

# 180-Hour, Skill Development Lab-based, Concept-Supported Agricultural Biotechnology Course Plan

**Suggested Lesson Planning Guide** (using *Biotechnology: Science for the New Millennium*, Ellyn Daugherty, 2006)

36 weeks, 5 hours of lab and lecture/discussion meetings/week

Activities may require adjustment to meet time limitations.

Biotech Online Activities, additional Biotech Live and Bioethics Activities, and skills testing may be added as needed.

Week	Lab(s)	Lab/Activity Lesson Focus	Text Section Support and Lecture Discussion Focus	Key Lab/Activity Skill Objectives Students will:
1	1a 1b  -  -	Scientific Notebook Laboratory Safety  Biotech Hubs Activity (www.BiotechEd.com) Biotech Company Stock Project (www.BiotechEd.com)	1.1 Defining Biotechnology 1.2 Biotechnology Products 1.3 Selecting Potential Products	- Start and maintain a legal scientific notebook - Learn emergency procedures and the location of safety hazards and emergency equipment - Setting up and stocking the biotech lab - Inventory Log (Biotech Live Activities 3.1 and 3.3) - Study of Biotech Industry (Ag focus) using Biotech Live Activities 1.1, 1.2, and 1.4 - Ongoing project – 1 <sup>st</sup> semester > presentations during Finals = 2weeks
2	1c - -	Cheese Production Chapter 1 Bioethics Activity Biotech e-Career Project –begin (www.BiotechEd.com)	1.4 Scientific Methodology 1.5 Biotech Careers 1.6 Bioethics	- Conduct a controlled experiment, analyze and report data - View interviews with biotech employees - Analyze a bioethical dilemma based on animal use
3	Ch 11 - 2c	Intro to Agricultural Biotechnology Biotech Online p.310 What is ARS? Microscopy	11.3 New Applications in Agriculture  2.1 Organisms and their Parts 2.2 Cellular Organization	- Give examples of agricultural biotechnology and its products - Discuss the role of USDA and ARS in ensuring safety of crops. - Learn microscope use for prepared and wet mount slides
4	2d  2e	Microscopic Measurement  Properties of Carbohydrates	2.2 Cellular Organization  2.3 Molecules of Cells	- Learn to estimate the size of microscopic specimen.  - Study the structure and characteristics of different carbohydrates and other biomolecules
5	3a 3b	Pipeting Micropipeting	3.1 Measuring Volumes	- Demonstrate skill using pipets and pipet pumps - Demonstrate skill using micropipets

6	- 3c	Pipet Skills Quiz Mass Measurement	3.2 Making Solutions	<ul style="list-style-type: none"> <li>- Demonstrate skill using pipets and micropipets</li> <li>- Demonstrate skill using balances and mixing solutes and solvents</li> </ul>
7	7a 7b  Ch 3	Using the Spec Using the Spec to Study Molecules Intro to Safe Use of Chemical Reagents	7.1 Using the Spectrophotometer	<ul style="list-style-type: none"> <li>- Learn how to operate a spectrophotometer and how light corresponds to colors of the visible spectrum</li> <li>- Use a VIS-spec to determine the absorption spectra and <math>\lambda_{\text{max}}</math> for three colored solutions</li> <li>- Intro to Using Chemical Reagents using Biotech Live Activities 3.3 and 3.4 (order chemicals)</li> </ul>
8	3e  3f	Mass/Volume Solutions Percent Mass/ Volume Solutions p.273 Pros and Cons of Fertilizer Use	3.3 Mass/Volume Solutions  3.4 Percent Mass/ Volume Solutions	<ul style="list-style-type: none"> <li>- Prepare various mass/volume solutions and check through spectrophotometry</li> <li>- Prepare various percent mass/volume solutions</li> <li>- Learn what a fertilizer is and the pros and cons of fertilizer use (p.273 Pros and Cons of Fertilizer Use)</li> </ul>
9	3g 3h	Molar Solutions Dilutions	3.5 Molar Solutions 3.6 Dilutions	<ul style="list-style-type: none"> <li>- Prepare various molar solutions</li> <li>- Prepare dilutions of solutions</li> <li>- Solution Preparation Skills Quiz</li> </ul>
10	7c 7d	Measuring pH Making Buffer	7.2 Introduction to pH 7.3 Buffers	<ul style="list-style-type: none"> <li>- Learn to use pH paper and a pH meter</li> <li>- Prepare a buffer to use in making a protein solution</li> <li>- Prepare buffers and test their ability to resist changes in pH</li> </ul>
11	4a 4b	DNA Solutions DNA Spooling	4.1 DNA Structure &Function	<ul style="list-style-type: none"> <li>- Prepare buffers and reagents for DNA isolation</li> <li>- Conduct alcohol precipitation of pure DNA sample</li> </ul>
12	4e 4f	Media Prep Sterile Technique	4.2 Sources of DNA	<ul style="list-style-type: none"> <li>- Prepare LB agar and LB broth</li> <li>- Pour sterile LB agar Petri plates</li> <li>- Discuss medical applications of sterile technique</li> </ul>
13	4g 4h	Bacteria Cell Culture Bacteria DNA Extraction	4.2 Sources of DNA 4.3 Isolating and Manipulating DNA	<ul style="list-style-type: none"> <li>- Streak isolated colonies and start broth cultures</li> <li>- Isolate genomic DNA from bacteria</li> </ul>
14	4i 4j  -	Agarose Gel Prep DNA Gel Electrophoresis Biotech Online p312-How much do you know about GMOs?	2.4 The "New" Biotechnology (rDNA and Genetic Engineering) 4.4 Gel Electrophoresis	<ul style="list-style-type: none"> <li>- Prepare an agarose gel</li> <li>- Load, run, stain and analyze DNA on a gel</li> <li>- Test knowledge and existing opinions to scientific advances in biotech</li> </ul>

15	-	GMO PCR/Genotyping (using kit from Ward's, Edvotek, Fotodyne or Bio-Rad)	13.1 DNA Synthesis in the Lab 13.3 Polymerase Chain Reaction 13.4 Applications of PCR Technology	<ul style="list-style-type: none"> <li>- Perform a PCR reaction</li> <li>- Use PCR to test DNA from a crop sample for a specific genotype (gained through genetic engineering).</li> </ul>
16	- -	Biotech Online p. 375 Bee Genomics Ch 14 Bioethics Activity	14.1 DNA Sequencing 14.2 Genomics/Genomic Projects	<ul style="list-style-type: none"> <li>- Describe how DNA sequencing is done and how it has impacted genome studies.</li> <li>- Explain how genome projects impact agricultural research and crop production</li> </ul>
17	-	Stock Project Summary and Presentations		<ul style="list-style-type: none"> <li>- Oral and PPT presentation of stock investment results.</li> </ul>
18	-	Biotech Notebook Final		<ul style="list-style-type: none"> <li>- Demonstrate the ability to retrieve accurate data and reference information from a legal, scientific notebook in a timely manner.</li> </ul>
19	10a	Flower Dissection	10.1 Intro to Plant Propagation 10.2 Plant Anatomy	<ul style="list-style-type: none"> <li>- Study of plant anatomy of reproductive structures</li> <li>- Biotech Live Activity 10.1, 10.2</li> </ul>
20	10b 10c	Seed Dissection Germination Study	10.2 Plant Anatomy 10.3 Plant Growth	<ul style="list-style-type: none"> <li>- Comparative study of seed germination</li> </ul>
21	10e	WFP Breeding	10.4 Intro to Plant Breeding	<ul style="list-style-type: none"> <li>- Dihybrid, heterozygous cross of selected WFP</li> <li>- Biotech Live Activity 10.4, 10.3, 11.4</li> </ul>
22	11a	Asexual Plant Propagation	11.1 Cloning Plants	<ul style="list-style-type: none"> <li>- Testing how media and plant organs affects rooting</li> </ul>
23	11c	Hormone Concentration Study	11.1 Cloning Plants	<ul style="list-style-type: none"> <li>- Testing how hormone concentration affects rooting</li> <li>- Biotech Live Activity 10.5</li> </ul>
24	11d	African Violet Cloning	11.2 Plant Tissue Culture	<ul style="list-style-type: none"> <li>- African Violet Tissue Culture</li> <li>- Biotech Live Activity 11.1, 11.5</li> <li>- Monarch Butterfly Bioethics Activity (Ch 10)</li> <li>- Plant Biologist Career Exploration</li> </ul>
25	5a -	Antibody Function  Biotech Immunology, Biotech Online p.337 Getting Sick	5.1 Structure and Function of Proteins 12.4 Creating Pharmaceuticals by Protein Engineering	<ul style="list-style-type: none"> <li>- Antibody-antigen testing</li> <li>- Describe immunology and the immune response</li> <li>- Explain how engineered proteins are used as pharmaceuticals.</li> <li>- Plant-based Pharmaceuticals</li> </ul>

26	5b or 5c 5g	Enzyme Function  PAGE (pre-lab)	5.3 Enzymes: Protein Catalysts  5.4 Studying Proteins Using PAGE	- Test enzyme activity at different concentrations  - Prepare animal muscle tissue samples to characterize proteins on a PAGE gel
27	5g	Identifying Animal Muscle Proteins using PAGE	5.4 Studying Proteins 5.5 Applications of Protein Analysis	- Load and run animal muscle tissue samples on vertical gels to study differences in protein composition. - Describe the value of protein PAGE in medical biotech
28	6d	Peroxidase Assay	6.4 Plant Proteins as Products	- Qualitative test for peroxidase activity - Biotech Live Activity 6.2 Herbal Remedies
29	6g 6h	Extracting HRP Assay for HRP with TMB	6.4 Plant Proteins as Products	- Isolate a plant enzyme - Colorimetric assay for peroxidase activity - Prepare for ELISA
30	14a	ELISA (lab)	14.3 Advanced Protein Studies	- Conduct a qualitative ELISA (antibody assay)
31	7g	Determining Protein Concentration	7.4 Determining Protein Concentration	- Use spectrophotometry and a best-fit standard curve to determine the concentrations of unknown protein (amylase) solutions
32	10e	Breeding Statistical Analysis	10.4 Intro to Plant Breeding	- Analyze results of dihybrid, heterozygous cross of selected WFP - Chi-Square analysis of breeding experiment data
33		Bioengineered Product Pipeline	Bioengineered Product Pipeline	- Biotech Live Activity 6.4 Product Pipeline Study focused on Agricultural Products - Give several examples of agricultural biotechnology products and their applications
34	Parts of 11j/ 11k	Testing for Genetic Engineering in Seeds	8.2 Transforming Cells	- Use of GUS staining and PCR to test for the presence of GUS gene in suspected GM seeds -
35	-		Bioengineered Product Pipeline Study presentations	Oral and PPT presentations of Bioengineered Product Pipeline studies
36	-	Lab Practical Final		- Demonstrate the ability to set-up a valid, controlled experiment to collect data similar to that in an agricultural biotechnology R&D, manufacturing, or quality control facility and analyze it in a timely manner. (ie. Testing for hemoglobin concentration)