Ohio CTE: Agricultural and Environmental Systems

Biotechnology

Research and Experiments: Use scientific methodology to conduct problem-based studies, develop products, and interpret results. 3.1

1. **Design a research plan, including the significance of the problem, purpose, hypotheses, objectives, appropriate controls, independent variables, dependent variables, methods of study, and a list of materials.** 3.1.1
2. **Examine sources for credibility.** 3.1.2
3. **Apply sampling methods that appropriately represent the population and implement procedures for systematic data collection.** 3.1.3
4. **Explain the importance and design of trialing, and the information gained from it.** 3.1.4
5. **Document results of the experiment in a laboratory notebook, including a statement of purpose, experimental design, observations, results, conclusions, and next steps.** 3.1.5
6. **Create, interpret, and use tabular and graphical displays and describe the data.** 3.1.6
7. **Compute measures of central tendency to interpret results and draw conclusions.** 3.1.7
8. **Define the concepts of confidence intervals and significant figures.** 3.1.8
9. **Use t-test and p-value to determine statistical significance of results.** 3.1.9
10. **Describe the relationships among variables using correlations and draw conclusions.** 3.1.10
11. **Draw conclusions based on observations and data analyses, recognizing that experimental results must be open to the scrutiny of others.** 3.1.11
12. **Prepare and present findings using scientific reports.** 3.1.12
13. **Evaluate experimental failure and use integrity to communicate findings.** 3.1.13
14. **Describe how biotechnology products are produced and used in the United States.** 3.1.14
15. **Describe how biotechnology products are regulated in the United States.** 3.1.15
16. **Describe biotechnology product safety assessment.** 3.1.16

	17 Identify the purpose of a bioreactor and its use in the agricultural industry. 3.1.17
Laboratory Standards Operational Procedures: Conduct experiments using proper industry-based protocols, methods, and techniques. 3.2	1 Use aseptic techniques to collect, prepare, and test samples. 3.2.1
	2 Prepare and dispense stock reagents, buffers, media, and solutions by calculating concentrations, adjusting factors such as pH, and selecting purification techniques and equipment. 3.2.2
	3 Test and maintain the integrity of stains, regents, chemicals, and mounts. 3.2.3
	4 Select and apply sterilization methods for regents, buffers, media, biological samples, and solutions. 3.2.4
	5 Perform laboratory measures by calculating and preparing a serial dilution, calculating quantities needed to perform a test analysis, and calculating unit conversions and concentrations (graphing results). 3.2.5
	6 Monitor physical properties of reagents, buffers, media, and solutions for conductivity and resistivity, pH, and turbidity, and explain the significance of each. 3.2.6
	7 Perform separation techniques, including chemical separations, chromatography, centrifugation, distillation and filtration, and interpret the results. 3.2.7
	8 Titrate liquids. 3.2.8
	9 Create a standard operating procedure and explain its use. 3.2.9
	10 Describe industry-based and required regulatory quality assurance practices for documentation. 3.2.10
Specimen, Equipment and Chemical Handling: Handle, prepare, transport, store, and dispose of specimens and chemicals. Monitor, record, and maintain the integrity of equipment and instrumentation, environmental conditions of the facility and inventory. 3.3	1 Prepare and interpret labels for chemicals, supplies, and equipment. 3.3.1
	2 Use chemical references to identify hazards associated with handling and storing chemicals. 3.3.2
	3 Safely transfer chemicals from storage containers to equipment used in the laboratory. 3.3.3
	4 Neutralize acids, bases, or caustic solutions for handling and disposal. 3.3.4
	5 Sample, monitor, and record the environmental conditions of a facility (e.g. air quality, HEPA, temperature, microbial contaminations). 3.3.5
	6 Identify and describe the purpose of common laboratory equipment. 3.3.6
	7 Select personal protective equipment for various laboratory protocols. 3.3.7

8 Identify required tools and procedures of different biosafety levels. 3.3.8

9 Adjust, calibrate, and perform systems diagnostics on laboratory equipment. 3.3.9

10 Use and maintain a record keeping system for laboratory equipment, chemicals, or products. 3.3.10

11 Use and maintain an inventory management system. 3.3.11

12 Use and calibrate precision weighing and measuring techniques (e.g. analytical balance, micropipette), based on the metric system. 3.3.12

13 Use volumetric glassware to accurately measure liquids. 3.3.13

Applying Chemistry to Laboratory Practices: Using common laboratory equipment, apply general and organic chemistry concepts to examine the structures, functions, binding of molecules, and methodologies for their purity and characterization. 3.4

1 Illustrate electron configurations of elements, compounds, and mixtures. 3.4.1

2 Use the periodic table to describe atomic structure and to characterize molecules based on functional groups. 3.4.2

3 Differentiate between organic and inorganic compounds. 3.4.3

4 Use common and chemical nomenclature for organic and inorganic materials. 3.4.4

5 Write names and formulas for common compounds. 3.4.5

6 Prepare solutions based on molarity, percent weight per volume (w/v) and percent volume per volume (v/v). 3.4.6

7 Describe chemical bonding, bond types, and the relationships that they have with the physical state of materials. 3.4.7

8 Apply the concepts of stoichiometry and the laws of thermodynamics to chemical reactions. 3.4.8

9 Balance chemical reactions. 3.4.9

10 Identify materials that can be used as a catalyst and describe their role in reactions. 3.4.10

11 Predict endothermic and exothermic characteristics of chemical reactions. 3.4.11

12 Use naming systems, including common and International Union of Pure and Applied Chemistry (IUPAC) conventions. 3.4.12

13 Calculate errors in various measurements, based on data acquired using common laboratory equipment. 3.4.13

14 Apply standard rules for determining the number of significant figures in measurements and in the answers to corresponding calculations. 3.4.14

15 Convert units of measure from English to metric, within the English system, and within the metric system. 3.4.15

16 Calculate the volume, temperature, and pressure of gases using the ideal gas law, Charles's Law, and Boyle's Law. 3.4.16

Microbiology Testing and Technology: Classify, differentiate between, and test for various kinds of microorganisms and microbial by-products. 3.5

1 Explain classification, composition, and preparation of culture media and prepare media for propagation. 3.5.1

2 Operate centrifuge, dissecting scope, compound microscope, spectrophotometer, incubator, colony counter, pipettes, and other basic microbiology and analytical equipment to examine biological specimens. 3.5.2

3 Explain the principles of microscopy and process a specimen for light microscopy. 3.5.3

4 Perform Gram staining to identify morphology and gram results of bacteria. 3.5.4

5 Prepare, incubate, and identify colonies microscopically and macroscopically (e.g., colonial morphology, staining procedures, biochemical analysis). 3.5.5

6 Use microbial taxonomy and classification systems to identify microbial organisms. 3.5.6

7 Compare and contrast cellular structure and functions of prokaryotic and eukaryotic cells. 3.5.7

8 Identify aerobic bacteria through morphological, physical, and biochemical properties. 3.5.8

9 Obtain specimens for microbiological testing. 3.5.9

10 Differentiate between types of viruses. 3.5.10

11 Explain virulence, pathogenicity, and the factors that contribute to pathogenicity. 3.5.11

12 Explain how chemical energy operates major cell processes (e.g. biosynthesis, movement, transport, growth). 3.5.12

13 Identify bacteriologic methods necessary for the isolation and identification of organisms. 3.5.13

14 Identify factors that affect and optimize rates of enzyme assay reactions. 3.5.14

15 **Describe the purpose of an enzyme-linked immunosorbent assay (ELISA) and interpret the results.** 3.5.15

16 **Describe types of assays and distinguish uses and limitations.** 3.5.16

17 **Follow complex instructions in performing an assay and explain the role of each step.** 3.5.17

18 **Perform biochemical assays of proteins, lipids, carbohydrates, nucleic acids, and enzymes.** 3.5.18

19 **Identify the purpose and implementation of bioassays for pathogens.** 3.5.19

20 **Apply quality assurance control processes within the lab setting (e.g. pre-analytic, analytic, and post-analytic sources of error).** 3.5.20

21 **Perform autoclave sterilization.** 3.5.21

Molecular-Genetics and Technology: Apply knowledge of genetic inheritance and modification to organisms and use genetic information and bioinformatics to analyze specimens. 3.6

1 **Use Punnett Square to predict and explain Mendel's Laws, genotype, and phenotype.** 3.6.1

2 **Explain epigenetics and provide examples of its effects.** 3.6.2

3 **Model, predict, and diagram the three-dimensional shape, types of bonds (covalent and hydrogen bonds), and antiparallel nature of DNA.** 3.6.3

4 **Model central dogma of molecular biology (e.g. replication, transcription, translation).** 3.6.4

5 **Describe post-transcriptional and post-translational modification of RNA and describe its function.** 3.6.5

6 **Explain gene editing including the process, possible benefits, and potential risks.** 3.6.6

7 **Identify, isolate, and manipulate peptides and proteins (i.e. primary, secondary, tertiary, quaternary structures).** 3.6.7

8 **Analyze DNA using common laboratory techniques (e.g. DNA isolation, gel electrophoresis, restriction enzyme digest, Southern Blotting, Northern Blotting).** 3.6.8

9 **Use bioinformatics to analyze DNA and proteins.** 3.6.9

10 **Explain cloning techniques including vector preparation, transformation, and selection.** 3.6.10

11 **Preform spectroscopy of biological materials explaining the principles behind the procedures, the purpose of a blank, and determine the concentration of biomolecular samples.** 3.6.11

12 **Evaluate genomes in relation to food, plants, animals, and natural resources.** 3.6.12

13 **Perform genotyping analysis for genetic diagnostics.** 3.6.13

14 **Transform bacteria with exogenous DNA to alter bacterial metabolism, reproduction, cell structures, and their functions.** 3.6.14

15 **Describe types and features of passive and active transport systems.** 3.6.15

16 **Describe molecular behavior and structure of large molecules, including carbohydrates, lipids, proteins, and nucleic acids.** 3.6.16

17 **Describe genome sequencing and the information gained from it.** 3.6.17

18 **Describe artificial selection and how it is used in plant and animal breeding.** 3.6.18

19 **Define genetically modified organisms and explain their impact on society.** 3.6.19

20 **Describe how vectors (e.g., plasmids, transposons, viruses) are used to transform hosts and microorganisms.** 3.6.20

21 **Explain gene by environment interactions.** 3.6.21

22 **Describe the difference between a quantitative and qualitative gene trait and give examples of each.** 3.6.22