

KADI SARVA VISHWA VIDYALAYA,
GANDHINAGAR

Ph.D. Course Work
in
BIOTECHNOLOGY

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**Ph.D. Course work for
Biotechnology
2009-10**

Course structure

Paper	Title	University Examination (marks)		Duration of exam	Schedule of exam
		Section A (general)	Section B (specialization)		
Paper-I	Research methodology	60	40	2 hrs	Every six months
Paper-II	Scientific communication	60	40	2 hrs	
Paper-III	(Recent Trends in Biotechnology)	100		2 hrs	

Paper-I Research Methodology

Syllabus

SECTION-A (Common to all faculty)

60 marks

- 1) Introduction to Research Methodology : Meaning of Research, Objectives of Research, Motivations in Research, Types of Research, Research Approaches, Significance of Research, Research Methods v/s Methodology, Research and Scientific Methods, Research Process, Criteria of Good Research 2
- 2) Defining the Research Problem : What is Research Problem?, Selecting the Problem, Necessity of and Techniques in defining the problem 3

- 3) Research Design: Meaning, Need, Features of Good Design, Concepts, Types. Basic Principles of Experimental Design, Developing a Research Plan 3
- 4) Sample Design : Implication, Steps. Criteria for selecting a sample procedure, Characteristics of Good sampling Procedure, Types of Sample Design, Selecting Random Samples, Complex random sampling Design. 4
- 5) Measurement and Scaling Techniques: Measurement in Research, Measurement Scales, Sources of Errors in measurement, Tests of Second measurement, Technique of developing Measurement Tools, Meaning of Scaling, Scale Classification Bases, Important Scaling Techniques, Scale Construction Techniques. 6
- 6) Methods of Data Collection: Collection of Primary Data, Observation Method, Interview method, Collection of Data through questionnaire and Schedules, Other methods. Collection of Secondary Data, Selection of appropriate method for data collection, Case Study Method, Guidelines for developing questionnaire, successful interviewing. Survey v/s experiment. 6
- 7) Processing and Analysis of Data : Processing Operations (Meaning, Problems), Data Analysis (Elements), Statistics in Research, Measures of Central Tendency, Dispersion, Asymmetry, Relationship. Regression Analysis, Multiple correlation and Regression, Partial Correlation, Association in case of Attributes 6
- 8) Sampling Fundamentals : Definition, Need, Important sampling Distribution, Central limit theorem Sampling Theory, Sandler's A-test, Concept of Standard Error, Estimation, Estimating population mean, proportion. Sample size and its determination, Determination of sample size Based on i) Precision Rate and Confidence level ii) Bayesian Statistics. 7
- 9) Testing of Hypothesis: Meaning, Basic concepts, Flow diagram, Power of a hypothesis test, Important parametric tests, Hypothesis Testing of Means, Differences between Means, Comparing Two related samples, Testing of Proportion, Difference between proportions, Comparing variance to hypothesized population variance, Equality of variances of two normal populations, hypothesis testing of Correlation coefficients, Limitations of Tests of hypothesis. 7
- 10) Chi- square test : Applications, Steps, characteristics, limitations 2
- 11) Analysis of Variance and Covariance : Basic Principles, techniques, applications, Assumptions, limitations. 6

- 12) Analysis of Non-parametric or distribution-free Tests : Sign Test, Fisher-Irwin Test, McNemer Test, Wilcoxon Matched pair Test (Signed Rank Test), Rank 4
- 13) Sum Tests : a) Wilcoxon-Mann-Whitney Test b)Kruskal-Wallis Test, One sample Runs Test, Spearman's Rank Correlation, Kendall's Coefficient of Concordance, Multivariate Analysis Techniques: Characteristics, Application, Classification, Variables, Techniques, Factor Analysis (Methods, Rotation), Path Analysis. 4

SECTION-B (For Faculty of Biotechnology)

40 marks

1. Biotechnology Products & Processes:

Biotechnology Experimental Design: Factorial Designs, Fractional Factorial Designs, Rechtschaffner designs, D-optimal designs, Response surface methodology, Process optimization and validation, Sample size determinations, Controlling variability, Analyzing and minimizing variations in Biotechnology procedures, Statistical experimental designs for cultivation & fermentations, optimizing Fermentations, multivariate analysis of chemical and biological data. 20

2. Quality assurance:

Development, validation, optimization of analytical methods for metabolites based on HPLC, spectrophotometry, chromatography and Bioassay etc., Quality assurance in Biotechnology Industries and, Contract Research Organizations etc. 10

3. Phytopharmaceuticals and Animal Cell based products:

Experimental Design in preparing and optimizing herbal extracts, testing herbs / herbal material from Bioactive materials. 10

Reference Books: Latest Editions of following Books

- 1) Kothari, C.R., Research Methodology (Methods and Techniques), New Age Publisher
- 2) Fundamentals of modern statistical methods By *Rand R. Wilcox*
- 3) Power Analysis for Experimental Research A Practical Guide for the Biological, Medical and Social Sciences by *R. Barker Bausell, Yu-Fang Li* Cambridge University Press
- 4) Design of Experiments: Statistical Principles of Research Design and Analysis, by *Robert O. Kuehl* Brooks/Cole

Research Methodology
Model Question Paper

- Instructions: 1) Section-I is of 60 marks
2) Section-II is of 40 marks
3) There is no negative marking for incorrect answers

SECTION-A

Q1. Multiple Choice Questions:. Choose one most correct answer from the provided choices. Write your choice on the right hand side column only. Illegibly written answers will not be considered. Each Question carries two marks. **(2x10 marks)**

- i) Why is a control necessary in a well planned experiment?
- a) To show what would normally happen and compare it with what happens when you change the independent variable.
 - b) To keep the experiment from becoming chaotic.
 - c) So that the experiment can be contained.
 - d) For graphing purposes only
- ii) Consider the following data:
14; 16; 16; • 22; 25; 38; 38; 38; 38; 2000
Which of the measures of central tendency would be the least useful?
- a) mean
 - b) mode
 - c) median
- iii) As the degrees of freedom increase (and especially when the degrees of freedom are more than 90), the graph of the chi-square distribution looks more and more _____.
- a) symmetrical
 - b) skewed right
 - c) skewed left
 - d) asymmetrical
- iv) The Goodness-of-Fit hypothesis test is typically a _____.
- a) two-tailed test
 - b) wagging-tailed test
 - c) left-tailed test
 - d) right-tailed test

- v) Determine the sampling technique: A medical researcher does a random survey of 100 female doctors and 100 male doctors.
- stratified
 - systematic
 - simple random
 - cluster
 -
- vi) Following is not the example of tests.
- Chi test
 - t-test
 - pie test
 - F-test
- vii) Following is not the part of basic principles of experimental designs
- Replication
 - Randomization
 - Local Control
 - Reduction
- viii) Following is the type of informal experimental designs.
- Before-and after with control design
 - Completely randomized Design
 - Latin square Design
 - Factorial Designs
- ix) For data that is normally distributed, is it possible for the standard deviation to be larger than the mean?
- No.
 - Yes.
 - There is not enough information to determine.
- x) What is the difference between the independent and dependent variables in an experiment?
- The independent variable is quantitative and the dependent variable is not.
 - The independent variable is what is changed and the dependent variable is what is measured.
 - The independent variable has disowned his parents and the dependent variable still relies on them for food, shelter, and gas money.
 - The independent variable is graphed on the y-axis and the dependent is graphed on the x-axis.

Q2. Fill in the Blanks:

(2 x 10 marks)

- i) ----- refers to a design that has more than one independent variable.

- ii) ----- is an external variable that affects the internal variable and intertwines with other extraneous variables such that it is difficult to determine unique effects of each.
- iii) ----- is the non-manipulated variable in factorial design.
- iv) ----- is an arbitrary value, designated as the significance level.
- v) ----- is the measure of the flat-toppedness of a distribution curve
- vi) ----- factorial designs consider the effect of varying two factors on the dependent variable.
- vii) ----- technique is used design or plan the experiment in such a way that the variations caused by extraneous factors can all be combined under the general heading of “chance”.
- viii) ----- measures seperstely the relationship between two variables in such a way that the effects of other related variables are eliminated.
- ix) ----- defines the limits within which the parameters of the population are expected to lie with a specified degree of confidence.
- x) When there really is a difference (association, correlation) overall, but random sampling caused your data to not show a statistically significant difference, the errors responsible for this are called _____

Q3. Answer true or false for the following statements: A correlation coefficient: **(4 marks)**

- a. Should not be calculated when there is an underlying relationship between the two variables but it is not linear.
- b. Does not provide evidence of a causal relationship between two variables.
- c. Should not be used to judge the biological importance of the relationship between two variables.
- d. Should be performed only when certain assumptions are satisfied (e.g. variables measured on a random sample of individuals, both the variables are quantitative and at least one of the two variables need to be normally distributed).

Q4. Answer true or false for the following statements: The paired t-test: **(5 marks)**

- a. Tests the null hypothesis that the two population means are equal
- b. Must have equally sized numbers of observations in each group.
- c. Assumes that the data in each group are normally distributed.
- d. Is appropriate for comparing the means of independent groups of observations.
- e. When appropriately used, is more powerful when the sample size is large.

Q5. Answer true or false for the following statements (5 marks)

- a. The p-value is the probability of the sample data arising by chance.
- b. The p-value is an arbitrary value, designated as the significance level.
- c. The p-value is the chance of getting an observed effect if the null hypothesis was false.
- d. The p-value is the chance of getting an observed effect if the null hypothesis was true.
- e. A very small p-value allows us to say that there is enough evidence to accept the null hypothesis.

Q6. Match the following : (5 marks)

Example

- i) Effect of digital BP instruments accuracy.
- ii) CVS Research in Institute during 1990-1995
- iii) Effect of temp on productivity
- iv) Effect of fertilizer X on plant cultivation
- v) Relationship of using mobile and brain tumor.

Research Design

- a) Exploratory Research studies.
- b) Descriptive and Diagnostic Res. Studies.
- c) Hypothesis Testing Research studies.
- Hypothesis Testing Research studies
- Hypothesis Testing Research studies

Q7. Write the below functions in sequence. (e.g. d-a-c-b-f-e) (1 mark)

- a) Selection of samples. b) Analysis of data c) Designing the methods of data collection.
- d) Formulating the objective of study e) Report preparation f) Collection data

SECTION-B

(Max. Marks -40)

Design an experiment for any one of the under mentioned research topic:

- I) To prove that dissolved oxygen promotes biosynthesis of antibiotics.
- II) To prove that bioassay method of Penicillin is more accurate, precise and reproducible than determination by titration method.
- III) To optimize fermentation conditions for production of Alcohol by yeasts and to evaluate the impact of pH, temperature and humidity on Alcohol yields.
- IV) You are given three herbal drug extracts which are reported to possess anti-bacterial activity. Design an experiment to find out the optimum proportion of each of the extracts to be combined to achieve maximum therapeutic efficacy.
- V) To prove that different plant organs show different responses to IBA, GA & and NAA

Note : The design should describe following :

- a) Type of design (e.g. Cross-over, 2 x 2 factorial etc.) 3 marks
- b) Sample size 2 marks

- | | |
|---|----------|
| c) Design table/ Flow chart | 15 marks |
| d) Parameters to be studied | 3 marks |
| e) Sample Selection method | 5 marks |
| f) Statistical Analysis to be involved in the study and the basis | 12 marks |

Paper-II Scientific Communication

SECTION-A (Common for all faculty)

60 marks

Syllabus

1. Basics of Communication skill.
 - a) English Grammar: Word Choice, Sentence Structure, paragraph structure, **Comprehension**
2. Types of Scientific Communications.
3. Importance of publishing research papers
4. Publishing Research paper :
 - a) Preliminaries, Format, Choosing Journal
 - b) Title, Running Title
 - c) Authors: Single and Multi authorship
 - d) Writing Abstract
 - e) Introduction section
 - f) Materials and Methods Section
 - g) Result Section
 - h) Figures : Design Principles, Legends, Table components, Graphs: Types, Style, Tables v/s Graph
 - i) Discussion Section: Format, Grammar Style, Content.
 - j) Acknowledgements
 - k) References : Different Styles
 - l) Selecting Keywords
 - m) Communication with the Editor, Handling Referees' Comments, Galey Proofs
5. Writing Review Articles
6. Preparing and Delivering of Oral **and Poster** Presentations
7. Avoiding Plagiarism
8. Preparing documents for MoUs, Confidentiality Agreements.
9. IUPAC symbols and Terminology for physicochemical quantities and Units, SI prefixes, Fundamental Constants, Standard Abbreviations and Symbols

SECTION-B

40 marks

Biotechnology:

1. Exercises on writing Biotechnology related research papers, preparing project proposals for funding agencies and preparing a power point presentations 20
2. Assignment on Critical analysis of research papers of interest published in refereed journals with respect to language, content, title, reference style, data, figures, tables, Discussion etc. and preparing a report on the same. 10
3. Assignment on Writing and submitting a review article related to doctoral research topic for an international journal. 10

Reference Books:

- 1) Study and Communication Skills for the Biosciences by *Stuart Johnson and Jon Scott*, Oxford University Press
- 2) Write and Publish a Scientific Paper by *Robert A. Day* Oryx Press
- 3) Scientific Easy when you know how by *Jennifer Peat* BMJ Books
- 4) Research Projects and Research Proposals A Guide for Scientists Seeking Funding by *Paul G. Chapin* Cambridge University Press

Model Question Paper for Paper-II (Scientific Writing)

SECTION-A

- 1) Which of the following is the most correct title for the provided abstract? (4 marks)
 - a) Anti-staphylococcal activity and mode of action of clofazimine
 - b) Bactericidal property of Clofazimine
 - c) Cofazimine is effective against S.aureus

ABSTRACT

Objectives: Infections caused by *Staphylococcus aureus* might be treated with agents whose primary indications are for other infections. Clofazimine, an established anti-mycobacterial drug, could be such a candidate. However, the anti-staphylococcal properties of clofazimine have not been fully described and its mode of action, possibly involving inhibition of both RNA polymerase and a membrane-located target, has not been explored in detail. We have now conducted experiments to address these issues. **Methods:** Using established procedures, we examined the

activity of clofazimine against a range of clinical isolates of *S. aureus* and determined whether it was bactericidal, exhibited a post-antibiotic effect (PAE), or interacted synergically with other agents. The potential for emergence of clofazimine-resistant mutants was also examined. Mode of action studies involved macromolecular synthesis assays, cross-screening against rifampicin-resistant mutants, susceptibility of RNA polymerase to clofazimine in vitro and several methods to detect drug-induced membrane damage. Results: Clofazimine demonstrated good anti-staphylococcal activity encompassing MSSA, MRSA and GISA. It was bactericidal and resistant mutants could not be isolated. Clofazimine did not exhibit a PAE and failed to act synergically with other drugs. No evidence for specific inhibition of RNA polymerase was obtained. Clofazimine caused non-specific inhibition of DNA, RNA and protein synthesis, consistent with membrane-damaging activity that was detected in three independent assays for membrane disrupting agents. Conclusions: Clofazimine is a potent anti-staphylococcal agent. It appears to be a membrane-disrupting agent and does not inhibit RNA polymerase.

- 2) Choose the correct word from the given choices to replace the underlined word/fill in the blank in the given sentences- (5 x 2 marks)
- a) Oral pediatric formulations of artemether are urgently needed, however the tablets are difficult to administer to young children, who cannot swallow whole tablets or tolerate the bitter taste of the crushed tablets.
- Because
 - As
 - Since
 - however
- b) I _____ several eminent scholars in my study of herbal drug resources.”
- Cited
 - Sited
- c) The differences between the control and experimental groups were _____
- Insignificant
 - Nonsignificant
- d) Noradrenaline _____ contractile response on rat vas deferens
- elicit
 - illicit
- e) Resistance to antibiotics is becoming _____ difficult problem in the management of bacterial infections.
- An Increasingly
 - More

iii) Highly

Q 3. Answer in Short:

- a) Give full form of IUPAC (2)
- b) Enumerate three most commonly followed styles of referencing (3)
- c) What is Running title? (2)
- d) Differentiate between histogram and bar chart (2)
- e) Define Plagiarism (2)
- f) Enumerate components of a tabular representation of result data (2)
- g) Give the standard abbreviations of : (3)
 - i) mililiter
 - ii) hour
 - iii) minutes
- e) Differentiate between research paper and review article (3)
- f) Define “ Rapid Communication” (2)
- g) Differentiate Symposium, panel Discussion and Seminar (3)

Q4. True or False (If false provide the correct answer) (2 x 6)

- I) Passive voice is the most suitable sentence arrangement for scientific communication
- II) Discussion section of a research paper discusses only the results obtained in the study
- III) The first author is always the one who is the research guide and last author is one who is major contributor in experimental work.
- IV) The numbers mentioned in the result table can have any number of decimal points.
- V) Introduction section consists of summary of literature survey conducted prior to the study.
- VI) The tense used in result section is mostly present tense.

SECTION-B

Q1. Provide the following for the given paper:

- a) Correct Title (not more than 50 letters) (5)
- b) Most suitable Keywords (2)
- c) Abstract (not more than 250 words) (10)
- d) Headings, footnotes and Legends to figures and tables (5)

Q2. Describe the result section using the provided tables and charts. (8)

Q3. Write a paragraph (not more than 100 words) on “Current Status of Biotechnology Industries in Gujarat”.

Note : You should put stress on method of writing, grammar, flow of thoughts, conclusion. Accurate data are not required. **(10)**

Paper-III Recent trends in Biotechnology

100 Marks

Introduction and Applications of following:

- a. Enzymes for industry/ Medicine, Immobilized enzyme technology, designer enzymes – Biosensors
- b. Molecular Farming, Edible Vaccines, Therapeutics from Transgenic Plants, Bio-Degradable Plastics, Molecular Markers, RAPD, RFLP, AFLP Techniques,
- c. Plant Cell culture and production of Secondary metabolites
- d. Animal cell culture Techniques, Gene Therapy, Stem Cells in Therapeutics, Oncogenes, Tumor suppressor Genes & Cancer Biology, AIDS & other Immuno- deficiencies
- e. Characterization and production of Recombinant Therapeutic proteins, Bioinformatics & Computer aided Drug Designing
- f. Biopesticides in integrated pest management
- g. Bioremediation of contaminated soils and waste land. Waste Management strategies
- h. Bio-Energy, Bio-Diesel: Tree borne and Algal oils and Trans-esterification, Hydrogen and Electricity from Microbes
- i. Biosafety in relation to recombinant organisms & transgenic research applications, Social and ethical issues.
- j. Process Economics, Cost Analysis and Investment Decisions

References:

1. Basic Biotechnology ---Colin Ratlidge and Bjorn Kristiansen, Cambridge University Press, 2006
2. Biotechnology and Biopharmaceuticals ---- Rodney J.Y. Ho and Milo Gibaldi, Wiley-Liss 2003
3. Culture of Animal Cells --- Ian Freshney Wiley-Liss 2006
4. Microbial Biotechnology ---- Alexander N Glazer and Hiroshi Nikaido, Cambridge University Press, 2006

Model Question paper for PhD Coursework:

Paper-III Recent Trends in Biotechnology

Q1. Multiple Choice questions:

(20 x 10 mark)

- 1) Trans- esterification of lipids is catalysed by
 - a) NaOH
 - b) Methanol
 - c) Microbial Lipases
- 2) Which of the following is essential for animal cell culture medium
 - a) Serum
 - b) Sodium chloride
 - c) Phosphates
- 3) Which of the following route of administration is best for Biopharmaceuticals?
 - a) Oral
 - b) Intramuscular
 - c) Intravenous
 - d) Intra-peritoneal
- 4) Growth rate in a bioreactor can vary due to :
 - a) Age of inoculum
 - b) Inoculum to fermentation volume ratio
 - c) Agitator speed
 - d) All of the above
- 5) Which of the following regulate the biosynthesis of microbial secondary metabolites
 - a) Carbon catabolite
 - b) Phosphate
 - c) Nitrogen
 - d) End product.
- 6) What type of molecules are Insulin, EPO, TPA & hGH
 - a) Proteins
 - b) Lipids
 - c) Glycosides
 - d) Glycoproteins
- 7) Which of the following is NOT a laboratory safety rule?
 - a) You should never mix acids with bases
 - b) You should tie back your long hair
 - c) You should never add water to acid
 - d) All of the above are valid safety rules

- 8) Stem Cells can be obtained from
- a) Bone Marrow
 - b) Umbellical Chord
 - c) Both these
- 11) What piece of laboratory equipment is best-suited for accurately measuring the volume of a liquid?
- a) Graduated cylinder
 - b) Graduated beaker
 - c) Erlenmeyer flask
 - d) Volumetric Flask
- 12) Which method is best for preservation of microbial cultures?
- a) Sand culture
 - b) Lyophilization
 - c) Dried culture on grains
 - d) Agar culture covered by sterile liquid Paraffin
- 13) Anoxic degradation of organic matter takes place in
- a) Rotating Biological contacters
 - b) Activated sludge processionisation, acceleration, deflection, detection
 - c) Anaerobic Digester
 - d) Middle of an agitated tank
14. Which one of the following statements is incorrect?
- a) *Escherichia coli* is obligate aerobe
 - b) *Escherichia coli* is obligate anaerobe
 - c) *Escherichia coli* is facultative anaerobe
- 15) Which one of the following gases is supposed to be responsible for Global warming
- a) CO₂
 - b) Methane
 - c) Ozone
 - d) All of them
- 16) Which one of the following pieces of information cannot be obtained from a computer controlled bioreactor?

- a) DO_2
 - b) Substrate concentration
 - c) Molecular mass of end product
 - d) Rate of Biosynthesis of the end metabolite
- 17) Activation Energy of a bioprocess can be reduced by
- a) Catalyst
 - b) Environmental conditions
 - c) Substrates concentration
 - d) End product concentration
 - e) All of them
- 18) Which of the following is not a biopesticide
- a) *Trichoderma*
 - b) *Stiernerema*
 - c) Azadirachtin
 - d) BT
 - e) All of them
- 19) Enzymes present in Detergents can be
- a) Lipases
 - b) Lipase & Protease
 - c) Lipase & Amylase
 - d) None of these
- 20) An endocrinal glycoprotein that stimulates the production of red blood cells by stem cells in bone marrow is:
- a). GM-CSF
 - b). CSF
 - c). GM-CSF
 - d). EPO

Q2. Fill in the Blanks:

(20 x 1 mark)

- 1) Pharmacopoeia does not describe the -----process of a drug.
- 2) Quality of biodiesel gets affected by the----- composition of the lipid.
- 3) A fungus commonly used as wide spectrum insecticide is-----

- 4) A widely used substrate for single cell protein manufacture is -----
- 5) p53 is a tumor-----gene
- 6) HPLC technique gives higher resolution than TLC techniques because of _____
- 7) Gas chromatography is not suitable for analysis of _____ type of compounds.
- 8) To work out the molecular mass of a secondary metabolite you would look at its _____ spectra.
- 9) For antiseptic effect minimum ____ % alcohol can be used.
- 10) Distilled water is free from_____ .
- 11) Clinical trials of a biopharmaceutical establish the efficacy and ----- of the molecule
- 12) One of the growth Hormone used in Plant Tissue culture to induce root formation is -----
- 13) The enzymes that converts *Bacillus thuringiensis var. kurstaki* parasporal crystal in to insecticidal toxin is-----
- 14) A biopharmaceutical manufactured through immobilized cells is -----
- 15) Humulin is used for treatment of ----- in human beings
- 16) New generation refrigerants contain----- rather than -----
- 17) _____ tissue forms new cells in plants
- 18) Chlorophyceae algal species synthesizing Hydrocarbons is -----
- 19) Gene associated with insecticidal activity of *Bacillus thuringiensis* against Coleopteran insects is -----
- 20) Blue green Alga commonly used as Biofertilizer is -----

Q3. True/False (correct the false statement)

(20 x 1 mark)

- 1) In Phase-IV Clinical Trials premarketing surveillance is conducted
- 2) LAL test for pyrogen testing is conducted on mice
- 3) Toxicity testing are normally done in Guinea pigs
- 4) Ministry of Environment is the highest authority for grant of permission to recombinant crops in India.
- 5) All experiments on efficacy of new phytopharmaceuticals on human beings require permission of Ethics Committee.
- 6) Every country has it's own Pharmacopoeia.
- 7) Control groups are not required for anti-inflammatory study.
- 8) All enzymes are thermolabile.
- 9) Patent Act in INDIA is applicable.
- 10) 95% alcohol (Ethanol) means rectified spirit.
- 11) Ampicillin is a generic drug.
- 12) Transgenic B.T. can be sourced from animals.
- 13) "Water for injection" is corrosive.

- 14) Herbal drugs do not have side effects.
- 15) MTT assay is used for detecting cytotoxicity
- 16) Microbial products can be used as artificial skin for human beings.
- 17) RNase is the enzyme not destroyed by thermal shock at 64⁰ C
- 18) GRAS microbes are at times dangerous.
- 19) *Sulfolobus acidocaldarius* is a polyextremophile used in Bioleaching
- 20) Integrity of HEPA filter is validated by smoke leak test

Q4. Match the Following:

(4 marks X 5)

A)

<u>Instrument</u>	<u>Principle</u>
1. Rotary Shaker	a) Sedimentation at high velocity
2. Refrigerated Centrifuge	b) Bioreactor with photoperiods
3. Photobioreactor	c) Wet heat
4. Autoclave	d) Agitation for mass transfer

B)

1) Lipids	a) PCR
2) Separation of Phytoconstituents	b) GC
3) Gene Ammplification	c) Soxhlet Apparatus
4) Chromatography of volatiles	d) HPTLC technique

C)

1) Spectrophotometer	a) Algal cultivation
2) LAL Test	b) Tree borne oils
3) Photobioreactor	c) Pyrogen Testing
4) Soxhlet assembly	d) Membrane Filter
5) Sterility Testing	e) Microbial growth

D)

1) Cheese	a) Gluten
2) Biodegradable plastics	b) Rennets
3) Flavour in Bread	c) Curd
4) Beer Flavour	d) Amino acids

E)

- | | |
|-------------------------|-------------------------|
| 1) Blood clot | a) PCR |
| 2) Anti Cancer Alkaloid | b) Alkaline Phosphatase |
| 3) Gene Ammplification | c) Plasmin |
| 4) Milk Sterility | d) Vincristin |

Q. 5. Write Short Notes on any two (10 marks X 2)

- a. Proteases and their uses
- b. Microbial Enzymes as medicines
- c. Quality assurance checks obligatory in fermentation
- d. Proliferation and differentiation in animal cell culture
- e. Perfusion monolayer culture
- f. aerobic treatment of waste water.
- g. Biodegradable Plastics
- h. International Conference on Harmonization, somatic embryogenesis
- i. Molecular Markers, RAPD, RFLP, AFLP Techniques
- j. –Biosensors
- k. Stem Cells in Therapeutics, Oncogenes,
- l. Tumor suppressor Genes & Cancer Biology, AIDS & other Immuno- deficiencies
- m. Biopesticides in integrated pest management
- n. Hydrogen and Electricity from Microbes
- o. Biosafety in Biotechnology.
- p. Biotechnology Investment Decisions based on Process Cost Analysis
