**Syllabus for Advanced Biotechnology**

**Text: Biotechnology: Science for the New Millennium (2007) by Ellyn Daugherty**

**First Semester**

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| ChapterSection | Lesson Objective  | Key Concepts in Lecture/Discussion/Lesson |
| 1.11.2 | Defining BiotechnologyBiotechnology Products | * Biotechnology definition/description/domains
* Examples of products and companies
* Genetically engineered products
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| 1.3 | Selecting Potential Products | * Product Development Plan
* Research and Development, manufacturing
* Testing/clinical trials, regulation
 |
| 1.5 | Biotech Careers | * Types of Jobs/Careers
* Educational Requirements
 |
| 1.6 | Bioethics | * Morals and ethics
* Values Clarification Model for Decision-making
 |
| 2.12.2 | Organisms and their PartsCellular Organization | * Levels of biological organization
* Prokaryotic versus eukaryotic cells
* Model organisms and product manufacture
* Cell structure and role in biotech,
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| 2.3 | Molecules of Cells(2 class meetings) | * Survey of carbohydrates, lipids, proteins, and nucleic acids
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| 2.4 | The New Biotechnology | * Central Dogma of Biology
* Recombinant DNA
* Synthesis of genetically engineered products
 |
| 4.1 | DNA Structure and Function | * Double helix of nucleotide chains
* Nitrogenous bases and base pairing
* Semi-conservative replication
* Protein synthesis
 |
| 4.24.3 | Sources of DNAIsolating DNA | * Prokaryotic, eukaryotic, viral DNA
* Gene expression
* Media prep, bacterial cell culture, sterile technique
* Vectors and rDNA technology
* Transformation
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| 4.4 | Studying DNA using Gel Electrophoresis | * How a gel box separates molecules
* Agarose gel electrophoresis
* Data from agarose gels
 |
| 5.1 | Protein Structure Protein Function | * Protein functions
* Importance of antibodies and enzymes
 |
| 5.2 | Protein Production | * Protein synthesis
* Transcription, Translation
 |
| 5.3 | Enzymes | * Enzyme activity
 |
| 5.45.5 | Studying ProteinsApplications of Protein Analysis | * Polyacrylamide gel electrophoresis
* Protein Indicators
* Data from PAGE gels
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| 6.16.2 | Sources of ProductsProduct Assays | * Products from nature
* Comprehensive Product Development Plan
* Assays and their applications
 |
| 6.3 | Searching for New Products | * Herbal remedies, Rainforest products
* Active ingredients
* Antibiotics and antiseptics
 |
| 6.46.5 | Plant ProductsProducing rDNA Products | * Plant protein products
* Recombinant DNA Products
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| 8.1 | Steps in Genetic Engineering(2 class meetings) | * Locating “genes of interest”
* Restriction enzymes and recombinant DNA
* Cloning and manufacturing
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| 8.2 | Transforming Cells(2 class meetings) | * Transformation, transduction, and transfection
* Making rDNA, endonucleases, and RFLPs
* Performing a transformation, selection of transformants
 |
| 8.3 | After Transformation | * Scale-up of transformants
* Products Assays
 |
| 8.4 | Fermentation, Manufacturing, and GMP | * Kinds of fermentation
* Growing cultures, bacterial and mammalian cell culture
* cGMP
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| 9.1 | Harvesting Protein Product | * Protein recovery from cell culture
* Introduction to column chromatography
 |
| 9.4 | Product Quality Control(2 class meetings) | * Quality Control, Quality Assurance, QC/QA testing
* Clinical Testing
 |
| 9.5 | Marketing and Sales | * Factors that affect sales
* Proprietary/Patent Rights
 |
| 10.1 | Plant Propagation | * Sexual versus asexual reproduction (cloning)
* Meiosis and sex cell formation
* Pollination and fertilization
 |
| 10.210.3 | Plant AnatomyPlant Growth and Structure | * Plant cells, tissues, and organs
* Meristematic tissue
* Isolating Plant DNA
* Mitosis and growth
* Seed germination
 |
| 10.410.5 | Plant BreedingStatistical Analysis | * Alternation of generations
* Genotypes and phenotypes
* Selective breeding and Punnett squares
* Averages, 10% rule, standard deviation, and Chi square analysis
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| 11.111.2 | Cloning PlantsTissue Culture | * Asexual plant propagation, plant tissue culture
* Plant hormones
* Starting and maintaining cultures
 |
| 11.3 | Biotech in Agriculture and Horticulture | * Selective breeding, inbreeding, genetic testing
* Genetically modified crops
* Hydroponics
* Plant-based Pharmaceuticals
 |
| 11.411.5 | Plant Genetic Engineering | * Isolating and characterizing plant DNA
* Modifying plant DNA, *Agrobacterim*, and Ti plasmid
* *Arabidopsis* as a “model” organism
 |
| 12.112.2 | Drug DiscoveryCombinatorial Chemistry | * Medical biotechnology, drug development, drug discovery
* Organic synthesis, combinatorial chemistry, parallel synthesis, screening
 |
| 12.3 | Peptide and DNA synthesis | * Peptide synthesizers
* DNA synthesizers
 |
| 12.4 | Protein/Antibody Engineering | * Antibody specificity
* Flow cytometry, vaccines
 |
| 13.1 | DNA Synthesis | * DNA synthesis in vivo
* Chromosomes and homologous pairs
* DNA replication and DNA polymerase
* In vitro DNA synthesis
 |
| 13.2 | DNA Synthesis Products/Application | * DNA probes, primers
* Southern blots
* Microarrays
 |
| 13.3 | Polymerase Chain Reaction (PCR) | * Performing and analyzing a PCR reaction
* Thermal cyclers
* PCR optimization
 |
| 13.4 | Applications of PCR | * DNA fingerprinting, criminalistics, and more
* VNTRs
* Forensics
 |
| 14.1 | DNA Sequencing | * Reasons to sequence
* Dideoxynucleotide sequencing
* Sequencing results and “BLAST”
* Human Genome Project
 |
| 14.2 | Genomics | * Genomics and bioinformatics
* Other genome projects
* RNA and genomics
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| 14.3 | Protein Studies  | * Proteomics
* X-ray crystallography, mass spectrometry, NMR,
* ELISA, Western blots
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| 14.4 | Other Applications of Biotechnology(2 class meetings) | * Pharmacogenetics, personalized medicine
* Environmental Biotechnology
* Biodefense/Bioterrorism
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Second Semester

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| Unit | Key Concepts in Lecture/Discussion/Lesson | Estimated Time Frame |
| Hallmarks of Cancer | * Self-sufficiency in growth signals
* Insensitivity to anti-growth signals
* Evading programmed cell death
* Limitless replicative potential
* Developing blood vessels
* Tissue invasion and metastasis
* Deregulated metabolism
* Evading the immune system
* Genome instability
* Inflammation
 | 4 weeks |
| Immunology | * The origin of immunology
* Inherent immunity
* Humoral and cell mediated immunity
* Primary and secondary lymphoid organ
* Antigen
* B and T cells and Macrophages
* Major histocompatibility complex (MHC)
* Antigen processing and presentation
* Complement
 | 2 weeks |
| Virology | * dsDNA viruses
* ssDNA viruses
* dsRNA viruses
* (+)ssRNA viruses
* (−)ssRNA viruses
* ssRNA-RT viruses
* dsDNA-RT viruses
 | 2 weeks |
| Bioinformatics | * Major bioinformatics resources (NCBI, EBI, ExPASy)
* Sequence and structure databases
* Sequence analysis (biomolecular sequence file formats
* Scoring matrices
* sequence alignment, phylogeny)
* Genomics and Proteomics (Large scale genome sequencing strategies
* Comparative genomics
* Understanding DNA microarrays and protein arrays)
* Molecular modeling and simulations (basic concepts including concept of force fields)
 | 3 weeks |
| Stem Cell Biology | * Introduction to concepts in stem cell biology (renewal, potency, etc.), definition of terms, intro to tissue stem cells; cell cycle
* Germline stem cells and germline-derived pluripotent cells
* Embryonic Stem cells
* Induced pluripotent stem cells & direct differentiation
* Hematopoietic Stem cells – Notch
* Prostate and Mammary Stem cells; TGFß and GPCRs
* Telomeres in Stem cell Biology
* Mesenchymal SCs
* Cancer and stem cells; RTKs, TGFß
* Therapeautic prospects; tissue engineering
* Animal models of regeneration
 | 2 weeks |
| Epigenetics | * Introduction to epigenetics, basic concept overview and brief history of the field
* Epigenetic modifications and gene expression- DNA methylation, histone modifications
* Epigenetic modifications and gene expression
* Genomic imprinting in mammals
* Studying multiple layers of epigenetic regulation; genome-wide analysis of epigenetic marks
* Epigenetic programming in cell renewal and pluripotency
* Epigenetics in disease: Imprinting disorders, Rett syndrome, ICF syndrome, etc
* Cancer epigenetics & epigenetics in drug discovery
 | 3 weeks |
| Independent research assignment | * Student will choose a topic of interest
 | Remainder of semester |