



# **PERIYAR UNIVERSITY**

**PERIYAR PALKALAI NAGAR**

**SALEM – 636011**

**DEGREE OF MASTER OF PHILOSOPHY  
CHOICE BASED CREDIT SYSTEM**

**SYLLABUS FOR  
M.PHIL. - BIOCHEMISTRY  
( SEMESTER PATTERN )**

**( For Candidates admitted in the Colleges affiliated to  
Periyar University from 2017-2018 onwards )**



## REGULATIONS

### OBJECTIVE OF THE COURSE:

- To improvise student's skills and develop individuality in Biochemistry research.
- Motivate students to understand and integrate applied research inventions to Industry, reaches common people

### ELIGIBILITY FOR ADMISSION

Candidate who have qualified for post graduate degree in Biochemistry of recognized university shall be eligible to register for the Degree of Master of Philosophy (M.Phil) in Biochemistry.

### FULL-TIME M.PHIL REGISTRATION

Candidates should have obtained a minimum of 55% marks except for whom have qualified their

P.G degree on or before 1st January 2009 and those who have qualified for the Master Degree before 01.01.2009.

### PART -TIME M.PHIL

In case of teacher or other employed candidates, candidates belonging to SC/ST community, for part -time M.Phil the minimum percentage of marks for registration is 50%.

### DURATION

The duration of the M.Phil Course shall extend over a period of one year from the commencement. Permitted for completion of course with two extension each of six months.

### STRUCTURE OF THE COURSE

The course of study for the degree shall consist of

Part -I comprise three theory papers according to the Syllabus prescribed, from time to time.

Paper I - Research Methodology Paper II - Analytical Technique .

Paper III - There shall be a third paper which shall be the background paper relating to the proposed Dissertation conducted internally by the department.

Part -II- Dissertation

### **SCHEME OF EXAMINATION**

#### Part –I Written Examination Papers I, II and III

The examination of paper I, II and III shall be held at the end of the year. The duration for each paper shall be 3 hours carrying a maximum of 100 marks. The department will conduct paper -III examination and the marks obtained by the candidate along with the question paper and valued answer scripts shall be sent to the head of the Institution at least 15 days before the commencement of the examination of papers I and II.

The examiners will be assigned from the panel of four names submitted by the department. If one examiner award a pass mark and the other award fail mark , the paper will be valued by a third examiner whose award of marks will be the final.

Part II- Dissertation The exact title of the Dissertation shall be intimated within one month after the completion of the written examination. The students will not be send to make any changes in the title after completing the paper III examination. Candidates shall submit the Dissertation to the university through the Supervisor and the head of the department at the end of the year from the commencement of the course which shall be valued by internal examiner (Supervisor) and one external examiner appointed by the University from a panel of four names sent by the supervisor through the Head of the Department at the time of submitting the dissertation .

The examiners who value the Dissertation shall report on merit of candidate as “Highly Commended “(75% and above) or “Commended “(50 % and above and below 75%) or “Not Commended”(below 50%). If one examiner commends the Dissertation and the other examiner, does not commend, the dissertation will be referred to a third examiner and the third valuation will be the final.

Submission or resubmission of the Dissertation will allowed twice a year. Passing Minimum A candidate shall be declared to have passed Part –I of the examination if he/she secures not less than 50% of the marks in each paper including paper –III for which examination is conducted internally.

A candidate shall be declared to have passed Part –II of the examination, if his/her dissertation is at least commended. All other candidate shall be declared to have failed in the examination.

<b>Part</b>	<b>Course</b>	<b>Name of the Course</b>	<b>Credit</b>	<b>Total</b>
I	Core I	Research Methodology	4	100
I	Core II	Analytical Techniques	4	100
I	Core III	GUIDE PAPER	4	100
II	Course II	DISSERTATION*	12	200
		TOTAL	24	500

**\*Dissertation evaluation- Thesis evaluation 150 + Viva Voce 50**

## **M.PHIL. BIOCHEMISTRY**

### **PART - I**

#### **CORE I - RESEARCH METHODOLOGY**

##### **UNIT I**

###### Scientific Research

Overview of scientific research, Applications of research of research and improvement. Choosing a topic and formulation of hypothesis.

Designing and investigation techniques employed and analysis of results. Sources of experimentation: Microorganisms, animals, plants and humans in experimentation.

Scientific writing – logical format for writing thesis and papers – abstract, Introduction, review of literature, materials and methods, results – illustration by tables and figures, discussion, and bibliography – Harvard and Vancouver systems.

##### **UNIT II**

###### Bioinformatics

The scope of bioinformatics. The internet. The world wide web. File formats and transfer protocol. Biological data bases-sequence and structure-NCBI, PDB. Data retrieval – the Entrez system. Searching sequence databases – sequence similarity searches, substitution matrices. Database search-FASTA and BLAST.

Protein multiple sequence alignments-CLUSTAL.

##### **UNIT III**

###### Biostatistics

Collection and classification of data – diagrammatic and graphic. Representation of data – measurement of central tendency – standard deviation – normal distribution – test of significance based on large samples – small samples.

Student t test. Correlation and regression – Chi square test for independence of attributes – ANOVA. Use of SPSS software.

##### **UNIT IV**

###### Safety, general guidelines and funding agencies

Biosafety – Introduction. Levels of Biosafety. General guidelines and practices. Guidelines for DNA research activities. General guidelines for research in transgenic plants, Good laboratory practices. Containments –Types, Basic Laboratory and Maximum Containment Laboratory.

Research bodies & funding agencies – UGC, CSIR, ICMR, DST, DBT, ICAR, DAE, DRDO, DOD, Fellowships – Junior, Senior Research, Fellowships and Research associates.

**UNIT V**

## Bioethics and Patenting

## Bioethics

Declaration of Bologna, Ethics in animal experimentation, CPCSEA guidelines – Technical, personnel, environment, animal husbandry, animal care; feed, bedding, water, sanitation and cleanliness, waste disposal, anesthesia and euthanasia.

Composition of (human) Institutional evaluation Ethical Committee (IEC) – General ethical issues. Specific principles for clinical evaluation of drugs, herbal remedies and human genetics.

Ethics in food and drug safety. Environmental release of microorganisms and genetically engineered organisms. Ethical issues in human gene therapy, cloning and embryonic stem cell.

Patenting – definition of patent – different types of intellectual property right, Case studies of patents (basmati rice, turmeric, neem). Product and process. Patenting multicellular organisms. Patenting and fundamental research.

**REFERENCE BOOKS**

1. How to write a scientific paper. R.A.Day. Cambridge university press.
2. Guide to scientific and technical writing. Cooray P.G
3. Methods of Research. Carter V Good and Douglas E seats
4. The craft of scientific writing Englewood Cliffs. Alley, 1987. Michael, N.N. Prentic.
5. Desk Top Publishing on PC, M.C. Sharma, 1887. BPB Publications.
6. Introduction to Bioinformatics, Lesk, A.M 2002. Oxford.
7. Fundamental concepts of bioinformatics Krane et al., Benjamin Cummings.
8. An introduction to Biostatistics, Sundar Rao, Jesudian Richard
9. Fundamentals of statistics, S.P.Gupta – Sultan Chand.
10. Ethics and the use of alternatives to animals in research and education. Shiranee Pereira. CPCSEA.
11. CPCSEA guidelines for laboratory animal (CPCSEA) – No.13 Scaward road, Valmiki Nager Chennai – 41.
12. Ethical guidelines for biomedical research on human subjects. ICMR, New Delhi, 2000.
13. Molecular and cell biology of human gence therapeutics, 1995. Dickson. Series Chapman and Hall.
14. Research and Development Funding Schemes of Central Government Departments and Agencies. Ministry of Science and Technology, Departement of Science and Technology, New Mehrauli Road, New Delhi – 110106.

## **M.PHIL BIOCHEMISTRY**

### **PART - I**

#### **CORE - II ANALYTICAL TECHNIQUES**

##### **UNIT - I**

###### **Microscopy**

Light microscope-Components, specimen preparation. Optical contrast, specimen stains,

Fluorescence microscopy, Fluorophores. Optical sectioning: Confocal microscopes, multiple photon microscopes, Imaging living cells and tissues. Stereo microscope, Electron microscope: Principle, specimen preparation for TEM and SEM

###### **Spectroscopy**

Principle, instrumentation, and applications of UV-visible spectrophotometry, Vibrational spectroscopy, NMR, ESR, Spectro-fluorimetry and luminometry. X-ray diffraction. Atomic spectroscopy – principle and applications of atomic flame and flameless spectrophotometry. Uses of LASER for spectroscopy.

##### **UNIT - II**

###### **Chromatography**

General principles, Components, Instrumentation and applications of chromatography – TLC, GLC, HPLC, ion exchange, molecular exclusion, affinity chromatography.

###### **Electrophoresis**

General principles and instrumentation. Electrophoresis of proteins – native gels, gradient gels, SDS Page, Isoelectric focusing, 2-D PAGE, Detection, estimation and recovery of proteins in gels. Western blotting. Electrophoresis of nucleic acids – agarose gel electrophoresis, DNA sequencing gels, pulsed– field gel electrophoresis, capillary electrophoresis.

##### **UNIT - III**

Centrifugation



Principle, instrumentation and applications of centrifugation. Preparative-ultracentrifugation and differential centrifugation, density gradient centrifugation (rate-zonal & isopycnic). Analytical ultracentrifugation – molecular weight determination.

### **Radiation**

Radiation hazards, prevention and safety measures. Detection and measurement of radioactivity, radiation dosimetry, solid and liquid scintillations counting – Cerenkov radiation. Autoradiography.

### **Immunotechniques**

Production and applications of antisera and monoclonal antibodies, Antigen – antibody interaction – precipitation and agglutination reaction, immunodiffusion, Immune- electrophoresis, immunofluorescence. RIA and ELISA – hormonal assay. HLA typing. Lymphocyte isolation and complement fixation. Immunohistochemistry.

## **UNIT – IV**

### **Molecular Biology Techniques**

Sequencing DNA – enzymic and chemical methods. Blotting techniques –Southern and Northern analysis. DNA finger printing, foot-printing. DNA makers– RFLP and RAPD. PCR – principle and applications – Types of PCR and applications of RT-PCR, real time-PCR. In situ hybridization and FISH. DNA chip technology and microarrays. Genome and proteome analysis – EI – MS, MALDI, SELDI, CI & MALDI –TOF.

## **UNIT – V**

### **Cell and Tissue Culture**

**Animal cell and tissue culture** – laboratory facilities, Aseptic techniques, eradication of infection, Equipments, Types of media preparation, primary culture and cell lines. Growth requirement, Subcultures, cell quantification, Cryopreservation and viability test. pluripotent stem cell lines, organ and embryo culture.

**Plant cell and tissue culture** – media preparation and cell culture, tissue culture, micropropagation and somoclonal variation, production and uses of haploids, protoplast culture, regeneration and somatic hybridization. Gene transfer methods in plants.

**Microbial culture:** Elementary details and media specifications in different microorganism culture.

**REFERENCE BOOKS**

1. Instrumental Methods of Analysis, Williams, Merrit etal.
2. Scientific Foundations of Clinical Biochemistry, Williams and Marks.
3. Concepts in Biotechnology, 1996.Ed: D. Balasubramaniam. Costed IBN, University Press, India.
4. Principles and Techniques in Practical Biochemistry. Wilson and Walker, 4th edition. Cambridge University Press.
5. Biotechnology and Genomics, P.K.Gupta, Rastogi publications 2004, India.
6. Biophysical Chemistry, Principles and Techniques, Upadhay and Nath, 2000, Copyright 2014. Himalaya. Publishing house, India.

**M.PHIL. BIOCHEMISTRY****PART - I****CORE III - GUIDE PAPER I - ENZYMOLOGY****UNIT- I****ISOLATION, EXTRACTION AND PURIFICATION OF ENZYMES**

Enzymes –General introduction, source of enzymes, Isolation of enzymes, extraction of soluble enzymes, membrane bound enzyme, cell disintegration and extraction. Purification of enzymes, Recombinant proteins, membrane protein and purification of antibodies .Development of enzyme assay, quantification of enzyme activity. Mechanism of enzyme catalysis.

**UNIT- II****ENZYME KINETICS**

Kinetics of enzyme catalysed reaction –kinetics of single substrate enzyme; the Eadie Hofstee and Hanes plot, rapid reaction kinetics ; pre –steady state kinetics,relaxation kinetics, King and Altman procedure, multi-substrate enzyme catalysed reactions; steady state and non –steady state methods. Enzyme inhibition ;reversible inhibition and Irreversible inhibition .Mixed inhibition, partial inhibition ,substrate inhibition, Allosteric inhibition and regulation.

**UNIT- III****TECHNIQUES OF ENZYMOLOGY**

Instrumental techniques: Electrochemical methods, Enthallimeter, Radiochemical methods and Dry –reagent techniques. Automation in enzymatic analysis: Fixed –time methods fixed concentration methods and methods involving continuous monitoring. Biosensors, Application of biosensors –Analysis- measurement of protein and enzyme activity – UV Absorption, Lowry, Dye binding, Bicinchonic acid. Active site –Investigations of active site structure, Trapping ES complex, Use of substrate analogues, Modification by using chemical procedures, enzymes modification by treatment with protease, enzyme modification by site directed mutagenesis.

**UNIT- IV****IMMOBILIZATION OF ENZYMES AND ENZYME ENGINEERING**

Preparation of immobilized enzymes: properties of immobilized enzymes. Application of immobilized enzymes. Bioconversion studies with immobilized enzyme packed-Bed

bioreactor. Determination of protein structure: Primary structure and its determination, secondary structure prediction and determination of super secondary structure and domain in protein, quaternary structure, and methods to determine tertiary and quaternary structure, X-ray crystallography, sequencing. Protein data base analysis, methods to alter primary structure of protein, examples of engineered protein, protein design, principles and examples.

### **UNIT- V**

#### **INDUSTRIAL UTILISATION OF ENZYMES**

Large –Scale application of microbial enzymes in food and allied industries. Leather industry, textiles, paper industries, Medical and pharmaceutical application of enzymes. Enzymes in aqueous biphasic system, Inter esterification of lipids.

#### **REFERENCE BOOKS.**

1. Enzymes By Dixon , E.C Webb, CJR Thorne and K.F. Tipton, Longmans , London.
  2. Fundamentals of Enzymology First Edition 1990. 2<sup>nd</sup> Edn. 1998. Nicholas C.Price, Lewis Stevans, Oxford University Press,
  3. Understanding Enzymes, Trevor Palmer, (1991. Third Edition, Ellis Horwood Limited.
  4. Protein Biotechnology, Gary Walsh and Denis Headon, 1994. John Wiley and Sons.
  5. Protein Biochemistry and Biotechnology, Gary Walsh, 2002. John Wiley and Sons Ltd.
  6. Enzyme kinetics and Mechanism –Paul F.Cook
  7. The Chemical kinetics of enzyme action by K.J Laidler and P.S.Bunting
  8. Enzymes structure and Mechanism ,Alan Fersht ,1985. 2nd ed., W.H.Freeman and Company.
  9. Enzymatic reaction mechanism, 1979. Christopher Walsh, Freeman Pub, San Francisco
  10. Immobilised enzymes by Ichiro Chibata, Halsted press Book
  11. Enzyme structure and function, S. Blackburn, 1976. Marcel Dekker, Inc., NY
- Principle, instrumentation and applications of centrifugation. Preparative-

## **M.PHIL. BIOCHEMISTRY**

### **PART - I**

#### **CORE III - GUIDE PAPER II**

##### **UNIT- I**

Introduction : An overview of Indian Medicine Ayurveda. Traditional medicine /Ethnomedicine. Classification, taxonomy and phytochemistry of Medicinal Plants.

Therapeutic potential of Medicinal plants- A global perspective. Recent development of some natural products.

##### **UNIT- II**

Secondary Metabolites : Definition, types ( Alkaloids, Steroids ,glycosides and flavonoids). Structure, Chemistry, Biosynthesis, Metabolism and Regulation of Secondary Metabolites, Secondary metabolites as plant therapeutics, Economic importance of Secondary products.

##### **UNIT- III**

Screening of Secondary Metabolites –Phytochemical analysis, Biochemical methods, qualitative and quantitative analysis –Separation procedures, Purification, and Structural elucidation of secondary compounds of therapeutic potential by HPLC and NMR Spectroscopy .

##### **UNIT- IV**

An overview of Liver metabolism and function. Anatomy and Physiological Significance of Liver and kidney .Liver disease, Kidney disorders, Molecular basis of Liver and Kidney disorders, Liver toxicity, Nephrotoxicity. Animal Models–Basis for clinical studies, Inflammatory disease – Allopathy and Ayurveda.

##### **UNIT- V**

Free radicals –Introduction, Modern theory of free radical, Oxidative Stress, Free Radical Scavengers. Antioxidants-Definition ,property and biological significance, Antioxidants – Enzymes and Vitamins. Antioxidants as markers for liver and kidney disease. Medicinal plants as a source of Direct and Indirect antioxidant activity.

**REFERENCE BOOKS**

1. Supplement to cultivation and utilization of medicinal; plants. Handass ,Kaul.M.K,1996.
2. Basic Medical Biochemistry –A Clinical approach second edition, Collen Smith Allan.D.
3. Plant Biochemistry –Recent Advances by Trivedi .P.C.
4. Role of Biotechnology in Medicinal and Aromatic Plants ,Volume-II, Irfen.A.Khan, Atiya Khanum
5. Plant Biochemistry by Dev and J.B. Harborne
6. Plant biochemistry and Molecular biology,Peter J .Lea, Richard C.Leegood
7. Biochemistry and Molecular Biology of Plants – Buchanan, 2009. Grussem Jones
8. Methods in Plant biochemistry and Molecular biology, William .V.Dashek
9. Introduction to plant Biochemistry, T.W.Goodwin and E.I .Mercer.
10. Biochemistry, Zubay G L.,1988. 4th edition, W M C Brown Publishers.
11. Medicinal plants in India , Indian Journal of Medical Research Seth S.D.Bhavana Sharma .
12. Antioxidants properties of some therapeutically active medicinal plant –an overview Gajera.H.P,Patel Sr .Gdakiya

**M.PHIL. BIOCHEMISTRY****PART - I****CORE III - GUIDE PAPER III - MEDICINAL HERBS AND  
PHYTOTHERAPEUTICS****UNIT- I**

List of Medicinal herbs; Explored medicinal herbs in varied geographical location. Phytochemicals – Classification and structure: Secondary metabolites metabolic pathways- significances of secondary metabolites; Flavonoids derivatives, Alkaloids-sub derivatives, Tannins, phytochemicals, Phenol, Phytosterols, proteins, Glycosides.

Principle and Procedure: Isolation, purification and characterization of Alkaloids, Flavonoids, Phenols, Tannins. Nanosynthesis- products of phytochemicals as nanoparticles for drug delivery, clinical application in selected diseases.

**UNIT- II**

Nanosynthesis- products of phytochemicals as nanoparticles for drug delivery, clinical application in selected diseases. Biological synthesis of nanoparticles by fungi, bacteria, yeast and actinomycetes.

Database similarity searching: BLAST, FASTA, sequence filters, PSI BLAST. Hidden Markov model.

**UNIT- III**

Free radicals, types of free radicals released in metabolic events and its effects. Lipid peroxidation – chain reaction at cell membrane, mitochondrial double membrane. Antioxidant defense mechanism, Glutathione cycle, Vit.C defense cycle, Role of Selenium in defenses.

**UNIT- IV**

Phytotherapeutics in rejuvenating organ function; Liver function, Kidney function, Blood pressure regulation, Uterine function, Blood sugar regulation, Reduction of cholesterol synthesis, Production, function and Regulation of endocrine hormone:Pancreas, gonadal, Pituitary gland and Thyroid hormones. Anti-aging properties in phytochemicals. Anti-inflammatory properties of phytochemicals.

**UNIT- V**

Experimental animals; models, rats, mice & rabbits; inbred strain; collection of different samples; whole blood, serum, organs etc... Routes of inductions for experimental preparations..Mechanism of action of Paracetamol, STZ, IST, ISO, Carageenum, CCl<sub>3</sub>, Alloxan. Animal Tissue Culture in research and phytotherapeutics invention.

## REFERENCES

1. Phytochemicals studies and analysis- Raman, 2<sup>nd</sup>Edn. , 2005.
2. Physiology by Rana Sindhe and Chatterjee.
3. Role of Biotechnology in Medicinal and Aromatic Plants ,Volume-II, Irfen .A .Khan,Atiya Khanum
4. Medicinal plants in India , Indian Journal of Medical Research Seth S.D.Bhavana Sharma .
5. Antioxidants properties of some therapeutically active medicinal plant –an overview Gajera.H.P,Patel Sr .Gdakiya
6. Fundamental concepts of Bioinformatics, Krane et al., 2002, Benjamin Cummins
7. Nanobiotechnology Molecular Diagnostics; Current Techniques and Applications, Jain, K. K., 2006. Taylor & Francis.
8. Nanobiotechnology in Biology and Medicine; Methods,Devices and applications, 2007. CRC Press.

## GENERAL REFERENCE

1. Robbins Pathologic Basis of Disease. Cotran, R.S. et al., 5th ed. Saunders, 1994.
2. An Introduction to the Principles of Disease. Walter, J.B., 3rd ed. Saunders, 1992.
3. Harrison's Principles of Internal Medicine. Wilson, J.D. et al., 14th ed.vMcGraw Hill,1997.
4. The Metabolic Basis of Inherited Disease. Scriver, C.R., Beaudet, A.L.,Sly, W.S., Valle, D.1995.7th edr-McGraw Hill.
5. Current Diagnosis. Conn, RB. et al., 1997 9th edn. L. Saunders.
6. Current Medical Diagnosis and Treatment 1999. Schroeder, S.A. et al., 38th ed. Lange.
7. Williams Textbook of Endocrinology. v.iilson, J.D. and Foster, D.W., 1998. 9<sup>th</sup>ed. Saunders, 1998.
8. Goodman arid Gilman's The Pharmacologic Basis of Therapeutics, Gilman, A.G. et al.,1996. 9th ed. MacMillan.
9. Basic and Clinical Endocrinology. Greenspan, F.S Forsham, P.H. (Eds.), 1997.4th ed. Lange Series, Appleton and Lange.



**JOURNALS**

1. Americ Journal of Clinical Pathology
2. Annals of Clinical Biochemistry
3. Annals of Internal Medicine
4. British Medical Journal
5. Clinical Chimica Acta
6. Clinical Chemistry
7. Clinical Biochemistry
8. Clinics in Endocrinology and Metabolism
9. Clinics in Laboratory Medicine
10. Critical Review of Clinical Laboratory Sciences
11. Current Clinical Chemistry'
12. Endocrinology
13. Journal of Bone and Mineral Research
14. Journal of Clinical Chemistry and Biochemistry
16. Journal of g1mical Endocrinology and Metabolism
17. Journal Clinical and Laboratory Medicine
18. Journal of Clinical Pathology
19. Lancet
20. New England Journal of Medicine
21. Pediatric Research
22. Therapeutic Drug Monitoring
23. Scandinavian Journal of Clinical and Laboratory Investigation .
24. Science.
25. Online Journals: see the CSCC web site: . [www.csc.ca/library .shtml](http://www.csc.ca/library.shtml)

**WEB SITES**

1. Medical Biochemistry 8 /19/ 2002
2. UMMS - Biochemistry [http:// jwww.ummed.edu/. dept/ courses/weblinksjbiochem.html](http://jwww.ummed.edu/.dept/courses/weblinksjbiochem.html)
3. Biochemistry Review Tables 8/19/ 2002

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4. Glycolysis and the Krebs Cycle 8/19/2002
5. KEGG Metabolic Pathways 8/ 19/2002
6. Metabolic, Pathways of Biochemistry 8/ 19/2002
7. Stryer Biochemistry 8/ 19/2002
8. Interactive Biochemistry' Web Links 8 19/2002
9. BioChemNet: Biochemistry <http://schmidel.com/bionet/biochem.htm>
10. F1ATPase 8/19/2002
11. The F1-ATPase 8/19/2002
12. ATPase 8/19/2002
13. MITOMAP: A human mitochondrial genome data
14. <http://www.gen.emory.edu/mitomap.html>
15. CancerNet-Credible, current, and comprehen cancer information from the National Cancer institute 8/19/2002
16. British Medical Journal8/ 19/2002
17. Liver Disorders 8/19/2002 .
18. CBS Health Watch <http://healthwatch.medscape>
19. The Nobel Foundation 8/19/2002
20. ConsumerLab.com:independent tests of the, vitamin, and mineral supplements  
<http://www.consumerlab.com>
21. NIH Office of Diet. Supplements <http://odp.od.nih.gov/ods/databases/ibids.html>
22. Neuromuscular Home Page 8/19/2002
23. Harvard Medi School Course Pages8/19/2
24. The WWW Virtual Library: Cell Biology: Metabolism and Cellular Respiration 81  
19/2002
25. bioethics.net <http://www.med.upenn.edu/bioethicsj/index.shtml>
26. The Online Ethics Center 8/19/2002
27. Food and Drug Administration <http://www.fda.gov>
28. healthfinder: a gateway consumer health and human services information web site
29. <http://www.healthfinder.gov/>