**M.Sc. Examination, 2019**
**Semester-III**
**Biotechnology**
**Course : XI**
**(Genetic Engineering)**

311

**Time : 3 Hours** **Full Marks : 40**

**Questions are of value as indicated in the margin**

1. Answer the following : 5×2=10
   a) Name the scientist who won Nobel prize for predicting the existence of restriction enzymes in bacteria. Name one scientist who won Nobel prize for showing the presence of restriction enzymes in bacteria.
   b) What is a Klenow fragment? How is it obtained?
   c) State two major differences between transformation and transfection.
   d) What is a palindrome? Give example?
   e) What is a restriction map?

2. a) What is a plasmid?
   b) Draw, with proper labeling, the structure of a typical bacterial plasmid?
   c) How can you convert a typical eukaryotic plasmid into an expression vector and a secretion vector?
   d) What is a shuttle vector?
   e) How can you convert a low copy plasmid into a multicopy one? 2+2+2+2+2=10

3. You want to clone a gene from a eukaryote in *E. coli*. Write, with suitable diagrams, the procedure for a) isolation of its mRNA, b) synthesis of its cDNA, and c) identification of the clone containing the gene in a *E. coli* plasmid vector. 3+4+3=10

4. a) Why is it necessary to label DNA for some molecular biology experiments?
   b) Why non-radioactive methods are preferable over radioactive methods of labeling DNA? – give two most important reasons.
   c) What is the major advantage of using random primers for DNA labeling?
   d) Briefly describe the procedure of a non-radioactive method of labeling DNA. 2+2+2+4=10

5. a) Briefly explain with a suitable diagram the principles of PCR technique.
   b) Briefly discuss the protocol of a typical PCR experiment. Briefly write about the applications of PCR technique. 3+3+4=10

6. Write short notes : 2½ ×4=10
   a) Southern Blotting b) Gene Editting c) Gene Silencing d) Real time PCR

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Use separate answer script for each group

312

**M.Sc. Examination, 2019**
**Semester-III**
**Biotechnology**
**Course : XII**
**(Animal and Plant Biotechnology)**

**Time : 3 Hours** **Full Marks : 40**

**Questions are of value as indicated in the margin**

## Group – A (Marks : 20)
## (Animal Biotechnology

Answer **any two** questions 10 ×2=20

1. a) What are the most important and common supplements used in the basal media for culturing animal cells?
   b) Suppose you have to set up a cell culture experiment with RAW264.7 cells. You need to plate cells in 5 experimental groups, each having triplicate wells and $2\times10^5$ cells per well. Your stock T25 flasks are having $3\times10^6$ cells per flask, which after harvesting gives 80% viability. If you retrieve all the cells of one T25 flask in 1 mL, what is the volume in (μL) of cells from this stock you need to plate per well for the experiment? What is the total minimum number of cells you must have in your stock to start with?
   c) Illustrate the general features of Advenoviral vectors. Briefly explain the selection system of recombinant baculoviral vectors. 1+4+(2+3)=10

2. a) Explain the strategies for generating transgenic mammalian animals.
   b) What are the distinctive features of the ova of Sea-urchin and Mammals? Mention different types of cleavages with examples. 4+(2+4)=10

3. Write short notes : 2½×4=10
   a) Biosafety cabinet
   b) P elements
   c) CRISPR/Cas9 in genome editing
   f) Role of Resact

## Group- B (Marks : 20)
## Plant Biotechnology

Answer **any two** questions 10 ×2=10

1. Comment on the following statements
   a)Murasighe and Skoog medium is one of the most popular basal medium used for plant tissue culture.
   b) *Agrobacterium* is a natural genetic engineer.
   c) Molecular marker technology is one of the most commonly used techniques for plant varietal identification.

P.T.O.

d) Direct gene transfer has some advantages over *Agrobacterium* mediated gene transfer in plant system.

e) RAPD and RFLP are structure marker whereas mi RNA based markers are functional markers. 2×5=10

2. How do different stresses affect the normal activity of crop plants? What are the common genes used for development of stress tolerant transgenic crops? Give the list of genes, gene constructs and respective activity in target plants with reference to common abiotic stresses in common crops. 2+2+6=10

3. What is anti-sense technology? How this technology has been used for development of "Calgen's flavr-savr tomato". Give a detailed description on the source and gene construct of the different targeting genes used for development of golden rice-I and I What are the reasons for which this technology was restricted only within laboratory instead of reaching to farmer's land successfully? 1+3+4+2=10

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Use separate answer script for each group

314

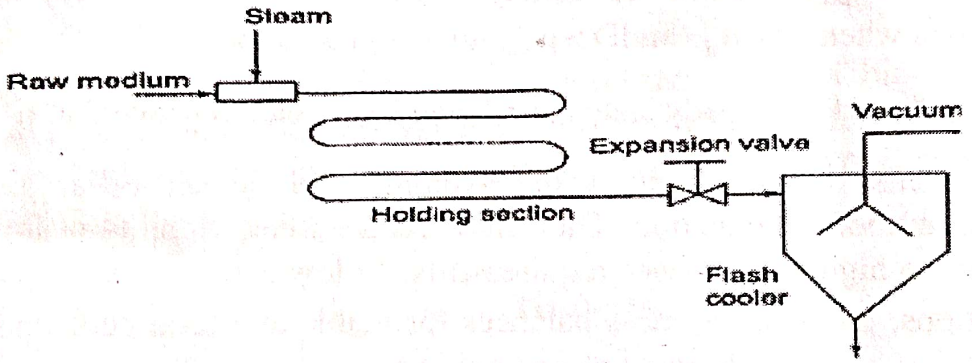
**M.Sc. Examination, 2019**
**Semester-III**
**Biotechnology**
**Course : XIII**
**(Bioprocess Engineering and Technology, Bioentrepreneurship)**

**Time : 3 Hours** **Full Marks : 40**

**Questions are of value as indicated in the margin**

**Group – A (Bioprocess engineering and Technology)**
Answer **any three** questions 10×3=30
[Note: Assume whatever it takes to answer the following questions]

1. a) What does the following schematic diagram represent? Indicate the "HTST" conditions with respect to this diagram. What is the generalized form of the design equation of a heating or cooling coil as shown in the diagram? Define each term in it. When is $\Delta T_{AMTD}$ used in place of $\Delta T_{LMTD}$ in the design equation? 3




b) Mathematically present the design equation of a batch medium sterilizer, while defining the degree of sterilization or Nabla ($\nabla$) factor. 2

c) How is air sterilized in a fermenter? What is $L_{90}$ value in case of air sterilization? 2

A 20 $m^3$ fermenter was provided with sterile air at a flow rate of 10 $m^3$ $min^{-1}$ for a fermentation process lasting 100 h. The following data were given: (i) Optimum linear air velocity =0.15 $ms^{-1}$; (ii) Filtration constant (k) = 1.535 $cm^{-1}$; (iii) the air in the fermentation pilot plant contained 200 cells $m^{-3}$ and acceptable degree of contamination was 1 in 1000 cells filtered ($N = 10^{-3}$). Solve the problem to pick the closest possible dimensions of the air filter in terms of length and radius from the choices given.

(A)Depth = 4.5 cm and radius = 0.15 m (B) Depth = 15 cm and radius = 0.6 m
(C) Depth = 15 cm and radius = 0.15 m (D) Depth = 45 cm and radius = 0.15 m

2. a) What is referred to as '*plasmid instability*' in bioreactors during mass production of recombinant protein? 1

b) Genetically engineered CHO cells were used to produce recombinant Erythropoietin (EPO) in a 10 kL fermenter. The probability of plasmid loss per generation was

P.T.O.

$1\times10^{-3}$. The specific growth rates of plasmid minus and plasmid plus cells were 0.95 $h^{-1}$ and 0.70 $h^{-1}$ respectively. Assume that the seed culture contained plasmid bearing cells only.

The model that describes plasmid loss in batch culture after 'n' generations is as follows: $f = \frac{1-\alpha-p}{1-\alpha-2^{n(\alpha+p-1)}\cdot p}$,

wherein, $f$ is the fraction of plasmid carrying cells after 'n' generations in a batch culture, $\alpha$ is the ratio of the specific growth rate of the plasmid free to that of plasmid bearing cells and p is the probability of plasmid loss per cell division. Assume that all the plasmid-bearing cells are identical in growth rates, plasmid copy number and probability of plasmid loss. Determine the fraction of plasmid-free cells after 24h of growth.

c) Draw the profiles of steady state biomass, substrate and product concentrations versus dilution rate (D) in a chemostat and indicate the point of complete cell wash out. Summarize the values of steady state biomass, substrate and product concentrations when $D < \mu_{max}$ and $D > \mu_{max}$ in a tabulated form. 2+2=4

d) In a chemostat, perform steady state mass balance on cells to prove that $\mu = D$. 2

3. a) Hybridoma cells, fusion products of myeloma and spleen cells, are used for monoclonal antibody production. They show reduced cell viability at lower dilution rates (D) due to high maintenance requirements. At low cell viabilities, $\mu \neq D$. Under these situations, perform the mass balances for viable and total cells and prove that the cell viability, $\left(\frac{n_V}{N_T}\right)_{ss}$ at steady state depends on growth, death and dilution rates.

2

b) Briefly describe the dynamic method of determination of the volumetric mass (oxygen) transfer coefficient, $K_1a$ in an aerated frementer with respiring culture?

c) What are the most widely accepted process scale up criteria? 1

d) Considering the effect of external mass transfer on ImE catalyzed reaction, define the following terms: (i) Damkohler Number (Da) & (ii) Effectiveness factor ($\eta$). Show that the effectiveness factor approaches unity when Da <<1. 1+1=2

e) In order to achieve 75% substrate conversion, evaluate the length of a plug flow reactor, which is continuously fed with lipid from *Chlorella vulgaris* at 1 M concentration and at a flow rate 1 L $min^{-1}$. The reactor has a cross sectional area of 0.1 $m^2$ with its 51% volume being occupied by the immobilized lipase. The kinetic constants are as follows : $V_{Mas}$= 10 mM $min._1$ and $K_M$ = 100 mM. 3

4. a) Define Sigma factor as a performance index for centrifuges of different sizes. 1

b) Determine the throughput (in $L.h^{-1}$) of a tubular continuous centrifuge with a length to outer diameter ($L/d_0$) ratio of 10:1, if the thickness of broth layer in the centrifuge

is(0.1 x outer diameter); length of bowl =750 mm; $\omega = 650\ s^{-1}$; $\Delta\rho = 50\ kg\ m^{-3}$; $\mu = 2$ mPa; and $D_p = 10\ \mu m$. 3

c) What is called a TFF or CFF system? What is its single major advantage over the traditional dead-end system of filtration? 1

d) What is the elementary transport equation describing electrophoresis. 1

e) A pilot scale gel filtration chromatography column packed with Sephacryl resin is used to separate two recombinant proteins, GCSF and EPO. The column is 6 cm in diameter and 0.4 m in height with a void volume of $2\times10^{-4}\ m^3$. The water regain value of the gel is $5\times10^{-3}\ m^3\ Kg^{-1}$ dry Sephacryl; density of the wet gel is $1.5\times10^{3}$ Kg $m^{-3}$. The partition coefficient for GCSF is 0.4 and that for EPO is 0.25. If the eluant flow rate is 750 ml $h^{-1}$,, what is the retention time for each protein? 4

5. What are single cell proteins? How are they produced? Name four microbes that are used to produce single cell proteins. Write two advantages and disadvantages of using single cell proteins. 2+2+2+2+2=10

6. What are biofertilizers? Mention two important types of biofertilizers. What are the advantages of biofertilizers over general chemical based fertilizers? Briefly discuss the mass production of one of the biofertilizers. Name two carrier materials used for biofertilizer formulation. 2+1+3+3+1=10

## Group- B

Answer **any one** question 1×10=10

1. Why do most startup companies fail? Briefly describe what can be done to prevent the failures. Discuss the reasons for the success of any one biotechnology farm in India. 3+4+3=10

2. Write short notes 2½ ×4=10

a) Limited liability partnerships

b) Business opportunity

c) Team building

d) Environment scanning

Use separate answer script for each group

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**M.Sc. Examination, 2019**
**Semester-III**
**Biotechnology**
**Course : XIV**
**(Ecology, Environmental Biotechnology and Emerging Technologies)**

**Time : 3 Hours** **Full Marks : 40**

**Questions are of value as indicated in the margin**

## Group – A (Marks : 20)
## (Ecology, Environmental Biotechnology)

Answer **any two** questions 2 ×10=20

1. a) Distinguish between fundamental and realized niche.
   b) Explain logistic equation of population growth.
   c) Explain competitive exclusion principle.
   d) Elucidate the relationship between primary and secondary productivity with examples. 2½ ×4=10

2. a) Write short notes
   i) Ozone depletion ii) Biological Oxygen Demand
   b) Describe the detrimental effects of surfactants, pesticide and heavy metals on environment. (2½ ×2)+5=10

3. a) What is biogas? Discuss the steps of biogas formation from biomass.
   b) What is Phytoremediation? Discuss various approaches of phytoremediation in controlling water pollution. (1+4)+(1+4)=10

## Group- B (Marks : 20)
## Emerging Technologies

Answer **any two** questions 10 ×2=10

1. Compare hard and soft ionization. Differentiate between EI and MALDI. Write down the empirical rules for the nuclear spin quantum number. Write comparative notes on SEM and TEM. 2+2+2+4=10

2. Give a basic schematic structure of a flowcytometer. Write down the types of filters used in flowcytometer and its principle of work. Define ADC in flowcytometry. Describe compensation in flowcytometry. 3+3+1+3=10

3. Describe the following : 2½ ×4=10
   a) IR in biomedical research
   b) Fluorescence Lifetime imaging microscopy
   c) Atomic force microscope
   d) Next Gen Sequencing

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M.Sc. Semester III

Practical Examination-2019

Paper XV (Genetic Engineering, Animal and Plant Biotechnology)

**Time-6 hours X 2 days** **Full marks: 80**

1.a) Write down in your answer script a protocol for amplifying a DNA fragment with a melting temperature of 60°C by PCR technique using Taq polymarase. Program the thermal cycler machine for executing this protocol with an extension time of 15 seconds, save your program & demonstrate it to the examiner. **(5 + 10 = 15)**

b) Digest the Lambda genomic DNA sample provided to you with the restriction enzyme EcoRI provided. Run the agarose gel provided and show the examiner the result. **(5)**

2. a) From the given sample of HepG2 cells, count the cells and find out the concentration. From these cells give a passage in a well of culture plate in such a way so that $5X10^4$ cells are seeded in 2 ml of culture. Show the detailed calculation to make the passage.

**(3+5+4=12)**

b) From the given cell samples A and B, find out the viability % of "B" with respect to "A" using MTT assay mentioning the following steps: perform the assay, take reading using proper technique and show the calculation.

**(4+2+2=8)**

3. a) Prepare somatic plant explants from the supplied specimen "P-1". Inoculate the prepared explants in supplied medium (M-1) following the standard protocol. Write down the principal, procedure and the necessary precaution of the whole procedure. Demonstrate the whole procedure in presence of examiner and leave your preparation with proper marking with your roll number.

**(3+2+2+2+1 =10)**

b) The supplied sample is a plant reproductive tissue "P-2". Inoculate the prepared explants in supplied medium (M-2) following the standard protocol. Write down the principal, procedure and necessary precaution of the whole procedure. Demonstrate the whole procedure in presence of examiner and leave your preparation with proper marking with your roll number.

**(3+2+2+2+1 =10)**

4. Viva-voce **10**

5. Practical record copy: **10**

**M.Sc. Examination 2020**
**Semester III**
**Biotechnology**
**(Course XI: Genetic Engineering)**

**Time: 3 hours** **Full Marks: 40**

**Questions are of values as indicated in the margin. Write answers in your own handwriting**

**Answer any four questions**

1. What are restriction enzymes? Draw the structure of a typical eukaryotic expression vector with proper labeling (No description necessary). Briefly describe with suitable diagrams, the principles of one non-radioactive DNA labeling and detection method routinely used in genetic engineering experiments. State four precautions you will adopt while isolating mRNA from the cells of an organism. **2 + 2 + (2+2) + 2 = 10**

2. Describe the process of cloning of an eukaryotic gene, stepwise as instructed below: a) Draw a schematic and labeled diagram (no description necessary) showing the synthesis of total cDNAs from the total mRNAs isolated from the relevant cells of this organism; b) briefly discuss, with figures wherever necessary, how you will clone the population of cDNAs you synthesized in the previous step into a suitable plasmid vector; c) Briefly discuss, following transformation into a bacterial host, how you will identify a specific colony containing the recombinant vector having the gene of your interest using i) colony hybridization, ii) PCR technique. Assume that the sequence of the gene is known and you have access to oligonucleotide primers specific for your desired gene. **3 + 3 + (2+2) = 10**

3. State why gene libraries are constructed? Briefly explain the specific reason when a genomic library or a cDNA library is made. With the help of suitable diagrams explain the principles of dideoxy sequencing method of Sanger. What is the most important drawback of Maxam-Gilbert's method of DNA sequencing over that of Sanger's method? State one important advantage of Maxam-Gilbert's method over that of Sanger's method of DNA sequencing. **1 + 2 + 5 + 1 + 1 = 10**

4. Briefly describe, with the help of suitably labeled diagrams, the principles of PCR method of amplifying a DNA sample. Briefly discuss various applications of PCR technique in biomedical sciences. **4 + 6 = 10**

5. Explain what is heterologous gene expression? What is a His-tagged recombinant protein? How is it made? State in bulleted form how a His-tagged protein can be purified using affinity purification method. What are inclusion bodies? How to reduce the formation of inclusion bodies during expression of heterologous gene in a bacterial host. Briefly state in bulleted format how you can optimize the expression of a gene in a bacterial host. **2 + 1 + 1 + 2 + 1 + 1 + 2 = 10**

6. Write short notes on any two: **2 x 5 = 10**

a) Oligonucleotide synthesis using phosphoramidites b) Northern Blotting c) Cosmids

**M.Sc. Examination 2020**
**Semester III**
**Biotechnology**
**(Course XII: Animal & Plant Biotechnology)**

**Time: 3 hours** **Full Marks: 40**

**Questions are of values as indicated in the margin. Write answers in your own handwriting. Answer two questions from each group. Use separate answer scripts for each group**

## Group A: Animal Biotechnology

Answer *any two* of the followings 2 x 10 = 20

1. What are Balanced salt solution, Basal medium and Supplemented medium? What is the role of FBS in animal cell culture? What are the general properties of a cell line? State the rationale behind using MTT assay as a viability assessment of cells. 3+2+2+3 = 10

2. a) What is the type of cleavage occurring in isolecithal eggs? Illustrate the different subtypes of this cleavage pattern. b) How is the Cre-loxP system applied for transgene expression via inversion using double floxing? 1 + 4 + 5 =10

3. Write Short notes on *any four* of the followings: 2½ × 4 = 10
   a) Somatic cell nuclear transfer
   b) Potency of stem cells
   c) Yamanaka factors
   d) Role of Resact
   e) Fate map in vertebrates
   f) Class II Biosafety cabinet

## Group B: Plant Biotechnology

Answer *any two* of the followings 2 x 10 = 20

1. Define the term "Organogenesis" in plant tissue culture. How direct organogenesis differ from indirect one? What are the common methodologies used for isolation of plant protoplast? How somatic hybrid differ from normal regular hybrid? What is the common procedure for development of somatic hybrid? What is synthetic seed?
   1+1+3+1+3+1=10

2. Comment on the strategies for development of following transgenic crops with their importance 2.5 x 4 = 10
   I. C4 rice
   II. Golden rice
   III. High Iron rice
   IV. Calgen's Flavr-savr tomato

3. Describe disease triangle. Can this triangle be four sided? Explain the Zig-Zag model of plant pathogen interaction. Give brief notes on PR protein and Plant R genes.
   1+2+3+2+2=10

**M.Sc. Examination 2020**
**Semester III**
**Biotechnology**

**(Course XIII: Bioprocess Technology & Bioentrepreneurship)**

**Time: 3 hours** **Full Marks: 40**

**Questions are of values as indicated in the margin. Write answers in your own handwriting. Answer three questions from group A and one question from Group B. Use separate answer scripts for each group**

**Group A: Bioprocess Engineering and Technology**

Answer any three questions **[3 x 10 = 30]**

[**Note:** Assume whatever it takes to answer the following questions]

**Q.1. (a)** Draw the time versus temperature profile of a batch sterilization medium. Define decimal reduction time. **[1+1 = 2]**

**(b)** What is degree of sterilization or ∇ Factor? A fermentation medium initially contained $10^{11}$ viable microorganisms. On sterilization, the risk of contamination was found to be 1 in 1000 i.e., the final count = $10^{-3}$. Evaluate $\nabla_{Overall}$. **[1 + 2]**

**(c)** It is desired to supply sterile air to a 50 L fermenter at a flow rate of 10 $m^3$ $min^{-1}$ for 100 h. Determine the length (L) of the membrane based air-filter if optimum linear air velocity is 0.15 m $s^{-1}$ and filtration constant (k) = 1.54 $cm^{-1}$. Fermentation pilot plant air contained 200 microbial cells $m^{-3}$ and acceptable degree of contamination was $10^{-3}$. **[3]**

**(d)** From the following growth equation, $\ln x = \ln x_0 + \mu t$, determine doubling time ($t_D$). **[2]**

**Q.2. (a)** A recombinant plasmid containing strain of *Pichia pastoris* was used to produce r-GMCSF in a 200 L fermenter. The probability of plasmid loss per generation is 0.005. The specific growth rates of plasmid free and plasmid bearing cells are 1.4 $h^{-1}$ and 1.2 $h^{-1}$ respectively. Assuming that inoculum contains plasmid bearing cells only. The model that describes plasmid loss in batch culture after n generations is as follows:

$$f = \frac{1-\alpha-p}{1-\alpha-2^{n(\alpha+p-1)}.p},$$

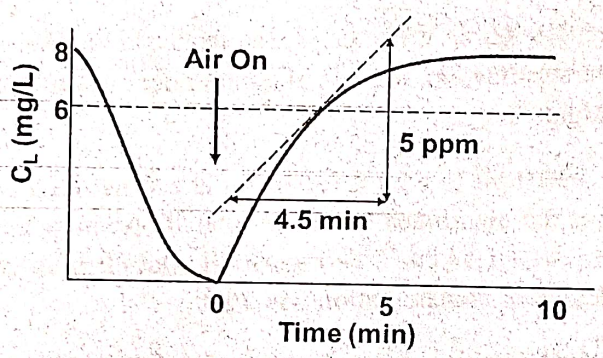
wherein, $f$ is the fraction of plasmid carrying cells after 'n' generations in a batch culture, $\alpha$ is the ratio of the specific growth rate of the plasmid free to that of plasmid bearing cells and p is the probability of plasmid loss per cell division. Assume that all the plasmid-bearing cells are identical in growth rates, plasmid copy number and probability of plasmid loss. Determine the fraction of plasmid-bearing cells after 18 h of growth. **[4]**

**(b)** A fed-batch culture was set up with intermittent addition of glucose solution. Determine initial volume and maximum biomass concentration if the following parameters at quasi-steady state (QSS) have the following values at t = 2 h. **[2]**

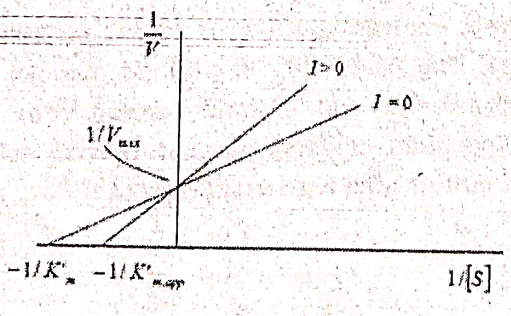
$V = 1$ L, $F = 200$ ml/h, $S_0 = 100$ g/L, $K_S = 0.1$ g/L, $Y_{X/S} = 0.5$ g/g, $X_0 = 30$ g, $\mu_m = 0.3$ $h^{-1}$

**(c)** Perform steady state mass balance on cells in a chemostat to prove that $\mu = D$. **[2]**

**(d)** Determine oxygen transfer rate (OTR) at 6 mg/L (ppm) DO concentration. **[2]**




**Q.3. (a)** From the following Lineweaver-Burk plot of $1/V$ vs. $1/[S]$, identify the type of enzyme inhibition. Give an example of such inhibition. What is Eadie Hofstee Plot? **[3]**




**(b)** An immobilized enzyme plug flow reactor was continuously fed with 1 M starch solution at a flow rate of 1 L $min^{-1}$. The reactor has a cross sectional area of 0.1 $m^2$ with its 50% volume

being occupied by immobilized α-amylase. The kinetic constants are as follows: $V_{Max}$ = 10 mM $min^{-1}$ and $K_M$ = 100 mM. Evaluate the length of the PFR to achieve 50% substrate conversion [3]

**(c)** Define RCF in a centrifuge. What is the applied centrifugal field at a point equivalent to 5 cm from the center of rotation and an angular velocity of 3000 radian/sec? [2]

**(d)** Draw a process flow chart for manufacturing any biotech product of your choice. [2]

**Q.4.** (a)What are single cell proteins (SCP)? (b) State the general steps involved in the production of SCP. (c) State two advantages and disadvantages of SCP. (d) State some of the applications of SCP. (e)What is biofuel? Briefly discuss the role of microalgae in biofuel production. **[1+2+2+1+1+3=10]**

## Group B: Bioentrepreneurship

Answer any one question **[10 x 1 = 10]**

Q.1. What do you mean by a business plan? Explain its importance. What are the essential components of a Biotech Business Plan? **[2 + 2 + 6 = 10]**

Q.2. Write short notes: **[4 x 2.5 = 10]**

(a) Organizational building

(b) Due diligence

(c) Bootstrapping

(d) Methods of technology transfer

**M.Sc. Examination 2020**
**Semester III**
**Biotechnology**
**(Course XIV: Ecology, Environmental Biotechnology and Emerging technologies)**

**Time: 3 hours** **Full Marks: 40**

**Questions are of values as indicated in the margin. Write answers in your own handwriting. Answer two questions from each group. Use separate answer scripts for each group**

## Group A: Ecology, Environmental Biotechnology

Answer *any two* of the following 2 x 10 = 20

1. a) Illustrate graphically the intrinsic rate of natural increase of a population. Explain with proper equation how it is modified in case of intraspecific competition in a population with continuous breeding.

   b) Justify the following two statements:

   i) Niche is considered as an 'n-dimentional hypervolume'.

   ii) When GPP exceeds RE, the ecosystem acts a Carbon sink.

   (1+4)+(2.5+2.5)=10

2. a) What are the common sources for water and air pollution in environment? What do you mean by the phenomenon "Green house effect".

   b) What do you understand by vermiculturing? Describe briefly the optimum factors for vermiculturing. (1.5+1.5+2)+(1+4)=10

3. What are the different steps of waste water treatment? Elaborate the primary step. Define bioremediation and discuss about the factors influencing it. Compare ex-situ and in-situ bioremediation. 2+3+1+2+2=10

## Group B: Emerging technologies

Answer *any two* of the following 2 x 10 = 20

4. Sketch and describe the basic components of a mass spectrophotometer. How m/z ratio related with TOF. Compare hard and soft ionization. Differentiate between EI and MALDI. 2.5+2.5+2.5+2.5=10

5. Write down the types of filters used in flowcytometer and its principles of work. Define ADC in flowcytometry. Describe the compensation in flowcytometry. Describe the principle of sorting in flowcytometry. 3+1+3+3=10

6. Write brief notes on any two of the following: 2 x 5 = 10

   a) Real Time PCR in Biotechnology
   b) Biosensors
   c) Scanning Electron Microscope

**M.Sc. Examination 2020**
**Odd Semester (Semester III)**
**Biotechnology**
**(Course XV: Laboratory- III)**
**(Genetic Engineering, Animal and Plant Biotechnology)**

**Questions are of values as indicated in the margin. Answer all questions. Write answers to the questions, as applicable, in your own handwriting.**

**Time : 6 Hours** **Full marks = 80**

**Q. 1. Group Genetic Engineering** **[20]**

i) Why ethanol precipitates nucleic acids from aqueous solutions containing salts like NaCl? What is the chemical nature of agarose? How do you remove ethidium bromide from nucleic acids stained with it? [2+1+2=5]

ii) Draw a clean, schematic and labeled diagram of a Southern transfer set up. No description necessary. [5]

iii) Explain the principles of Blue-White colony selection method used for the identification of cloned genes. [5]

iv) Briefly explain, with the help of suitably labeled diagrams, the principles of a non-radioactive method of DNA labeling and detection. [5]

**Q.2. Group Animal Biotechnology** **[20]**

a) What are the fundamental requirements of culturing mammalian cells? What are the methods of maintaining a running animal cell culture free of contaminations?

b) You have stock of cultured cells at an amount of $1\times10^6$ cells per flask having 80% viability. You have to set up cells for 5 experimental groups, each in triplicate, and $2\times10^5$ cells per well. At least how many stock flasks do you need for setting up the experiment? If you harvest and resuspend all the stock cells in 1 mL culture medium, what is the volume (in µL) of cells from this stock you need to plate per well for the experiment?

c) What are the factors responsible for achieving good transfection efficiency?

d) You have four different 293T cell cultures with different percentages of confluence – (A) 100%, (B) 90%, (C) 75%, (D) 20%. The cells are transfected maintaining same experimental conditions by Calcium phosphate method. Arrange the cultures according to the increasing level of transfection efficiency. Give reasons for your arrangement.

e) Calculate the transfection efficiency of the sample images given in the attached file.

[3+3]+4+2+5+3 = [20]

**Q.3. Group Plant Biotechnology** [20]

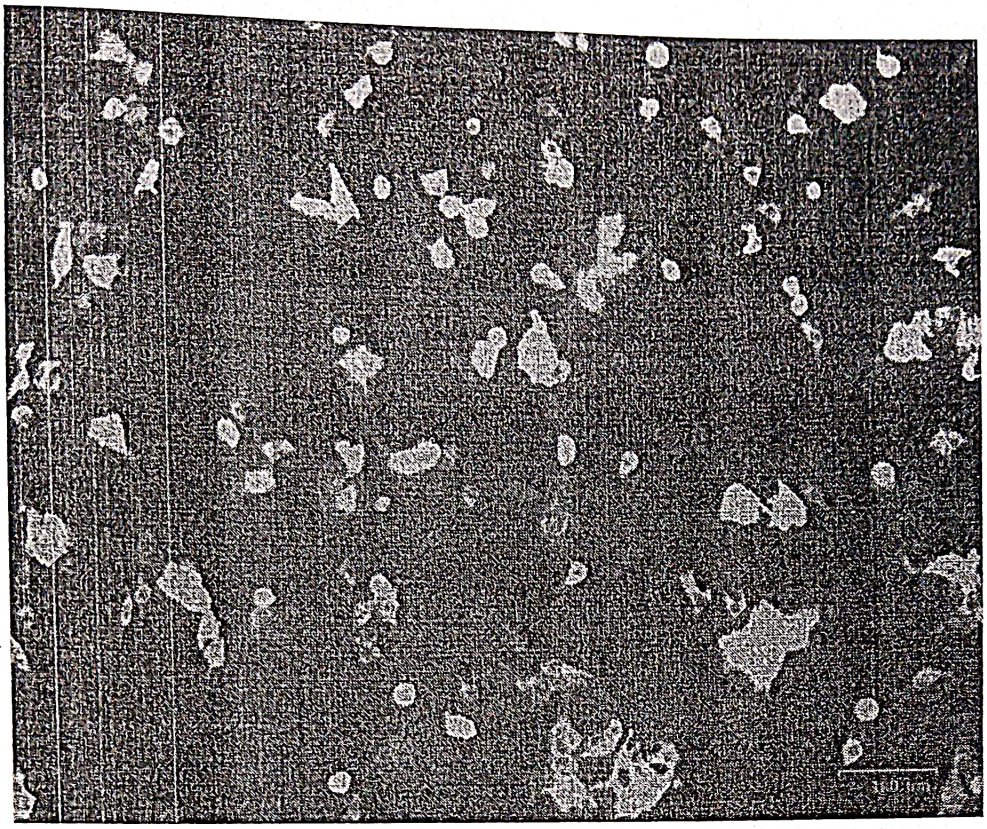
Briefly describe the principle, methodology and precaution of the allotted plant tissue culture experiment (given in the attached file) in details . [5+10+5=20]

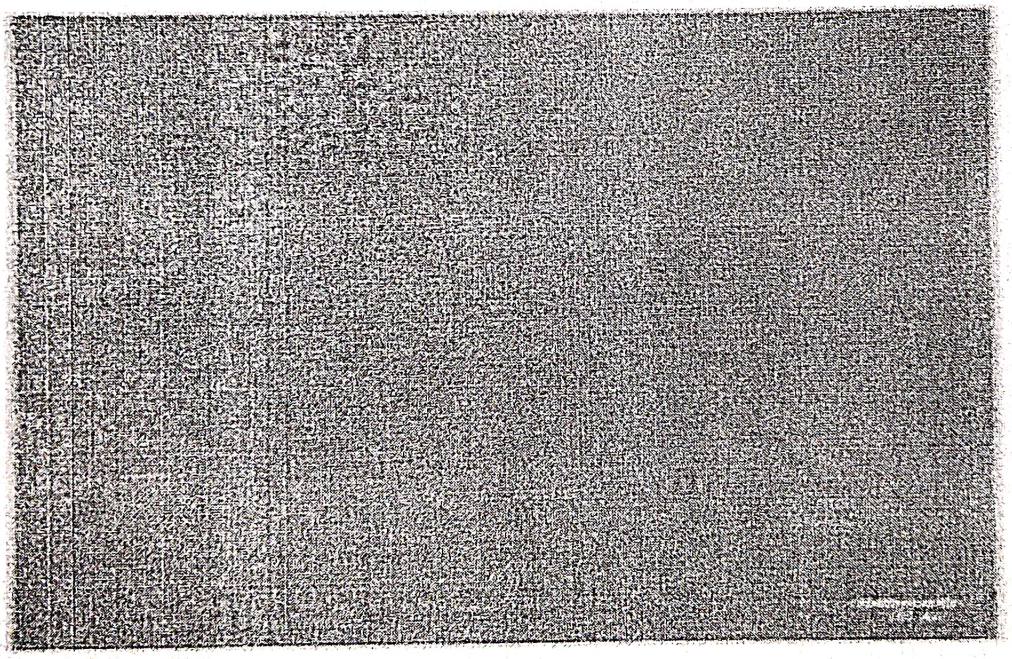
**Q. 4. Viva- Voce** [20]

Viva-Voce will be conducted by online mode through google meet system at the address: meet.google.com/awp-robz-nnj You will be instructed over phone individually to join for the online viva examination to the above mentioned link while your written examination is continuing.

Set -1

Q : 2e (T1)





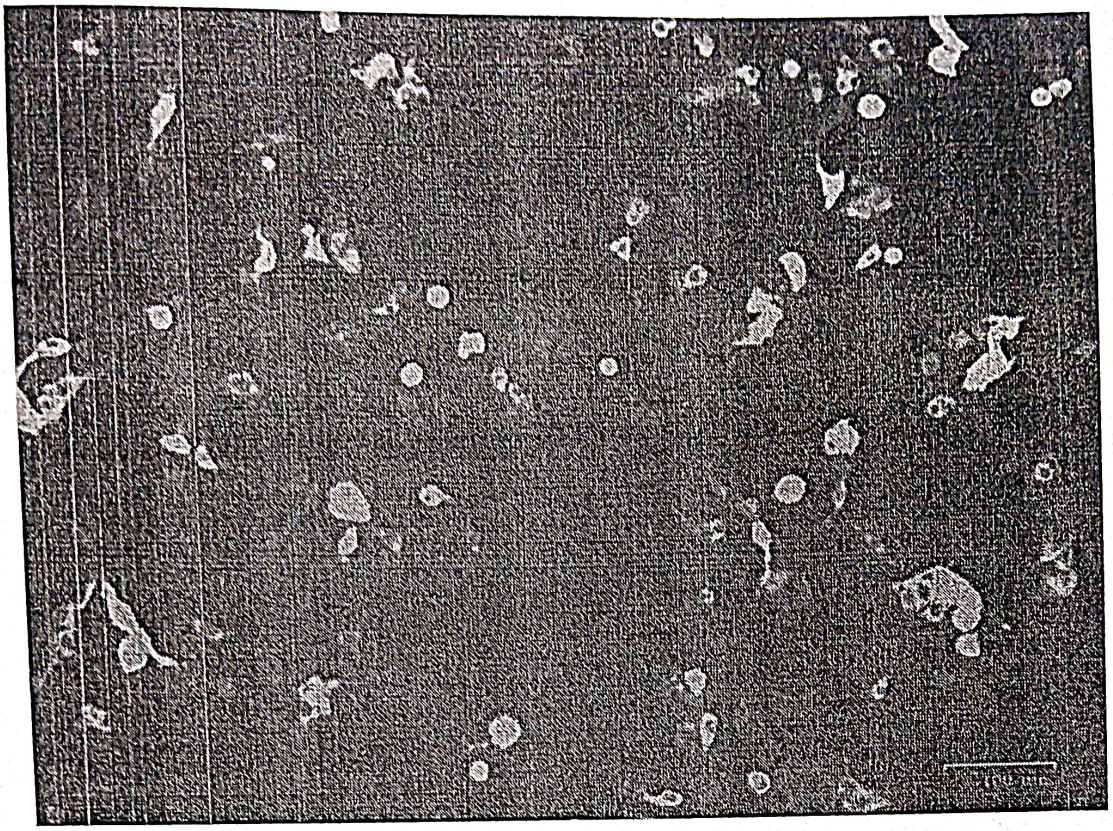
15/2/21

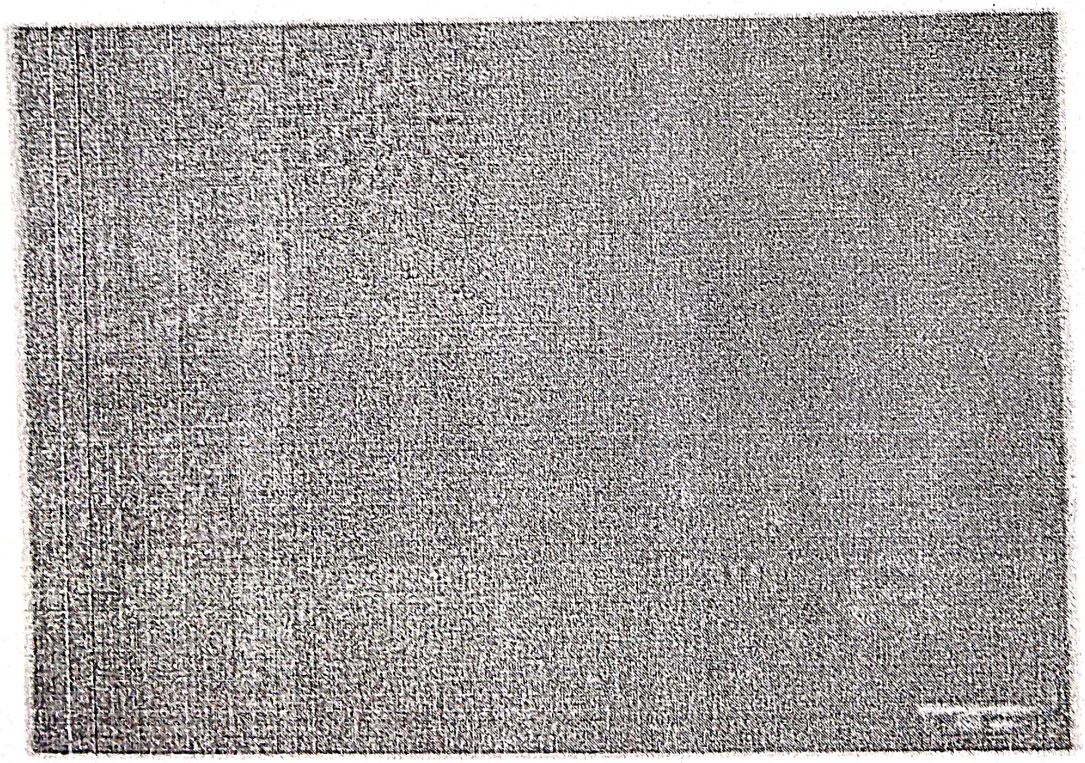
**Q.3** Experiment and Sample- "Meristem tip culture in Strawberry plant".

15/02/21

Q : 2e (T2)

Set- 2

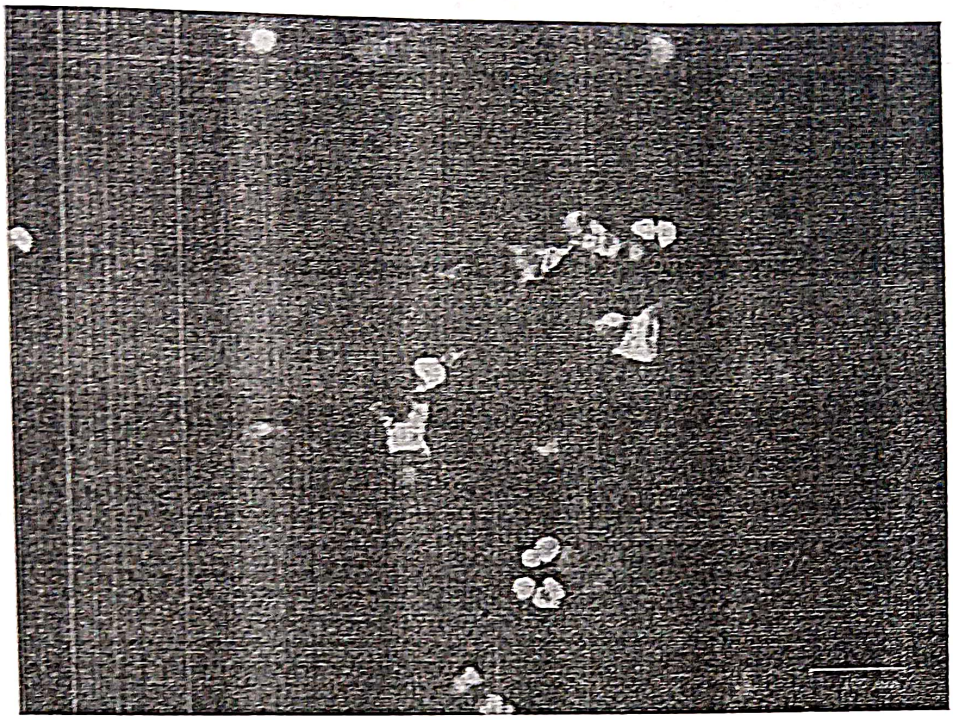


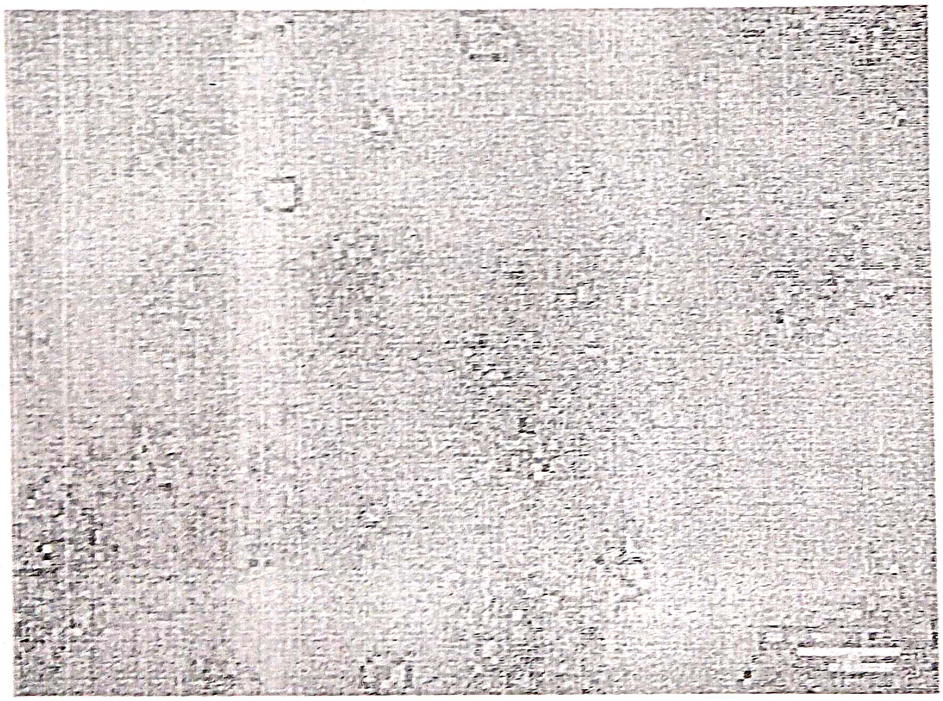


**Q.3.** Experiment and sample: Node culture in grass plant.

Q : 2e (T3)

Set-3





**Q.3.** Experiment and sample: Embryo culture in rice plant.

15/2/21

15/2/21

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# M.Sc. Examination 2022
## Semester III
## Biotechnology
## Core Course - XI
## (Genetic Engineering)

**Time: 3 hours** **Full Marks: 40**

**Questions are of value as indicated in the margin**

**Answer any four questions**

1. With suitable diagram/s, briefly explain the mechanisms of DNA methylation in *E. coli*. Draw the schematic diagram of a typical yeast expression cum secretion vector with appropriate labelling (No description necessary).

7 + 3 = 10

2. Draw a suitably labelled schematic diagram showing the method of synthesis of total double strand cDNA from the total mRNA sample of an organism (no description necessary). Briefly explain the method of creating a point mutation in a cloned DNA sequence using PCR method.

5 + 5 = 10

3. With a suitably labelled diagram briefly discuss the method of dideoxy sequencing technique of a piece of DNA sample. Briefly state, in bulleted form, three disadvantages of Maxam-Gilbert technique.

7 + 3 = 10

4. Draw a schematic diagram with proper labelling, the general principle of PCR amplification of a DNA sample in a thermal cycler (no description necessary). Briefly discuss in bulleted form the applications of PCR method in forensics and molecular diagnostics (one each).

5 + 5 = 10

5. What do you mean by heterologous gene expression? What is a His-tagged recombinant protein? How you can purify a his-tagged protein using affinity chromatography? Briefly state in bulleted form how you can optimise the expression of a recombinant gene in a bacterial host.

2 + 2 + 3 + 3 = 10

6. Write short notes on any two: 2 x 5 = 10
   a) Southern Blotting.
   b) Non-radioactive labeling of DNA.
   c) Transgenesis using embryonic stem cell.
   d) Klenow enzyme.

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# M.Sc. Examination 2022
## Semester III
## Biotechnology
## Core Course - XII
## (Animal & Plant Biotechnology)

**Time: 3 hours** **Full Marks: 40**

Questions are of values as indicated in the margin

### Group A – Animal Biotechnology

**Answer any two questions** **10 x 2 = 20**

1. a) Describe the typical set up of an animal cell culture laboratory. What are the protection measures necessary for animal cell culture?
   b) What is meant by subculture or passage? Draw and explain a typical growth cycle. What are the general characters of a cell line?

   (3+2)+(1+2+2)=10

2. a) What is the difference between totipotent and pluripotent stem cells? What are the potential therapeutic applications of iPSCs?

   b) What is Fate map – explain with example. Mention the distinctive features of the ova of sea-urchin and mammals.

   (1+4)+(2+3)=10

3. a) Schematically explain the gradual development of Lentiviral vectors.

   b) Write short notes on (any two)
   i) Adenovirus vectors
   ii) MTT assay
   iii) Class III Biosafety cabinet

   5+(2.5x2)=10

### Group B - Plant Biotechnology

**Answer any two questions** **10 x 2 = 20**

4. What is somaclonal variation? How these variations develop in plant tissue culture derived plants? Give a brief description on genetic engineering of crop plants for abiotic stress tolerance. What are the advantages of "Calgen's Flavr Savr" tomato over normal tomato? How this tomato was developed?

   1+1+4+1+3=10

5. What is co-integrated vector? How it differs from binary vector? What are the advantages of binary vector over co-integrated vector? Diagrammatically describe the different constructs employed for development of golden rice I and II with proper line diagram?

   2+2+2+4=10

6. What do you mean by disease triangle in plant pathology? How humans influence this triangle? Discuss the R-avr interactions in plant pathology along with the "guard hypothesis". Describe the different types of plant R proteins with structural features.

   2+1+3+4=10

350

# M.Sc. Examination 2022
## Semester III
## Biotechnology
## Core Course - XIII
## (Bioprocess Engineering and Technology, Bioentrepreneurship)

**Time: 3 hours** **Full Marks: 40**

Questions are of values as indicated in the margin

### Group A - Bioprocess Engineering and Technology

**Answer any *three* questions** **10x3 = 30**

1. (a) Prove that a tubular plug flow reactor is always smaller than the stirred tank reactor for a given conversion when kinetics are in positive order.
   (b) You were asked to produce a cellobiose dehydrogenase enzyme using *T. clypeatus*. You have a bubble column reactor, stirred tank reactor and fluidized bed reactor. Suggest your preferences and rejection reasons with justifications.

   5+5=10

2. (a) Explain the effect of permeability on glutamic acid production.
   (b) Draw a schematic diagram for mass culturing of *Rhizobia*.

   5+5=10

3. (a) Derive the design equation for a plug flow and stirred tank reactor.
   (b) Explain the surface culture method of citric acid production.

   5+5=10

4. (a) Write short notes on
   (i) Dirac-delta function,
   (ii) Airlift bioreactor.
   (b) Estimate the theoretical growth and product yield coefficient for ethanol fermentation by *S. cerevisiae* as described by the following equation

   $$C_6H_{12}O_6 \longrightarrow 2C_2H_5OH + 2CO_2$$

   (2.5+2.5)+5=10

### Group B - Bioentrepreneurship

**Answer any *one* questions** **10 x 1 = 10**

5. (a) what are the qualities necessary to be a successful entrepreneur?
   (b) What is business opportunity? What are its different elements?

   3+(3+4) =10

6. What are the different sources of funding available for an entrepreneur?

   10

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**M.Sc. Examination 2022**
**Semester III**
**Biotechnology**
**Core Course - XIV**
**(Ecology, Environmental Biotechnology and Emerging Technologies)**

**Full Marks : 40** **Time 3 Hrs**

Questions are of value as indicated in the margin

## Group A - Ecology, Environmental Biotechnology

**Answer any *two* questions** **10x2= 20**

1. Define second and third -generation biofuel with examples. What is Saccharification process? Explain how the different pretreatment methods affect Saccharification process.

5+ 1+ 4= 10

2. Draw and explain with examples about different types of survivorship curves. Define vermicomposting. What are the advantages of vermicomposting vis-a-vis other methods of composting?

5
4+1+4=10

3. What are the different steps of waste water treatment? Elaborate the preliminary and primary steps of waste water treatment. Define algal bloom. Discuss about the controlling methods of HABs.

2+4+1+3=10

## Group B- Emerging Technologies

**Answer any *two* questions** **10x2= 20**

4 Y. a) Sketch and describe the basic components of a mass spectrophotometer. Differentiate between EI and MALDI. How m/z ratio related with TOF? Compare hard and soft ionization.
b) Write the Principle of FRET

(3+2+1+1) +3=10

5 Z. a) Give a basic structure of flow cytometry. Define ADC in flow cytometry. Describe the basic principle of cell sorting in flow cytometry.
b) Write the basic principle of TEM. Mention two drawbacks of SEM

3+1+3+(2+1)=10

6 B. a) Explain the fingerprint and functional group regions in an IR spectrum. "IR spectroscopy can be called rotational and vibrational spectroscopy" do you agree? Justify your answer. Why are the IR peaks not very sharp?
b) Derive Bragg's law expression

(3++2+1)+4=10

847

# M.Sc. Examination, 2022
## Semester - III
## Biotechnology
## Course: XV (Laboratory-III)
## (Genetic Engineering, Animal and Plant Biotechnology)

**Time: 6 hrs × 2 days** **Full Marks: 80**

1. Briefly describe the principle, methodology and precaution of any one of the following tissue culture experiments in detail. You have to demonstrate the respective technique properly in presence of examiners:

a) Embryo culture for supplied plant material (A)

b) Anther culture for supplied material (B)

2.5+5+2.5+10=20

2. Perform MTT assay with the samples provided and assess the percent reduction of cellular dehydrogenase activity. Show your calculation and results properly.

10+10=20

3. a) Briefly describe the protocol for digestion of a piece of DNA with a restriction enzyme.

b) Briefly describe the protocol for transformation of *E. coli* cells with plasmid DNA using $CaCl_2$ method.

10+10=20

4. Viva-voce. 10

5. Submission and evaluation of practical record copies. 10

565

**M. Sc. Examination (2023)**
**Biotechnology**
**Semester – III**
**Paper – XI**
**(Genetic Engineering)**

**Time: 3 hours** **Full marks: 40**

Questions are of value as indicated
Answer any ***four*** questions

1. (a) Define restriction endonuclease and mention how bacteria protect their DNA from the action of restriction endonuclease.
(b) Mention the role of T4 polynucleotide kinase and terminal deoxynucleotide transferase in recombinant DNA technology.
(c) How will you determine the quality and quantity of isolated genomic DNA?
(d) Distinguish between cloning vector and expression vector.
(e) What is RT-PCR and how does it differ from real time PCR?

2+2+2+2+2 = 10

2. Write notes on:
(a) Cosmid vector
(b) YAC vector
(c) YEP vector
(d) Bt cotton.

2.5 x 4 = 10

3. (a) How will you prepare genomic DNA library in bacteriophage lambda vector?
(b) What is packaging extract and how it is prepared?

6 + 4 =10

4. (a) Describe schematically the synthesis of double stranded cDNA from mRNA by RNaseH procedure.
(b) What modifications are done in cDNA ends using synthetic DNA linkers and adapters for cloning into bacteriophage lambda vector?
(c) What is the difference between lambda replacement vector and insertion vector?

4+4+2 = 10

5. (a) Write the principle and procedure of automated DNA sequencing.
(b) How does automated DNA sequencing differ from Sanger's manual method of DNA sequencing?
(c) Mention two methods of next generation DNA sequencing (NGS).

6 +3 +1 = 10

6. (a) Describe the chemical method of oligonucleotide synthesis.
(b) Outline the steps involved in Southern blotting and analysis.

5 + 5 =10

(566

**Biotechnology**
**Semester – III**
**Paper – XII**
**(Animal and Plant Biotechnology)**

**Time: 3 hours** **Full marks: 40**

Questions are of value as indicated

## Group – A
(Animal Biotechnology)
Answer *any two* questions

1. a) Explain the conditions and requirements along with their purposes for a typical mammalian cell culture.
   b) Explain the significance of growth cycle in relation to the cellular health in culture.
   c) What is cellular senescence and how is it related to programmed cell death?

5+3+2=10

2. a) "Electroporation is generally favoured for stable cell line generation, while chemical transfection methods are favoured for transient gene expression" – Justify the statement.
   b) Give an account of the most recent developments of lentiviral vectors.
   c) Compare Adenoviral and Adeno-associated viral vectors mentioning their advantages and disadvantages.

3+3+4=10

3. a) What is acrosomal reaction? Diagrammatically explain slow block mechanism to polyspermy.
   b) Write short notes on *any two* of the following:
      i) Adult Stem cells
      ii) Typical Eukaryotic expression vector
      iii) Holoblastic cleavage

2+3+(2½ × 2) = 10

## Group B
(Plant Biotechnology)
Answer *any two* questions

1. What are the common applications of plant suspension culture? Draw and describe a regular plant transformation vector with different structural and functional components. What are the different strategies used for development of high-iron rice? Mentioned different genes (with individual roles) which were genetically engineered for development of C4 rice.

1+3+3+3=10

2. Briefly describe the following genetic elements with their application in Plant Genomics and Biotechnology

i) Chloroplast transit peptides
ii) CRT
iii) NOS terminator
iv) Antisense RNA
v) SSR

2x5=10

3. What are PR proteins? Name the types of PR proteins with examples. Explain the Zig-Zag model in plant pathogenesis with a suitable diagram.

2+2+6=10

(365)

**M. Sc. Examination, 2023**
**Biotechnology**
**Semester – III**
**Paper – XIII**
**(Bioprocess Engineering and Technology, Bioentrepreneurship)**

**Time: 3 hours** **Full marks: 40**

Questions are of value as indicated

## Group A
(Bioprocess Engineering and Technology)
Answer *any three* questions

1. Explain the importance of surface pore size for separation of salt and water by reverse osmosis process. Describe different types of membrane separation processes. How does a fermenter differ from a bioreactor?

2+5+3=10

2. Write a note on the commercial production of vitamins. Explain the significance of photobioreactors in mass cultivation of microalgae and cyanobacteria for biofuel production. What are the critical design considerations and operational parameters that need to be optimized for efficient biofuel yield?

2+4+4=10

3. Write short notes on: 2.5x4=10
   a. Flocculation and floatation
   b. Reverse osmosis
   c. Airlift bioreactor
   d. Liquid-liquid extraction

4. Define residence time. Draw a schematic diagram of a plugged flow reactor. How are temperature and pH maintained inside a bioreactor?

2+5+3=10

5. Discuss the fermentation process in single cell protein (SCP) and its applications. Explain the effect of permeability on glutamic acid production.

5+5=10

## Group – B
(Bioentrepreneurship)
Answer *any one* question

1. What is entrepreneurship? What is the difference between an entrepreneur and a businessman? What is the criterion for setting up a successful startup?

2+2+6=10

2. What do you understand by business opportunity? How can one identify business opportunities?

5+5=10

(568)

**M. Sc. Examination, 2023**
**Biotechnology**
**Semester – III**
**Paper – XIV**
**(Ecology, Environmental Biotechnology and Emerging technologies)**

**Time: 3 hours** **Full marks: 40**

Questions are of value as indicated

## Group A
(Ecology, Environmental Biotechnology)
Answer *any two* questions

1. Outline the different stages of ecological succession process. Define ozone depletion. How do greenhouse gases affect the ozone depletion? What do you mean by heavy metal pollution?

   4+2+2+2=10

2. With the help of a schematic diagram explain the wastewater treatment process. What is an algal bloom and HAB? Why do HABs occur?

   5+3+2=10

3. Write short notes on: 2.5x4=10
   i) Logistic equation of population growth.
   ii) Competitive exclusion principle.
   iii) Flocculation
   iv) Biogas

## Group B
(Emerging technologies)
Answer *any two* questions

1. a) Draw and describe a flow cytometry with fluorescence activation. How are cells sorted in flow cytometry?
   b) Draw a schematic diagram of confocal microscope. In unstained live cell samples, what is the advantage of use of confocal microscopy over phase contrast microscopy?

   3+2+(3+2) =10

2. (a) Explain a reason that the laser is matched to the absorption of the matrix (CCA) and not the peptide. What would happen to the peptide if it absorbs a high energy pulse of laser light? Sketch and describe the basic components of a mass spectrophotometer.
   b) With a proper schematic diagram explain the basic principle of AFM

   (2+2+3)+3=10

3. a) Compare and contrast 2D-IR microscopy with Confocal microscopy. Discuss the advantages and limitations of 2D-IR microscopy.
   b) Write the advantages of confocal microscopy over phase contrast microscopy.
   c) Write a short note on RT PCR

   (3+3)+2+2=10

569

# M.Sc. Examination 2023
## Subject Biotechnology
## Paper XV (Practical)

**Time 6 hrs** **Full marks 80**

Answer all questions.

1. a) Calculate the transfection efficiency of the given samples (N1-N12).
b)Four plates of healthy MCF-7 cells with following confluencies – A: 30%, B: 100%, C: 95% and D: 85% were transfected with the same amount of pcDNA-GFP. Show the expected transfection efficiency with reason. 5+5=10

2. a) Estimate the confluency percentage in the given adherence cell culture samples (M1-M12). Comment on the health quality of the culture you are viewing.
b) You are given a suspension cell culture (stock) of late log phase. The cell count is $3\times10^6$/mL. You have to set up an experiment of 3 experimental sets each having triplicates in a 96 well culture plate. The final volume of each well will be 300 µl. If each well needs to have $3\times10^5$ cells, calculate the volume of the cell suspension to be added from the stock in each well. What is the total volume and number of cells required to set up the experiment if you plan to start with 10% extra cells than what is actually needed?
5+5=10

3. Briefly describe the principle, methodology, and precaution of embryo culture of the supplied plant sample (P-1) in detail. You must demonstrate the respective technique properly in the presence of examiners.
2.5 + 5+ 2.5+10 = 20

4. Perform colony-PCR from the supplied bacterial plate containing colonies. Run the PCR product in an appropriate agarose gel, save the gel picture, and show it to the examiners. Write the principle of colony PCR along with calculations of PCR components and gel preparation technique. 15+5=20

5. Viva-voce 10

6. Practical copy 10

(588)

M.Sc. Examination 2024
Biotechnology
Semester-III
Paper-XI (Genetic Engineering)

Time: 3 hours

Full Marks: 40

Questions are of value as indicated in the margin

Answer *any four* questions

1. Define a restriction enzyme and explain its working principle. Name two restriction enzymes along with the name of the organisms from which they are derived. How genomic DNA can be quantified. How can its quality be determined?

(1+2) + 2+ 2.5 + 2.5 = 10

2. Define plasmid. What are the essential requirements of a plasmid to be used as cloning vector? Name two commonly used plasmids. What is the difference between a normal vector and an expression vector? Explain YAC with a diagram.

(1+3+2+1+3) = 10

3. With the help of schematic diagrams explain the methodology of production of insect resistant Bt cotton plant

10

4. Discuss the two ways through which cDNA ends can be modified. What is the difference between insertional vector and replacement vector? What is NGS? What is the difference between Sanger sequencing and NGS?

(2+2) +2+ 2 + 2 = 10

5. What are the different steps involved in the construction of genomic DNA library. Explain each step briefly.

3 + 7 = 10

6. Describe the steps involved in the conversion of mRNA to first strand cDNA. Describe how second strand cDNA is synthesized by replacement method from first strand cDNA.

5+5 = 10

M.Sc. Examination 2024
Biotechnology
Semester-III
Paper – XII (Animal and Plant Biotechnology)

Time: 3 hours | Full Marks: 40

**Answer Group A and Group B questions in separate answer scripts**

Questions are of value as indicated in the margin

## Group – A (Animal Biotechnology)

Answer *any two* questions 2 x 10 = 20

1. What are the criteria of an animal cell culture medium? What do you mean by a cell line? What is confluence and what is its significance in maintaining a cell culture? Mention sterilization methods followed for different components used in animal cell culture. What is the significance of MTT assay?

2+1+2+3+2=10

2. a) Explain a shuttle vector with example. Discuss the working principle of YAC.

b) Compare Adeno viral and Adeno-associated viral vectors. Give an account of the generational modification of retroviral vectors.

(2+3)+(2+3)=10

3. Write short notes on *any four*

2½×4=10

a) Pharming

b) Holoblastic Cleavage

c) Acrosome reaction in mammals

d) Cre recombinase

e) Yamanaka factors

f) Class III biosafety cabinet

## Group B (Plant Biotechnology)

Answer *any two* questions 2 x 10 = 20

4. What do you mean by cybrid? How does this structure differ from a typical hybrid in its origin, cellular composition and application? Briefly describe the structural and functional aspects of the *Agrobacterium*-based plant transformation vector with special reference to the binary type. Briefly describe the principles of direct gene transfer protocols commonly practiced for developing transgenic crops.

1+3+3+3=10

5. Briefly describe the specific metabolic engineering steps taken for the development of the following genetically modified crops with special emphasis on the respective gene constructs:

i.) Golden rice

ii.) High-iron rice
iii.) C4 rice
iv.) Calgen's FLAVR SAVR™ tomato

2.5x4=10

6. What do you mean by PR proteins and R proteins in plants? How many types of PR and R proteins exist in the plant kingdom? Describe one plant PR protein and one R protein in detail with examples. Briefly describe the basic concept behind the "Zig-zag" model of plant pathogens' interaction with appropriate diagram.

2+2+4+2=10

582

# M.Sc. Examination 2024

**Biotechnology**

**Semester-III**

**Paper – XIII (Bioprocess Engineering and Technology, Biocntrepreneurship)**

**Time: 3 hours** **Full Marks: 40**

**Answer Group A and Group B questions in separate answer scripts**

Questions are of value as indicated in the margin

## Group – A (Bioprocess Engineering and Technology)

Answer any *three* questions

1. (a) Explain the engineering principles that differentiate batch, fed batch, and continuous fermentation processes.
   Address the following aspects:
   i) **Operational principles:** How are nutrients supplied, and products removed in each type of fermentation?
   ii) **Kinetic control:** Discuss how microbial growth and product formation are controlled in each process.

   (b) Identify key challenges in scaling up continuous bioreactors and propose one potential solution. (2+3)+5=10

2. (a) What are the various processes for citric acid manufacture? Write a short note on citric acid production with alkane- utilizing microorganisms.
   (b) What are the effects of cell permeability on glutamic acid production? Explain the direct fermentation process of L-lysine (2+3)+(2+3)=10

3. (a) Explain the role of centrifugation and filtration in the removal of microbial cells and solid matters during downstream processing. Compare their efficiency and limitations for large-scale industrial applications.
   (b) Discuss the industrial applications of whole-cell immobilization. How does this technique improve the efficiency of processes such as enzyme production or bioconversion? (2+3)+(2+3)=10

4. (a) Explain the procedure for preparing inoculum of *Rhizobium* and seed inoculation with rhizobia.
   (b) Explain the chemical and biological methods of volumetric oxygen transfer rate determination in a bioreactor 5+5=10

P.T.O.

## Group – B (**Bioentrepreneurship**)

Answer any <u>one</u> question

5. What is the difference between entrepreneurship and bioentrepreneurship? What are the necessary steps to be a successful bioentrepreneur?

4+6=10

6. What are the different means of availing of funding for an entrepreneur? Which means do you think would be most suitable for the biotechnology industry?

6+4=10

583

# M.Sc. Examination 2024

**Biotechnology**

**Semester-III**

**Paper – XIV (Ecology, Environmental Biotechnology and Emerging technologies)**

**Time: 3 hours** **Full Marks: 40**

**Answer Group A and Group B questions in separate answer scripts**

Questions are of value as indicated in the margin

## Group – A (Ecology, Environmental Biotechnology)

Answer any *two* questions

1. (a)What are the advantages of vermicomposting vis-à-vis other methods of composting?
   (b) Discuss the process of biogas production, focusing on the role of microorganisms and the stages involved in anaerobic digestion.

   5+5=10

2. What are the different steps of wastewater treatment? Elaborate the (a) preliminary and (b) primary steps of wastewater treatment. Define algal bloom. Describe the controlling methods of HABs.

   2+(2+2)+1+3 = 10

3. Critically evaluate the role of ecological modelling in understanding and predicting population dynamics in ecosystems experiencing energy flow disruptions due to overexploitation of renewable resources. Using an example, describe how models of ecological succession can inform sustainable resource management practices. Propose a dynamic model framework that integrates energy flow, population dynamics, and ecological succession for predicting long-term ecosystem stability under anthropogenic stress.

   3+3+4=10

## Group B (Emerging technologies)

Answer *any two* questions

4. Analyze the complementary roles of Fluorescence Lifetime Imaging Microscopy (FLIM) and Fluorescence Resonance Energy Transfer (FRET) in studying molecular interactions. Address the following aspects in your answer:

   A. Principles: Explain the underlying physical phenomena that make FLIM and FRET effective for detecting molecular interactions.

   B. Data interpretation: How do fluorescence lifetime measurements in FLIM enhance the sensitivity of FRET experiments?

C. Quantitative analysis: Discuss how these techniques can be combined to derive quantitative data about protein-protein interactions.

D. Limitations: Identify and critically assess two major limitations of using FLIM and FRET in live-cell imaging.

3+2+3+2=10

5. How do Cryo-EM and AFM achieve high-resolution imaging? In which scenarios is one technique preferred over the other, and why? Write the principle of confocal microscopy.

3+3+4=10

6. "Highly purified peptides P1, P2, and P3 were subjected to MALDI mass spectral analysis". The following observations were made:

P1: Showed a m/z of 16 more than the expected value.
P2: Showed a m/z of 80 more than the expected value. MS/MS spectra of the peptide resulted in a precursor ion with m/z 98 less than the expected m/z.
P3: Showed a m/z that was double the expected value.
[Note: z=+1 for all the mass spectra.]

Which one of the options given below comprises all correct interpretations? Give brief reason for your answer.
A. P1: Cys is oxidized; P2: has undergone oxidation at multiple Met residues; P3: is a non-covalent dimer.
B. Pl: Met is oxidized; P2: is phosphorylated; P3: is a covalent dimer.
C. P1: Met is oxidized; P2: multiple Cys are oxidized; P3 is a covalent dimer.
D. P1: Cys is oxidized; P2: phosphorylated and oxidized at Met; P3: is a non- covalent dimer.

3+7=10

578

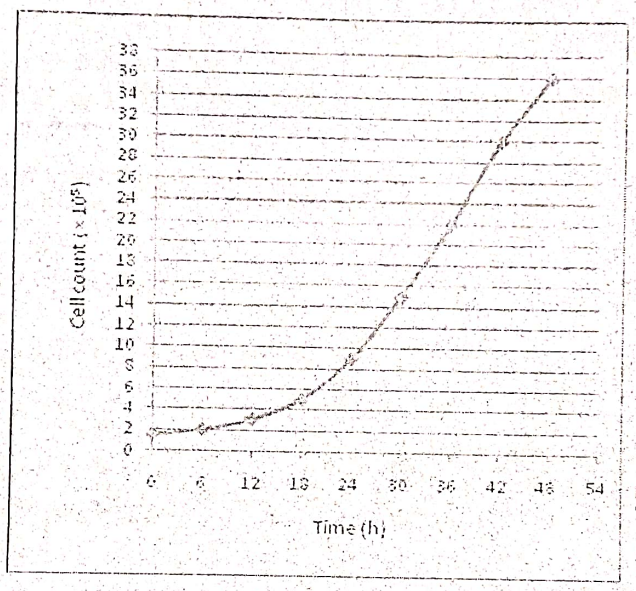
# M.Sc. Examination 2024
## Subject Biotechnology
## Paper XV (Practical)

Time 6 hrs

Full marks 80

Answer all questions.

1. Following is the growth curve of an Animal cell culture up to 48 h. Calculate the doubling time of the cells and the approximate number of divisions that has taken place. Show your calculation.




3+2=5

2. Perform and MTT assay with the cell samples (C1-C11, each for one student) provided in triplicates. Compare with Blank (B1-B3) and present your results graphically. Comment on your results.

8+2=10

3. Briefly describe the principle, methodology, and precaution of embryo culture of the supplied plant sample (PB-1) in detail. You must demonstrate the respective technique properly in the presence of examiners.

2.5 + 5+ 2.5+10 = 20

4. i) Write down the principle and the procedure of Transformation using a plasmid containing an antibiotic resistance gene.

ii) Suppose you are performing a bacterial transformation experiment using a plasmid containing an antibiotic resistance gene. The following data was recorded:

a) The total amount of plasmid DNA used in the transformation: 20ng.

b) The total volume of the transformation mixture is 100μL.

c) A 50µL aliquot of the transformation mixture was plated on an antibiotic-containing agar plate.

d) The number of colonies counted on the plate: 13.

Calculate the transformation efficiency, defined as the number of transformant colonies per microgram of DNA. Express the answer in terms of colonies per microgram (CFU/µg).

iii) Define Transfection efficiency and determine the transfection efficiency of the given sample. 5+5+5=15

5. Write the steps for preparation and transformation of competent *E. Coli* using $CaCl_2$. Explain the procedure of colony PCR along with calculation for a 25µl reaction mix. 6+4 =10

6. Viva-voce 10

7. Practical copy 10