fertilization?
27. Write on the role of cytokinin in different plant tissue culture techniques.
28. What is pH? Write the role of pH in gelling of culture medium.
29. What is meant by organogenesis? Write with examples.
30. What is osmoticum? Write its importance in protoplast culture.
31. What is herbicide resistant marker? Write how it works as selectable marker gene.
32. What is *bar* gene? Write its functions.
33. What are the advantages of plant bombardment in plant genetic transformation?

Immunology

Long questions

1. Explain the mechanism of T-cell receptor DNA rearrangement due to Recombination Signal Sequence (RSS) along with role of enzymes. (Preboard, 2079)
2. What do you understand by precipitation and agglutination reaction? Write about any two immunological techniques based on precipitation reaction. (Preboard, 2079)
3. What do you understand by complement system? What are three major types of complement system? Discuss any one in detail. (Preboard, 2079)
4. Write about process involved in B-cell development with diagrams. (Preboard, 2079)
5. Define *antigens*. Discuss the factors that influence immunogenicity of a molecule. (Internal, 2079)
6. Define *cytokines*. Classify them according to structure and function. (Internal, 2079)
7. Discuss activation and differentiation of B cells. Write in detail about expression of immunoglobulin molecules. (Preboard, 2078)
8. What do you understand by inflammation and inflammatory responses? Discuss how lymphocyte migration is related to inflammatory responses. (Preboard, 2078; Internal, 2072)
9. What do you understand by cell mediated immunity? Discuss about the interaction of T-cell receptor with MHC molecules and antigens. (Preboard, 2078)
10. Discuss the working principle of Fluorescent Activated Cell Sorting. What are its uses and advantages? (Preboard, 2073)
11. Give a detailed structure of spleen. Discuss how it plays an important role in immunity of human body. (Preboard, 2073)
12. Define antigen. What are the characteristics of antigen? How can the efficiency of antigens be improved? (Preboard, 2073)
13. Explain in detail about the role of immunoglobulin genes and the recombination process in generation of antibody diversity. (Preboard, 2073)
14. Define cell mediate immunity. Describe in detail about T cell development. (Preboard, 2073; Internal, 2072)
15. How do you differentiate between receptors of Type I and Type II cytokines? Explain in brief about general mode of signal transduction mediated by these types of cytokine receptors. (Preboard, 2073; Internal, 2072)
16. What do you understand by antibody diversity? What are the various mechanisms by which it can be generated? Discuss any two mechanisms involved with suitable diagrams. (Internal, 2072)
17. Give a brief history of immunology. Discuss various specific and non-specific aspects of defense system in our body. (Internal, 2072)
18. Cross-linkage of bound IgE results in a particular type of hypersensitivity. Identify the type of hypersensitivity and discuss the pathway by which such reactions take place. (Internal, 2072)

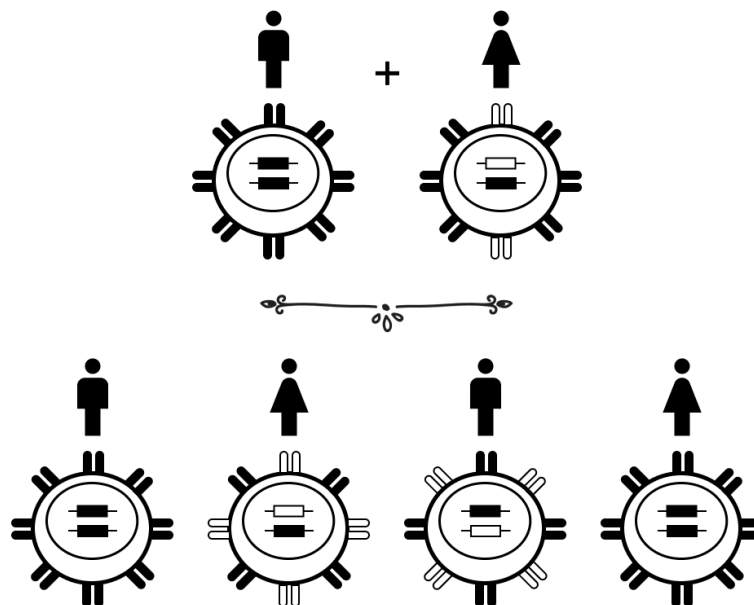
Short questions

1. Write about the invention of Chicken cholera vaccine. (Preboard, 2079)
2. Hen egg white lysosome has conformational (non-sequential) amino acid sequence. Elaborate. (Preboard, 2079)
3. Draw a labeled diagram of lymph node. Write its function and association with immune system. (Preboard, 2079)
4. Write four differences between immunogen and antigen. (Preboard, 2079)
5. State two mechanisms of antibody diversity. (Preboard, 2079)
6. Write six differences between MHCI and MHCII molecules. (Preboard, 2079)
7. Write about immunohistochemistry and immunoblotting. (Preboard, 2079)
8. Write in short about the process of inflammation with a suitable diagram. (Internal, 2079)

9. What do you understand by CDR in terms of an antibody molecule? Draw a labeled diagram of an antibody molecule and explain. (Internal, 2079)
10. Write down the principle involved in immune electrophoresis and explain the procedure with a suitable flowchart. (Preboard, 2078)
11. What is MALT? Describe its anatomy with a labeled diagram. (Preboard, 2078)
12. State the distinct difference between idiotype and isotype with a suitable diagram. (Internal, 2079)
13. Discuss in detail the structure of B cell receptor. (Preboard, 2073)
14. Write down any two advances in immunotechnology. (Preboard, 2073)
15. Define professional antigen presenting cells. Why are they called so? (Preboard, 2073)
16. How do lectin and alternative pathway function in complement system? (Preboard, 2073)
17. Discuss in brief about antibody engineering. (Preboard, 2073)
18. What do you understand about immunogens? (Preboard, 2073)
19. What is the composition and use of adjuvant during immunization? (Internal, 2072)
20. Discuss why most cells can present antigen with MHCI but not with MHCII. (Internal, 2072)
21. Antibody engineering is considered as next generation therapeutics. Justify. (Internal, 2072)
22. What is germinal center activity? Give its importance. (Internal, 2072)
23. Discuss three applications of immunotherapy with examples. (Internal, 2072)
24. Discuss the principle of immunogold technique. (Internal, 2072)
25. What are various types of ELISA? Explain any one with a suitable diagram. (Internal, 2072)
26. How can you relate molecular mimicry and autoimmunity? (Internal, 2072)
27. Food poisoning caused by *Staphylococcus* enterotoxins results in inflammation of intestine. How enterotoxins mediate intestinal inflammation? (Internal, 2072)
28. *Negative selection of T-cells ensures self-tolerance.* Comment on this. (Internal, 2072)

Very short questions

1. Explain the following diagram:



2. State two molecules which fall under Immunoglobulin superfamily. (Internal, 2079)
3. Write two salient features of cytokine TNF. (Internal, 2079)
4. State two differences between humoral and cell-mediated immunity. (Preboard, 2078)
5. State two differences between affinity and avidity. (Preboard, 2078; Internal, 2072)
6. What is adaptive immune response? Write down any two cells associated with it. (Preboard, 2078)

7. State two enzymes involved in ELISA. (Preboard, 2078)
8. Define mitogen. Give one example. (Preboard, 2078)
9. LPS is a mitogen. Define.
10. Define PAMP and PRR with examples.
11. What is the first line of defense in immunology?
12. What do you understand by lymphocyte migration?
13. Define allotype. (Preboard, 2073)
14. Define cytokines. (Preboard, 2073)
15. Write the functional role of IL-15. (Preboard, 2073)
16. How can Interferon γ be used as therapeutic agent against visceral leishmaniasis? (Preboard, 2073)
17. Briefly describe sandwich ELISA. (Preboard, 2073)
18. What is DTH test? (Preboard, 2073)
19. Write about structure of MHC II. (Preboard, 2073)
20. Write about role of thymus in removing auto immune cells. (Preboard, 2073)
21. Write any two uses of dendritic cells. (Preboard, 2073)
22. Write any two functions of bone marrow. (Preboard, 2073)
23. Write about mechanism of immune tolerance. (Preboard, 2073)
24. Write any two uses of immunohistochemistry. (Preboard, 2073)
25. What is superantigen? Draw a labeled diagram.
26. Write a short note on immunoaffinity chromatography.
27. Explain cross reactivity with an example. (Internal, 2072)
28. Define idiotypes. (Internal, 2072)
29. How can you calculate the affinity of a molecule in an Ag-Ab reaction? (Internal, 2072)
30. Write about ligand-receptor pairs involved in T-cell activation. (Internal, 2072)
31. What type of signal is required for T-cell activation? (Internal, 2072)
32. Differentiate between effector and memory T-cell. (Internal, 2072)

Biophysical Chemistry

Long questions

1. Describe the structure of biomolecules on the basis of symmetry. Add a note on application of symmetry and its operations to macromolecules. (Preboard, 2079)
2. Write on symmetry and its types in macromolecules. (Preboard, 2077)
3. Write in detail about IR spectroscopy for biomolecular structure prediction. (Preboard, 2079)
4. Write in brief about Bragg's law. How is it useful in predicting macromolecular structure? (Preboard, 2079)
5. Write in detail about MALDI-TOF mass spectroscopy. In what way is it superior to Electro spray mass spectroscopy? (Preboard, 2079)
6. Briefly describe quaternary structure of proteins emphasizing on symmetry and symmetry elements. (Internal, 2079)
7. Explain briefly on interpretation of small molecules and macromolecular structure by NMR technique. Add notes on 2D NMR for better illustration. (Internal, 2079)
8. How light scattering phenomenon is used in predicting macromolecular structure? Write in short about Raman scattering phenomenon. (Preboard, 2077)
9. Write about X-ray diffraction and how it is useful in predicting macromolecular structure. (Preboard, 2077)
10. How mass spectroscopy is useful in predicting molecular structure? (Preboard, 2077)
11. Describe instrumentation of mass spectroscopy. How do you interpret mass spectrum? (Preboard, 2078)
12. Write in brief about 2D NMR for structure prediction. (Preboard, 2078; for n-propanoic acid, Internal, 2073)
13. *All standard amino acids share common structural features and are grouped into different classes based on their R groups.* Explain with structural formulas of all standard amino acids. (Preboard, 2078)
14. Briefly explain basic components of Scanning Tunneling Microscopy (STM). How do you quantify electron tunneling phenomenon? (Preboard, 2078)
15. Provide hierarchical organization of protein structure with example. How do motifs differ from domains? (5+2.5) (Internal, 2073)

Short questions

1. Write in brief about NOESY. (Preboard, 2079)
2. Write in brief about membrane potential. (Preboard, 2079)
3. Write about Monte Carlo simulation and its uses in biomolecules. (Preboard, 2079)
4. Write the working principle of Scanning Electron Microscopy. (Preboard, 2079)
5. Write the working principle of Tunneling microscopy. (Preboard, 2077)
6. During hydrolysis of a peptide in acidic condition, enthalpy change (ΔH) at 25 °C is +90.2 KJ, entropy change for the process is +50.5 J/K. Is the reaction spontaneous at 25 °C? Is there any possibility to make the process spontaneous at given condition? (Preboard, 2079, 2078)
7. How circular dichroism is helpful in prediction of biomolecular structure? (Internal, 2079)
8. How electro spray mass spectroscopy works? (Internal, 2079)
9. How X-ray diffraction is helpful for predicting macromolecular structure? (Internal, 2079)
10. What is 2D NMR? Explain in brief about COSY. (Preboard, 2077)
11. Write in brief about equilibria and membrane potential. (Preboard, 2077)
12. What is Bragg's law and why is it useful? (Preboard, 2078)
13. What is the use of Ramachandran's map in molecular structure prediction? (Preboard, 2079, for protein 2078)
14. Derive an equation to show the relation between free energy and equilibria. (Preboard, 2078)
15. Write a note on molecular dynamic simulation. (Preboard, 2078; Internal, 2073)
16. What is cooperative binding? Explain in brief its significance in hemoglobin binding to oxygen. (Internal, 2073)

Very short questions

1. How internal energy is interpreted molecularly? (Preboard, 2079)
2. What is Gibb's free energy? (Preboard, 2079)
3. How Raman spectra are generated? (Preboard, 2079)
4. Non-bonding interactions are very important in biological process. Why? (Preboard, 2079)
5. What do you understand by 3D domain swapping? (Preboard, 2079; Internal, 2073)
6. How scanning tunneling microscope works? (Internal, 2079)
7. What is the H^+ concentration in a solution with pH 7.2? (Internal, 2079)
8. What is hydropathy index of an amino acid? (Preboard, 2077)
9. What is entropy? (Preboard, 2077)
10. How IR spectra are generated? (Preboard, 2077)
11. How work is defined in thermodynamics? (Preboard, 2077)
12. How λ_{max} is predicted in UV spectrophotometry?
13. Define domains in a protein. (Preboard, 2078)
14. What do you understand by dihedral symmetry? (Preboard, 2078)
15. What is atomic resolution? (Preboard, 2078; Internal, 2073)
16. Define resting potential of a membrane. (Preboard, 2078)
17. How many particles are there in a unit cell of simple cubic structure? (Preboard, 2078)
18. What is an asymmetric unit? (Internal, 2073)
19. How do you distinguish between inorganic (salt) and biological (protein) crystal? (Internal, 2073)
20. Write two advantages of using 1H NMR over ^{13}C NMR. (Internal, 2073)

Metabolic biochemistry & secondary metabolites

Long questions 7 marks

1. Explain briefly about gluconeogenesis and energetics formed in gluconeogenesis. (Internal, 2079)
2. Describe briefly about urea cycle, formation of glutamate and glutamine disorders of amino acids. (Internal, 2079)
3. What is a cofactor? How would you differentiate it with a coenzyme? Describe briefly the metabolic function of a coenzyme of vitamin K? (Internal, 2079)
4. Explain de-novo synthesis of cholesterol and its regulation. Add a note on cholesterol lowering drugs. (Preboard, 2079)
5. Outline synthesis of purine and pyrimidine, and disorders of metabolism of purine and pyrimidine. (Preboard, 2079)
6. Describe the process of glycogenolysis and write its importance. Add a note on regulation of glycogen metabolism. (Preboard, 2079)
7. Describe in brief about Shikimic acid pathway. Why is this pathway important? (Preboard, 2079)
8. Describe biosynthesis of carbohydrates in rice crop. (Internal, 2072)
9. Write down the mechanism of thiamine pyrophosphate in pyruvate carboxylase enzyme. (Internal, 2072)
10. Explain in detail about β -oxidation of palmitic acid with its energetics. (Preboard, 2078)
11. Describe electron transport chain in eukaryotes. (Preboard, 2078)
12. Describe the pathway by which starch is synthesized in plant. (Preboard, 2073)
13. Explain the process how vitamin B-complex participates in the body. (Preboard, 2073)
14. Describe the process how fats form in plants. (Preboard, 2073)
15. Explain the types of secondary metabolites synthesized by plants. (Preboard, 2073)
16. Describe the process of stearic acid synthesis in plants. (Internal, 2072)
17. Explain the metabolic functions of vitamin B12 in human body. (Internal, 2072)
18. Describe the process of secondary metabolites synthesis. (Internal, 2072)
19. Explain the process of degradation of purine nucleotides. (Internal, 2072)

Short questions 2 marks

1. Write short notes on anaplerotic reactions of TCA cycle. (Internal, 2079)
2. Write two physiological functions of retinol. (Internal, 2079)
3. What do you understand by high energy compounds? Explain with suitable examples. (Internal, 2079)
4. Explain the function of transaminases in catabolism of amino acids with an example. (Internal, 2079)
5. Write short notes on inhibitors and uncouplers of oxidative phosphorylation. (Preboard, 2079)
6. ATP is the cell's storehouse of energy. Where, within the ATP molecule is this energy stored? Where does that energy come from? (Preboard, 2079)
7. How are fatty acids activated and transported into mitochondria during β oxidation? (Preboard, 2079)
8. Name two metabolic disorders of amino acid metabolism and indicate the enzyme defect. (Preboard, 2079)
9. What are the biological activities of terpenes? Explain with examples.
10. Write down the reactions of C4 pathway and its significance. (Internal, 2072)
11. Describe the cofactors derived from Vitamin B6. (Internal, 2072)
12. Differentiate between primary and secondary metabolites. (Internal, 2072)
13. Write short notes on rhodopsin cycle. (Preboard, 2078)
14. Sketch the pathway of Entner-Doudoroff pathway. (Preboard, 2078)
15. Describe the function of epinephrine in carbohydrate metabolism. (Preboard, 2073)
16. Describe the process how fatty acid goes from cytosol to matrix. (Preboard, 2073)

17. Explain the number of ATP produced by acetyl CoA through TCA cycle. (Preboard, 2073)
18. Describe the reactions how phosphoenol pyruvate changes to oxaloacetate. (Preboard, 2073)
19. Explain secondary metabolites of microbial origin. (Preboard, 2073)
20. Describe reactions of pyruvate synthesis. (Preboard, 2073)
21. Describe process of sucrose biosynthesis. (Internal, 2072)
22. Describe the reactions of fates of pyruvate. (Internal, 2072)
23. Explain the structural composition of important secondary metabolites. (Internal, 2072)
24. Describe the functions of glyoxysome in plants. (Internal, 2072)
25. What do you know about metabolic regulation? Explain with examples. (Internal, 2072)

Very short questions 1 mark

1. What is the rate limiting step of pentose phosphate pathway? (Internal, 2079)
2. What is amino acid pool? (Internal, 2079)
3. What is metabolic flux? (Internal, 2079)
4. What is Cori cycle? (Internal, 2079)
5. What is sunshine vitamin? (Internal, 2079)
6. Name two glycolytic pathway intermediates produced by pentose phosphate pathway. (Preboard, 2079)
7. Write a note on ketosis. (Preboard, 2079)
8. Why does a person with chronic liver or chronic renal disease suffer from manifestations of vitamin D deficiency? (Preboard, 2079)
9. What is substrate level phosphorylation? Give three examples. (Preboard, 2079)
10. Mention three different sources and fate of acetyl CoA. (Preboard, 2079)
11. Write short note on von Gierke's disease. (Preboard, 2079)
12. What is photorespiration? (Internal, 2072)
13. Define phytoalexin. (Internal, 2072)
14. Write the structure of UDP glucose. (Internal, 2072)
15. What is ATP cycle? (Preboard, 2078)
16. Write the structure of salicylic acid. (Preboard, 2078)
17. Draw the structure of micelle. (Preboard, 2073)
18. Write the chemical structure of NAD⁺. (Preboard, 2073)
19. Write the structure of fatty acid synthase complex. (Preboard, 2073)
20. Write the functions of ADP-glucose. (Preboard, 2073)
21. Write the function of thermogenin. (Preboard, 2073)
22. What is gluconeogenesis? (Preboard, 2073)
23. Write the structure of fat. (Preboard, 2073)
24. How glucose-6-phosphate changes to fructose-6-phosphate? (Preboard, 2073)
25. What is the energy content of GTP? (Preboard, 2073)
26. Write the structure of ascorbic acid. (Preboard, 2073)
27. Which enzyme converts α -ketoglutarate to succinyl CoA? (Internal, 2072)
28. Write the structure of β -carotene. (Internal, 2072)
29. Write the structure of glycoside. (Internal, 2072)
30. Define alkaloid. (Internal, 2072)
31. What is oxidative phosphorylation? (Internal, 2072)

Bioinformatics

Long questions 7 marks

- Using Needleman- Wunsch algorithm, find the alignment between given pair of sequences:
Sequence 1: ATGCT
Sequence 2: AGCT
Rewards & penalties: match = 1, mismatch = -1, gap = -2 (Pre-board, 2079)
- Describe a method used for RNA secondary structure prediction. Also mention the importance of RNA secondary structure prediction. (5+2) (Pre-board, 2079)
- Define data mining. Illustrate the different steps in data mining. (2+5) (Pre-board, 2079)
- Explain in detail about the general process involved in solving a problem using genetic algorithm. (Pre-board, 2079)
- A researcher is involved in predicting possible small molecule inhibitors against diabetes using Structure based Drug Design (SBDD) but he can't find any possible tertiary structure (3D) of target protein under consideration. How may he be able to prepare the protein tertiary structure (3D) to facilitate his research? Outline and describe the steps in detail. (Internal, 2079)
- A certain genome has both exons and introns. What are other possible features present in the sequence you could use for its gene prediction? Also describe a software/server that can be helpful for gene prediction in this context. (Internal, 2079)
- What is data mining? Explain different data mining methods. (Preboard, 2073; Internal, 2072)
- Define gap penalty and explain how many ways gap penalty can be assigned. (Preboard, 2073)
- How gene prediction is done for prokaryotic and eukaryotic DNA? (Preboard, 2073)
- Construct phylogenetic tree using UPGMA method.

OTU					
OTU	A	B	C	D	E
B	5				
C	4	7			
D	7	10	7		
E	6	9	6	5	8
F	8	11	8	9	8

(Preboard, 2072)

- What do you mean by biological database? How is data mining done? (Preboard, 2072)
- What is homology modeling? How is protein structure predicted for an unknown amino acid sequence by homology modeling? (Preboard, 2072)
- What is multiple sequence alignment? How is multiple sequence alignment done? Write its applications.
- Write about different types of biological databases. (Preboard, 2077)
- Explain different character based phylogenetic tree construction methods. (Preboard, 2077)
- Explain steps followed by BLAST algorithm to find a matching sequence. (Preboard, 2077)

Short questions 2 marks

- Write the applications of phylogenetic analysis (Pre-board, 2079)
- Explain the terms homologous, orthologous, and paralogous with suitable examples (Pre-board, 2079)

3. Discuss in brief about CASP (Pre-board, 2079)
4. Calculate the E-value when a query sequence of 100 residues is aligned to a database containing 10^{12} residues with a p-value for un-gapped HSP region in one of the databases matches of 1^{-20} (Pre-board, 2079)
5. Differentiate between structure-based and ligand-based drug design (Pre-board, 2079)
6. State the differences between structural and functional genomics (Internal, 2079)
7. Write the principle of pyrosequencing with flow-chart. (Internal, 2079)
8. What are the pitfalls/ challenges of Computer-aided Drug Design (CADD)? (Internal, 2079)
9. Write in brief about Computer-aided drug design. (Preboard, 2072)
10. How is secondary structure prediction of RNA done? (Preboard, 2077, 2072)
11. What is BLAST? Explain. (Preboard, 2072)
12. Write the features of FASTA file format with an example. (Preboard, 2077, 2072)
13. Distinguish between s and e value in BLAST. (Preboard, 2077)
14. What are secondary and tertiary protein structure prediction methods? (Preboard, 2077)
15. Discuss alignment score. (Preboard, 2077)
16. What do you mean by data management system? (Preboard, 2073)
17. What are the applications of multiple sequence alignments? (Preboard, 2073)
18. How image analysis is done in microarray? (Preboard, 2073)
19. What do you mean by primary databases? Explain with examples. (Preboard, 2073)
20. Explain the features of gene bank flat file. (Preboard, 2073)
21. Write down the differences between PAM and BLOSUM substitution matrices. (Preboard, 2077; Internal, 2072)
22. List and explain different data retrieval tools. (Internal, 2072)
23. What is QSR? (Internal, 2072)

Very short questions 1 mark

1. Write two applications of bioinformatics (Pre-board, 2079)
2. What is microarray? Write the names of two microarray databases (Pre-board, 2079)
3. Expand OUT and SRS (Pre-board, 2079)
4. What is meant by jackknifing (Pre-board, 2079)
5. What is genome annotation (Pre-board, 2079)
6. Write a code to show the use of *x operator* in PERL (Pre-board, 2079)
7. Who is called the father and mother of bioinformatics? (Internal, 2079)
8. What is gene synteny? (Internal, 2079)
9. Expand WWW and PDB. (Internal, 2079)
10. Write the names of two softwares for protein structure visualization (Internal, 2079)
11. Write a similarity between CATH and SCOP. (Internal, 2079)
12. Define an OTU. (Preboard, 2073)
13. What is a global alignment? (Preboard, 2073)
14. What is Entrez? (Preboard, 2073)
15. What is internet? (Preboard, 2073)
16. Write short note on FASTA file. (Preboard, 2073)
17. Write in brief about ExPASy. (Preboard, 2073)
18. Write in brief about Cn3D. (Preboard, 2072)
19. What is BLOSUM? (Preboard, 2072)
20. Write briefly about PERL. (Preboard, 2072)
21. What is CATH? (Preboard, 2072)
22. What is e-value? (Preboard, 2072)

23. What are protein visualization tools? Give examples. (Preboard, 2077)
24. Expand OMIM, HTTP. (Preboard, 2077)
25. What do the symbols \$, @ and % mean when prefixing a variable? (Preboard, 2077)
26. What is genetic algorithm? (Preboard, 2077)
27. What is MFE? (Internal, 2072)
28. What are the three methods by which you can align a pair of sequences? (Internal, 2072)
29. Who created Atlas of Protein sequences and structures? (Internal, 2072)
30. Expand NCBI, EMBL. (Internal, 2072)

Practical

1. Write the name of software designed by Deepmind which has revolutionized computational prediction of protein 3D folding.
2. Which matrix can be best utilized among PAM1, PAM250, BLOSUM62, and BLOSUM80 for analyzing evolutionary divergence between any five species in consideration?
3. What is the role of bioinformatics in genome sequencing?
4. You are comparing a DNA query with proteins in a specific database. Which method of BLAST are you using?