Biotechnology Curriculum

I. Overview/General Information

1. Define biotechnology in such a way that it includes all the historic and current applications
2. List five major areas of application for biotechnology
3. Give at least 5 specific examples that shows use of biotechnology from all of the major areas listed above
4. Discuss the safety and ethical questions related to biotechnology industry

II. Macromolecules

A. Nucleic acid

1. List building blocks of nucleic acids
2. Identify Parts of nucleotide monomer (phosphate group, pentose, nitrogenous base)
3. Differentiate between RNA and DNA
4. Identify base pairing in DNA and its significance
5. Explain antiparallel nature of DNA
6. Differentiate between 5’ and 3’ end of DNA
7. Differentiate between nucleotide, DNA, gene, and chromosome
8. Differentiate between plasmid and chromosomal DNA

B. Protein

1. List building blocks of protein
2. Differentiate between polar, nonpolar, acidic and basic side groups of amino acids
3. Identify peptide bonds
4. Identify amino (N) and carboxyl (C) terminal of a protein
5. Differentiate between primary, secondary, tertiary and quaternary structure of a protein
6. Explain denaturation of a protein
7. List seven major function of proteins

III. DNA

A. Replication

1. Describe the semi conservative method of DNA replication
2. Describe the process of DNA eplication, including the role of origins of replication and replication forks
3. Explain the role of DNA polymerase
4. Define antiparallel and explain why continuous synthesis both DNA strands not possible
5. Differentiate between leading and lagging strand
6. Describe the significance of Okazaki fragments
7. Explain the roles of DNA ligase, primer, primase, helicase and single stranded binding proteins

B. Describe the role of DNA in protein production

1. Explain how RNA differs from DNA
2. Explain the flow of information from gene to protein
3. Distinguish between transcription and translation
4. Distinguish between coding and noncoding strand of DNA
5. Differentiate between exon and intron
6. Define codon and explain the relationship between linear sequence of codons on mRNa and the linear sequence of amino acids in a polypeptide
7. Explain the significance of the reading frame during translation
8. Differentiate between mRNA, tRNA and rRNA in terms of structure and function
9. Describe the process of translation (initiation, elongation, termination)
10. Explain the role that promoters, enhancers, activators and repressors may play in the role of gene expression
11. Describe transcriptional regulation through repression (tryptphan operon) and activation (lac operon)
12. Differentiate between structural and regulatory genes
13. Define point mutation
14. Distinguish between insertion, deletion and base-pair substitution

IV. Microorganism

1. Describe cell structures and their function in prokaryotic cells
2. Discuss the structure of viruses
3. Contrast prokaryotic cells to eukaryotic cells
4. Compare DNA in prokaryotes to that in eukaryotes
5. Identify the use of prokaryotes and viruses in biotechnological research

V. Techniques

A. Lab skills

1. Practice the use of: micropipette, centrifuge, inoculation loop, electrophoresis, vortex and water bath,
2. Familiarize with the use of safety equipment such as shower, goggles, fire extinguisher
3. Define biohazard, recognize the biohazard symbol and learn proper disposal techniques of biohazardous material
4. Practice sterile technique

B. Bacterial Culture

1. Know the use of Petrie dish, agar, selective and nonselective media
2. Know how to streak and grow a bacterial culture
3. Be able to inoculate a broth culture
4. Differentiate between a bacterial colony and ‘lawn’ of bacteria

C. DNA isolation

1. Isolate plasmid DNA
2. Isolate chromosomal DNA

D. Restriction enzyme

1. Describe the natural function of restriction enzymes
2. Describe the role of palindromic sequences in restriction site recognition
3. Differentiate between blunt ends and sticky ends of DNA
4. Interpret a restriction map for a given piece of DNA/plasmid

E. DNA Gel electrophoresis

1. Explain the theory of gel electrophoresis
2. Demonstrate the ability to pour, load, run and stain a gel
3. Compare staining techniques in terms of sensitivity and ease of use
4. Interpret DNA gel

F. Transformation

1. Explain the theory of transformation (genotype and phenotype)
2. Explain the process and application of transformation (nature of plasmid vector, competent cells)
3. Calculate transformation efficiency
4. Explain how to differentiate between transformed and non transformed bacteria (role of selective media)

G. Polymerase chain reaction (PCR)

1. Discuss the process of PCR (thermocycling, forward and reverse primer, polymerase, NTPs, buffer, target sequence, water control/blank)
2. Compare and contrast the process of PCR to DNA replication in terms of enzymes required, unwinding of DNA, type of primer, building blocks, temperature)
3. List several applications for PCR

H. Southern and Northern blotting

1. Explain the use of southern and northern blotting
2. Define RFLP (restriction fragment length polymorphism) and VNTR (variable number tandem repeat) and its use in restriction enzyme analysis

I. Column chromatography

1. Describe the theory of HIC (hydrophobic interaction chromatography)
2. Explain the process of HIC
3. Differentiate between binding-, washing- and elution buffers
4. List several applications of HIC