Multiple Category Scope and Sequence: Scope and Sequence Report For Course Standards and Objectives, Content, Skills, Vocabulary

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	Unit	Course Standards and Objectives	Content	Skills	Vocabulary
District Intermediate **Biotechnology (51.1201) (District)** 2014-2015 **Tuttle, Jonathon**	**Getting Started** (Week 1, 4 Weeks)	UT: CTE: Health Education, UT: Grades 9-12, Biotechnology Standard 1 Students will investigate the past, present and future applications of Biotechnology as well as relevant careers. ▪ Objective 1 Describe historical applications of Biotechnology. a. Create a timeline of historical biotechnology developments. b. Replicate a historical application of biotechnology. (e.g., yogurt, cheese, sauerkraut, bread.) ▪ Objective 3 Explore the various science and non-science fields and careers associated with biotechnology. a. Use the Internet, field trips, job fairs, interviews and speakers to explore biotechnology. b. Outline career paths for various occupations in the biotechnology field.	**Course Mechanics:** ▪ Canvas navigation ▪ Quizlet navigation ▪ CTSO opportunities ▪ Laboratory safety ▪ Making Biotech Real ▪ Lab notebook content ▪ Poster content **Scientific Method:** ▪ Experimental design	▪ 01.02 Research and present biotechnology concepts using effective communication skills ▪ 03.02 Maintain accurate records and documentation by reporting relevant data in order of occurrence	▪ antibiotic ▪ antibodies ▪ biotechnology ▪ cloning ▪ concentration ▪ data ▪ dependent variable ▪ DNA ▪ E. coli ▪ genome ▪ GMO ▪ Human Genome Project ▪ hypothesis ▪ independent variable ▪ negative control ▪ PCR ▪ plasmid ▪ positive control ▪ proteases ▪ reagent ▪ recombinant DNA technology ▪ restriction enzyme ▪ virus
	Biotech Biology Basics (Week 5, 6 Weeks)	UT: CTE: Health Education, UT: Grades 9-12, Biotechnology Standard 4 Students will describe the properties of atoms and molecules and prepare lab reagents. ▪ Objective 1 Explain chemical concepts relevant to biotechnology. a. Atomic mass (molecular weight/formula weight). b. Bonding (ionic, covalent, and hydrogen). c. Characteristics of the four types of bio-molecules (carbohydrates, lipids, proteins, nucleic acids).	**Biochemistry:** ▪ Macromolecules a. carbohydrates b. lipids c. proteins d. nucleic acids ▪ Molecular structure		▪ carbohydrates ▪ catalyst ▪ denature ▪ enzyme ▪ eukaryotic ▪ hydrogen bond ▪ hydrophilic ▪ hydrophobic ▪ lipids ▪ nucleic acids ▪ nucleotide ▪ peptide bond ▪ polymer ▪ polypeptide ▪ primary structure ▪ prokaryotic

d. Characteristics of molecules in water (hydrophobic vs. hydrophilic, polar vs. non polar).
e. Acid base chemistry, pH scale and buffer properties.

Standard 5
Students will describe the structure and function of cells and their components.

- Objective 1
  Identify key cellular components and correlate with function. (i.e. nucleus, chromosomes, ribosomes)
  a. Describe the structure of nucleus, nucleolus, endoplasmic reticulum, golgi apparatus, ribosomes, mitochondria, etc.
  b. Explain the major function of each.
- Objective 2
  Compare and contrast prokaryotic and eukaryotic cells.
  a. Describe a prokaryotic cell: example – cell size, cell wall, cell membrane, genetic material, etc.
  b. Describe a eukaryotic cell: example – cell size, cell membrane, genetic material, membrane bound organelles, etc.

Standard 7
Students will compare and contrast different types of nucleic acids and proteins and illustrate the flow of genetic information within the cell.

- Objective 3
  Describe the structure and function of proteins.
  a. Describe the four levels of protein structure.
  b. Explain the relationship between the structure and function of proteins.
  c. Identify functional classes of proteins. (i.e., structural, regulatory, enzymes, transport)
  d. Illustrate the primary, secondary, tertiary, and quaternary protein structure.

- Polymers

a. dehydration synthesis

b. condensation

Cells:

- Eukaryotic vs. Prokaryotic

- proteins
- quaternary structure
- respiration
- secondary structure
- substrate
- tertiary structure

	e. Discuss ways proteins are used in biotechnology. f. Use computer resources to visualize the three dimensional structure of proteins. (Protein data bank, Cn3D, Chime) g. Demonstrate the ability to use proper separation techniques to differentiate between proteins based on size and structure (chromatography and SDS-PAGE). h. Explore the effects of environment on the function of enzymes (i.e., temperature, pH, salt concentration).				
Basic Biotech Skills (Week 11, 4 Weeks)	UT: CTE: Health Education, UT: Grades 9-12, Biotechnology Standard 2 Students will demonstrate appropriate safety procedures and equipment use in the laboratory. ▪ Objective 1 Demonstrate appropriate use of personal protective devices. a. Describe how personal protective devices protect the experiment and the lab worker. b. Wear personal protective devices when appropriate. (e.g., lab coats, gloves, eye protection.) c. Demonstrate safe removal of gloves. ▪ Objective 2 Maintain a sanitary laboratory environment. a. Explain the appropriate sterilization methods. (e.g., steam, chemical - ethanol and bleach.) b. Demonstrate proper aseptic/sterilizing procedures. ▪ Objective 3 Exhibit appropriate behavior to protect coworkers and self. a. Explain the dangers of contamination via food, drink, cosmetics, lotion, eye drops and contact lenses. b. Follow proper disposal and clean-up procedures with respect	**Metric System** ▪ Prefixes ▪ Length, Volume, Mass, Temperature **Tools and Instruments Use** ▪ Pipettes ▪ Micropipettes ▪ Balances ▪ Microscopes ▪ Spectrophotometer ▪ pH meter **Solution Preparation** ▪ Solution, solvent, solute ▪ The Three Stooges formulas ▪ Concentration a. mass/volume b. % c. X d. Molarity	▪ 02.02 Demonstrate proper aseptic/sterilizing techniques ▪ 03.04 Practice proper use and handling of pipettes ▪ 04.04 Prepare solutions of defined concentrations and pH	▪ absorbance ▪ acid ▪ aqueous solution ▪ base ▪ buffer ▪ Curly ▪ dilution ▪ gram ▪ Larry ▪ liter ▪ mass ▪ micro ▪ micropipet ▪ milli ▪ Moe ▪ molarity ▪ mole ▪ molecular weight ▪ percent transmittance ▪ pH ▪ pipet ▪ solute ▪ solution ▪ solvent ▪ spectrophotometer ▪ volume	

to chemicals and laboratory equipment as indicated by SOPs and MSDS. (e.g., broken glass, sharps, spills.)
c. Show locations of emergency exits and equipment. (e.g., fire extinguishers, blankets, eye washes, showers.)

- Objective 4
  Use biotechnology laboratory equipment correctly and safely.
  a. Identify equipment and describe when to use it.
  b. Demonstrate the proper use of biotechnology equipment (micropipette, centrifuge, spectrophotometer, pH meter, electrophoresis apparatus – protein & DNA, thermocycler, microscope, autoclave, balance, water baths.)
  c. Demonstrate proper use and handling of micropipettes.

Standard 3
Students will follow laboratory procedures properly.

- Objective 1
  Follow laboratory protocols.
  a. Understand the purpose of individual steps within a protocol.
  b. Perform the steps of laboratory protocols accurately and in sequence.
- Objective 2
  Comply with policies and requirements for documentation and record keeping.
  a. Follow standard operating procedures.
  b. Maintain accurate records and documentation according to minimum good documentation practices (GDP).
- Objective 3
  Demonstrate proper handling of chemicals.
  a. Communicate the rationale for various laboratory-labeling procedures.
  b. Recognize and comply with the labeling of chemicals used in a

- pH
- Serial dilutions

laboratory setting for safe handling and storage. (flammability, corrosiveness, toxicity, etc.)
c. Reference and interpret the guidelines in Material Safety Data Sheets (MSDS).

Standard 4
Students will describe the properties of atoms and molecules and prepare lab reagents.

- Objective 1
  Explain chemical concepts relevant to biotechnology.
  a. Atomic mass (molecular weight/formula weight).
  b. Bonding (ionic, covalent, and hydrogen).
  c. Characteristics of the four types of bio-molecules (carbohydrates, lipids, proteins, nucleic acids).
  d. Characteristics of molecules in water (hydrophobic vs. hydrophilic, polar vs. non polar).
  e. Acid base chemistry, pH scale and buffer properties.
- Objective 2
  Demonstrate accurate and correct solution preparation.
  a. Use proper units of scientific measurement.
  b. Calculate concentrations of solutions (molarity, % volume per volume, % weight per volume).
  c. Calculate how to dilute a stock solution to make a working solution (C1V1 = C2V2).
  d. Measure and adjust the pH of specific solutions with commonly used acids and bases.
  e. Correctly label reagents, specimen samples, and reactions.
  f. Prepare solutions of defined concentrations and pH.
- Objective 3
  Relate dilution to solution preparation.
  a. Explain dilution principles.
  b. Prepare serial dilutions of specific solutions.

The Magic of DNA (Week 15, 6 Weeks)	UT: CTE: Health Education, UT: Grades 9-12, Biotechnology Standard 7 Students will compare and contrast different types of nucleic acids and proteins and illustrate the flow of genetic information within the cell. ▪ Objective 1 Describe the structure of nucleic acids. a. Identify the components of the nucleotides. b. Compare and contrast the structure and function of DNA and RNA. c. Explain how the chemical structure of DNA applies to gel electrophoresis. d. Perform a restriction digest and analyze the results with gel electrophoresis. ▪ Objective 2 Describe how DNA functions as a template for DNA replication. a. Identify the major components and outline the process of DNA replication. b. Explain how DNA replication applies to the amplification of nucleic acids in PCR and DNA sequencing. of nucleic acids in PCR and DNA sequencing. c. Amplify and analyze DNA using PCR and gel electrophoresis. d. Demonstrate the ability to use PCR technology. ▪ Objective 5 Describe how DNA mutations affect the organism. a. Characterize the different types of mutations. (e.g., point mutation, frame shift, nonsense, etc.) b. Explore the consequences of mutations on the organism. (e.g., cancer, genetic disease) c. Explore how DNA differs between individuals within a species.	**DNA** ▪ Structure ▪ Replication **Restriction Enzymes** ▪ Cut sites ▪ Palandromes ▪ Sticky ends ▪ Ligase ▪ Restriction digest **Gel electrophoresis** **Bioinformatics**	▪ 07.01 Perform and analyze DNA gel electrophoresis	▪ agarose ▪ antiparallel ▪ base pair ▪ bioinformatics ▪ chromosome ▪ complimentary DNA ▪ DNA base ▪ DNA polymerase ▪ DNA replication ▪ gel electrophoresis ▪ hydrogen bond ▪ ligase ▪ nucleic acids ▪ restriction enzymes ▪ restriction fragment ▪ sticky end
Life's Language (Week 21, 3	UT: CTE: Health Education, UT: Grades 9-12, Biotechnology	**Protein Synthesis**	▪ 07.02 Demonstrate the ability to use proper	▪ antibody ▪ anticodon

Weeks)

Standard 7
Students will compare and contrast different types of nucleic acids and proteins and illustrate the flow of genetic information within the cell.

- Objective 3
  Describe the structure and function of proteins.
  a. Describe the four levels of protein structure.
  b. Explain the relationship between the structure and function of proteins.
  c. Identify functional classes of proteins. (i.e., structural, regulatory, enzymes, transport)
  d. Illustrate the primary, secondary, tertiary, and quaternary protein structure.
  e. Discuss ways proteins are used in biotechnology.
  f. Use computer resources to visualize the three dimensional structure of proteins. (Protein data bank, Cn3D, Chime)
  g. Demonstrate the ability to use proper separation techniques to differentiate between proteins based on size and structure (chromatography and SDS-PAGE).
  h. Explore the effects of environment on the function of enzymes (i.e., temperature, pH, salt concentration).
- Objective 4
  Outline the process of protein synthesis as related to the Central Dogma of Molecular Biology.
  a. Explain the progression of information from DNA to traits.
  b. Identify the major components, outline the process and describe the products of transcription.
  c. Distinguish between transcription in prokaryotic and eukaryotic systems. (e.g., introns, exons, post transcriptional modifications, etc.)
  d. Identify the major components, outline the process and describe the product of translation. the

- Genetic information
- Central Dogma of Molecular Biology
- Transcription
- Translation
- Mutation

Microarray Technology

ELISA

PAGE

separation techniques to differentiate between proteins based on size and structure (chromatography and SDS-PAGE)

- antigen
- Central Dogma of Molecular Biology
- codon
- ELISA
- exon
- gene
- genetic code
- genome
- intron
- mRNA
- mRNA processing
- noncoding DNA
- PAGE
- polypeptide
- protein synthesis
- reverse transcriptase
- RNA polymerase
- rRNA
- splicing
- start codon
- stop codon
- transcription
- translation
- tRNA

	product of translation. e. Describe the uses of recombinant proteins in biotechnology. (e.g., medicine, agriculture, etc.) f. Manipulate the production of recombinant protein in bacteria. (e.g., GFP)			
Recombinant DNA Technology (Week 24, 4 Weeks)	UT: CTE: Health Education, UT: Grades 9-12, Biotechnology Standard 5 Students will describe the structure and function of cells and their components. ▪ Objective 2 Compare and contrast prokaryotic and eukaryotic cells. a. Describe a prokaryotic cell: example – cell size, cell wall, cell membrane, genetic material, etc. b. Describe a eukaryotic cell: example – cell size, cell membrane, genetic material, membrane bound organelles, etc. Standard 6 Students will demonstrate proper bacterial identification and maintenance of cultures. ▪ Objective 1 Prepare bacterial growth media. a. Identify growth requirements for common microorganisms. b. Utilize the appropriate media and conditions for specific experiments. (i.e. antibiotics, temperatures, selective media.) ▪ Objective 2 Inoculate agar and broth media. a. Explain the different methods of inoculation. b. Select the appropriate media and methods of inoculation. c. Inoculate media using various techniques. (i.e., streak, spread) d. Demonstrate the ability to culture and maintain microorganisms. ▪ Objective 3 Identify common categories of bacteria.	**Bacteria as model organisms** ▪ Bacterial types ▪ Classification ▪ Gram stain test ▪ Plate preparation ▪ Inoculating media ▪ Culturing **Plasmids** **Bacterial Transformation** **Protein Purification**	▪ 06.01 Prepare bacterial growth media ▪ 06.02 Demonstrate the ability to culture and maintain microorganisms ▪ 08.01 Perform a transformation and analyze results	▪ aerobic ▪ anaerobic ▪ antibiotic ▪ cell culture ▪ chromatography ▪ clones ▪ competent cells ▪ Escherichia coli ▪ gram- ▪ gram+ ▪ LB agar ▪ LB broth ▪ lysosyme ▪ medium ▪ pathogen ▪ pellet ▪ plasmids ▪ recombinant DNA ▪ supernatant ▪ transformation ▪ vector

	a. Explain and identify bacterial properties useful for classification (morphology, cell wall composition, and metabolism). b. Perform staining tests to identify bacteria (gram stain). Standard 8 Students will explain recombinant DNA techniques in bacteria. ▪ Objectives 1 Describe the use of plasmids in bacterial transformation. a. Describe the elements of a functional plasmid (origin of replication, selection gene, multiple cloning sites, and promoter). b. Explain the role of restriction enzymes in generating recombinant plasmids. c. Describe competent cells, transformation and selection methods. d. Perform a bacterial transformation and analyze results. ▪ Objective 2 Describe the process of plasmid DNA isolation. a. Analyze the protocol for isolating plasmid DNA. b. Understand how to quantify the amount of DNA purified.		
Biotechnology in Agriculture (Week 28, 5 Weeks)	UT: CTE: Health Education, UT: Grades 9-12, Biotechnology Standard 7 Students will compare and contrast different types of nucleic acids and proteins and illustrate the flow of genetic information within the cell. ▪ Objective 2 Describe how DNA functions as a template for DNA replication. a. Identify the major components and outline the process of DNA replication. b. Explain how DNA replication applies to the amplification of	**Plants as model organisms** ▪ Sexual vs. asexual reproduction ▪ Cloning **Genetically Modified Organisms (GMOs)** ▪ Bt ▪ Roundup Ready PCR Technology	▪ artificial insemination ▪ asexual reproduction ▪ Bacillus thruingiensis (Bt) ▪ embryo transfer ▪ embryonic stem cells ▪ enucleated oocyte ▪ genetically modified organism ▪ herbicide ▪ in vitro fertilization ▪ microinjection ▪ nuclear transfer ▪ pharmaceutical ▪ pharming

	nucleic acids in PCR and DNA sequencing. of nucleic acids in PCR and DNA sequencing. c. Amplify and analyze DNA using PCR and gel electrophoresis. d. Demonstrate the ability to use PCR technology. Standard 8 Students will explain recombinant DNA techniques in bacteria. ▪ Objectives 1 Describe the use of plasmids in bacterial transformation. a. Describe the elements of a functional plasmid (origin of replication, selection gene, multiple cloning sites, and promoter). b. Explain the role of restriction enzymes in generating recombinant plasmids. c. Describe competent cells, transformation and selection methods. d. Perform a bacterial transformation and analyze results.	▪ taq polymerase ▪ Primers ▪ Target region ▪ Phases a. Denaturation b. Annealing c. Elongation	▪ selective herbicide ▪ tissue culture ▪ transgenic
DNA Talks (Week 33, 4 Weeks)	UT: CTE: Health Education, UT: Grades 9-12, Biotechnology Standard 7 Students will compare and contrast different types of nucleic acids and proteins and illustrate the flow of genetic information within the cell. ▪ Objective 2 Describe how DNA functions as a template for DNA replication. a. Identify the major components and outline the process of DNA replication. b. Explain how DNA replication applies to the amplification of nucleic acids in PCR and DNA sequencing. of nucleic acids in PCR and DNA sequencing. c. Amplify and analyze DNA using PCR and gel electrophoresis. d. Demonstrate the ability to use	**DNA use in Forensics** ▪ STRs ▪ VNTRs ▪ Markers ▪ Probability	▪ anneal ▪ denaturation ▪ DNA fingerprint ▪ DNA hybridization ▪ DNA polymerase ▪ DNA replication ▪ extension ▪ human genome project ▪ microarray ▪ PCR amplification ▪ polymerase chain reaction ▪ primer ▪ SNP ▪ template ▪ VNTR

PCR technology.

- Objective 5
  Describe how DNA mutations affect the organism.
  a. Characterize the different types of mutations. (e.g., point mutation, frame shift, nonsense, etc.)
  b. Explore the consequences of mutations on the organism. (e.g., cancer, genetic disease)
  c. Explore how DNA differs between individuals within a species.

Biotech Course Wrap Up (Week 37, 2 Weeks)