BIO101

MERCER COUNTY COMMUNITY COLLEGE
DIVISION OF MATH SCIENCE AND HEALTH PROFESSIONS

COURSE OUTLINE

BIO101  General Biology I
Course Number  Course Title

4  3/3

Credits  Hours: lecture/laboratory

Catalogue Description

Introduces fundamental concepts and principles of biology. Topics include biological chemistry, cell biology, metabolism and energy, cell reproduction, molecular biology, and inheritance. Investigative laboratory exercises develop skills in basic techniques and reinforce lecture material. The course is intended for biology majors or non-science majors requiring a 4 credit laboratory course.

Prerequisites
High school biology or BIO 100; high school chemistry or CHE 100

Corequisites: BIO 101 Lab, MAT 135.

Revision date: Fall 2015

Required Texts
Exploring Biology in the Laboratory, 2nd edition.

Recommended Texts
Biology, 10th Edition (or 9th or 8th Edition)

Course Coordinator:
L. Blinderman
Email: blinderl@mccc.edu
Office: MS 110  Phone: (609)-570-3833
Information resources:
The library has a collection of books that students may use for reinforcement of the content being taught in this course. The lecture textbook and laboratory manual are available in the library.

Other learning resources:
Science Daily  http://www.sciencedaily.com/
Science News  http://www.sciencenews.org
NOVA videos  http://www.pbs.org/wgbh/nova/

Tutors  The Science Center is located in MS211 and provides tutoring, laboratory specimen, and microscopes.

General Information

MyMercer contains your MercerMail, financial information, class schedule, grades, and other information. www.mccc.edu/mymercer

A student who has special needs because of a disability is entitled to receive accommodations (Americans with Disabilities Act and Section 504 of the Rehabilitation Act of 1973). Arlene Stinson, LB 217, 570-3525, stinsona@mccc.edu

Course Goals (CG):
Students will be able to:
1. Apply concepts of evolution to all course topics (GE Goal 1, 3, 9 MCCC CS A, B)
2. Review foundational concepts in chemistry, including the chemistry of water and organic biomolecules (GE Goal 1, 3, MCCC CS A, B)
3. Elucidate the structure and function of eukaryotic cellular organelles (GE Goal 1, 3, MCCC CS A, B)
4. Describe the fluid mosaic architecture of the plasma membrane and its role in the maintenance of cellular homeostasis. (GE Goal 1, 3, MCCC CS A, B)
5. Integrate concepts of energy, metabolism, biochemistry, and molecular mechanisms in an analysis of enzyme function. (GE Goal 1, 3, MCCC CS A, B)
6. Examine in detail and integrate processes of cellular respiration and compare energy production in aerobes and anaerobes. (GE Goal 1, 2, 3, MCCC CS B)
7. Explore the eukaryotic cell cycle in depth including DNA replication). GE Goal 1, 3, 4 MCCC CS A, B, D)
8. Investigate chromosomal replication and movement in meiosis and connect crossing over to genetic diversity in sexually reproducing organisms. (GE Goal 2, 3, MCCC CS B)
9. Explain principles of genetics and elucidate their connection to modern genetic analysis. (GE Goal 2, 3, MCCC CS A, B, D)
10. Explain how genes codes for proteins including regulation of transcription and translation (gene expression). (GE Goal 3, MCCC CS B)
11. Examine and classify specimen using modern taxonomy. (GE Goal 1, 3, 4 MCCC CS A, B, D)
12. Employ the scientific method and practice skills in pipetting, measurement, methodology, and analysis in a series of laboratory experiments that support lecture concepts. (GE Goal 1, 2, 3, 4, 9 MCCC CS A, B, D)
General Education (GE) Knowledge Goals

Goal 1. Communication. Students will communicate effectively in speech and writing.
Goal 2. Mathematics. Students will use appropriate mathematical and statistical concepts and operations to interpret data and to solve problems.
Goal 3. Science. Students will use the scientific method of inquiry, through the acquisition of scientific knowledge.
Goal 4. Technology. Students will use computer systems or other appropriate forms of technology to achieve educational and personal goals.

MCCC Core Skills (CS)
Goal A. Written and Oral Communication in English. Students will communicate effectively in speech and writing, and demonstrate proficiency in reading.
Goal B. Critical Thinking and Problem-solving. Students will use critical thinking and problem solving skills in analyzing information.
Goal D. Information Literacy. Students will recognize when information is needed and have the knowledge and skills to locate, evaluate, and effectively use information for college level work.
Goal E. Computer Literacy. Students will use computers to access, analyze or present information, solve problems, and communicate with others.
Goal F. Collaboration and Cooperation. Students will develop the interpersonal skills required for effective performance in group situations.

CLASSROOM CONDUCT

The college welcomes students into an environment that creates a sense of community pride and respect.

Attendance It is a student’s responsibility to attend all classes. If a class meeting is missed, the student is responsible for content covered, announcements made in his/her absence, and for acquiring materials distributed in class. The laboratory component of the course is critical to satisfying the course objectives. A student who misses more than two laboratory sessions will fail the course. A passing grade must be obtained in the laboratory in order to pass the course.

Tardiness It is expected that students will be on time for all classes. Students late for an exam may be denied the opportunity to take the exam. A student who enters the laboratory late may not be able to participate in the lab. A student who is late for lab will miss the lab quiz and forfeit the points.

Behavior Students are expected to follow ordinary rules of courtesy during class sessions. The instructor has the right to eject a disruptive student from the class at any time. Phones and other devices are to be turned off prior to the start of and not used during class time. This includes texting. Leaving class and then returning while the class is in session is not acceptable behavior. Children are not permitted in the classroom without prior approval of the instructor.

ACADEMIC INTEGRITY STATEMENT: Any student who (a) knowingly represents the work of others as his/her own; (b) uses or obtains unauthorized assistance in the execution of any academic work; or (c) gives fraudulent assistance to another student is guilty of cheating. Violators will be penalized in accordance with established college regulations, policies, and procedures. All violations of academic integrity will be reported to the Academic Integrity Committee. Refer to the Student Handbook for additional information.
EXAMS: All exams covering lecture content are given in class. Students must take the exams when they are scheduled. Absence constitutes a zero score on any missed exam. Each exam can be taken one time only and there normally will be no make-ups. In the case of an emergency, the student must contact the instructor within 24 hours.

GRADING PROCEDURE: Exams, homework, in-class graded activities, lab quizzes, lab reports and practicals contribute to the points possible in the course. Lab comprises approximately 38% of the total points.

Because the laboratory component is critical towards satisfying the educational requirements of BIO 101, any student missing more than 2 laboratory sessions will receive an “F” (Failure) final grade for the semester unless the student has already officially withdrawn from the course. Missed laboratory sessions cannot be made up; any potential concerns should be discussed in advance with the laboratory instructor.

<table>
<thead>
<tr>
<th>% of Total Points Earned</th>
<th>Final Course Grade</th>
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<tbody>
<tr>
<td>93 – 100</td>
<td>A</td>
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<td>90 – 92</td>
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LECTURE OUTLINE

<table>
<thead>
<tr>
<th>Week</th>
<th>Topic</th>
<th>Chapter</th>
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<tbody>
<tr>
<td>1</td>
<td>Introduction, Themes in Biology, Evolution</td>
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<tr>
<td>2</td>
<td>The Chemical Context of Life</td>
<td>2</td>
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<td>3</td>
<td>Water Supports Life</td>
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<tr>
<td>4</td>
<td>Carbon and the Molecular Diversity of Life</td>
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<td>5</td>
<td>The Structure and Functions of Large Biomolecules</td>
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<td></td>
<td>EXAM 1</td>
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<td>6</td>
<td>Cell Biology</td>
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<td>7</td>
<td>Cell Membrane Structure and Function</td>
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<td>8</td>
<td>Metabolism</td>
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<td>9</td>
<td>Cellular Respiration</td>
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<td></td>
<td>EXAM 2</td>
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<tr>
<td>11</td>
<td>The Cell Cycle and Cell Division/Mitosis</td>
<td>12</td>
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<td>12</td>
<td>Meiosis and Sexual Life Cycles</td>
<td>13</td>
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<td>13</td>
<td>Mechanisms of Inheritance</td>
<td>14</td>
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<td>14</td>
<td>The Chromosomal Basis of Inheritance</td>
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<td>15</td>
<td>DNA Replication</td>
<td>16</td>
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<td>16</td>
<td>From Gene to Protein: Gene Expression</td>
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# SCHEDULE OF LAB EXPERIMENTS AND EXERCISES

<table>
<thead>
<tr>
<th>Week</th>
<th>Laboratory</th>
<th>Lab Exercise</th>
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<tbody>
<tr>
<td>1</td>
<td><strong>The Scientific Method, Measurement</strong></td>
<td>1, 2</td>
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</table>
| 2    | **The Microscope**  
Quiz #1 | 3 |
| 3    | **pH, Composition of Organic Molecules**  
Quiz #2 Microscope | 4, 5 |
| 4    | **Enzymes**  
Quiz #3 Chemical Aspects | 7 |
| 5    | **Diffusion and Osmosis**  
Quiz #4 Enzymes | 8 |
| 6    | **The Cell**  
Quiz #5 Diffusion and Osmosis | 6 |
| 7    | **LAB PRACTICAL 1**: Labs Weeks # 1 to 6 | |
| 8    | **Cellular Respiration**  
No quiz | 10 |
| 9    | **Classification, Viruses**  
Quiz #6 Cellular respiration | 16, 17 |
| 10   | **Bacteria**  
Quiz #7 Classification and Viruses | 18 |
| 11   | **Protists**  
Quiz #8 Bacteria | 19 |
| 12   | **Cell Division**  
**Meiosis**  
Quiz # 9 Protists | 11, 12 |
| 13   | **Heredity, Electrophoresis**  
Quiz #10 Cell Division | 13 handout |
| 14   | **LAB PRACTICAL 2**: Labs Weeks #8 to 13 | |

The course instructor reserves the right to change the schedule and grading procedure at any time.
UNIT OBJECTIVES
Objectives Chapter 1 (Course Goals 1, 2, 3, 11, 12)

1. Define the terms evolution and biology
2. Describe characteristics of living things including regulation, energy processing, growth and development, reproduction, response to environment, evolutionary adaptation, and order
3. Explore the hierarchy of the biosphere, ecosystems, communities, populations, organisms, organ systems, organs, tissues, cells, organelles, molecules, and atoms
4. Contrast unicellular and multicellular life forms
5. Explain how emergent properties result from arrangement and interaction of parts within system
6. Discuss the utility of reduction and of systems biology in the study of life
7. Explore how organisms interact with environments, exchanging matter and energy
8. Examine cycling of nutrients and flow of energy in ecosystem dynamics
9. Review forms of energy including light, chemical, kinetic, and thermal
10. Discuss the relationship between structure and function as a major theme in biology
11. Discuss cells as the most basic form of life
12. Examine characteristics of cells including cell membrane, DNA, cellular reproduction
13. Contrast prokaryotic and eukaryotic cells and provide examples of each
14. Explain how DNA serves as the genetic code and hereditary material
15. Discuss feedback mechanisms and provide ex. of positive and negative feedback
16. Analyze evolution as the core theme in biology
17. Review the age of the earth and the age of life in billions of years
18. Define taxonomy and discuss its utility in classification of living things
19. Review the characteristics and examples of the 3 domains of life including bacteria, Archaea, and Eukarya. Place organisms in the correct domain.
20. Discuss why evolution is considered the major theme in biology
22. Describe in detail Darwin’s observations: that natural selection includes random variation, more offspring produced than can survive, competition, adaptation at the species level, reproductive fitness, heritable traits
23. Discuss the difference between microevolution (genetic change on the population level) and speciation
24. Examine examples of adaptations in plants and animals and analyze the mammalian forelimb as an example of homologous structures with an evolutionary relationship
25. Explore the Galapagos finch as an example of ancestral and descendent species
26. Contrast between hypothesis and a theory in science. Provide an example of a scientific theory.
27. View biology through the lens of the natural world and evidence based data
28. Explain hypothesis testing and why a valid hypothesis is testable, falsifiable
29. Construct an experiment using the scientific method including an experimental variable, control treatment (group), controlled variables, dependent variable (lab)

Objectives Chapter 2: The Chemical Context of Life (Course Goals 1, 2, 12)

1. Contrast the following terms and concepts: matter, element, compound
2. Examine the elements essential to life including CHON
3. Provide an example of a trace element important in normal body functioning
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4. Examine an atom and its subatomic particles
5. Discuss the use of radioactive isotopes
6. Distinguish between a structural and molecular formula
7. Contrast covalent, ionic, and hydrogen bonds
8. Explain importance of molecular structure with respect to function
9. Analyze a reaction to identify the reactants and the products.
10. Provide the molecular formula and common names of the reactants and products in photosynthesis
11. Determine the pH of substances and perform an experiment to investigate buffer action (lab)

Objectives Chapter 3: Water (Course Goals 1, 2, 12)
1. Discuss the importance of water as a medium for life on Earth
2. Describe how the properties of water support life: cohesion, adhesion, and surface tension, temperature (including kinetic energy, heat, and specific heat), and water as a solvent
3. Discuss ability of water to retain and release heat and the application to cells, lakes, and oceans
4. Describe the effects of evaporative cooling. Explain how sweating enables some life forms to survive.
5. Explore water as a solvent including the definitions of solute, solvent, hydrophilic, hydrophobic, aqueous and colloidal solutions
6. Explain the relationship between pH and H+ ions, and the logarithmic pH scale
7. Provide examples of acids, bases, and neutral substances
8. Explain why buffers are essential to living organisms

Objectives Chapter 4: Carbon (Course Goals 1, 2, 12)
1. Examine the ability of carbon to form complex and diverse molecules
2. Contrast organic with inorganic molecules
3. Provide examples of organic molecules
4. Analyze the bonding of carbon atoms with hydrogen, oxygen, and nitrogen atoms
5. Provide a definition and examples of hydrocarbons
6. Define isomer and provide examples of isomers
7. Recognize 7 functional groups including hydroxyl, carbonyl, carboxyl, amino, sulfhydryl, phosphate, methyl
8. Examine the structure and function of the ATP molecule

Objectives Chapter 5: Biological Molecules (Course Goals 1, 2, 12)
1. Identify 4 classes of large biomolecules and distinguish between a monomer and a polymer
2. Outline classification of carbohydrates: simple sugars, disaccharides, starches, monomers, polymers
3. Discuss the importance of glucose, starch, cellulose, glycogen, and chitin in living organisms
4. Compare and contrast the carbohydrates found in animals and plants and the difference between structural and storage polysaccharides
5. Describe categories of lipids including fats (saturated, unsaturated, partially hydrogenated, and triglycerides), steroids (including cholesterol) and phospholipids
6. Explain the importance of phospholipid structure to cell membranes
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7. Provide examples of the functions of various proteins
8. Discuss the function and characteristics of enzymes
9. View the 20 amino acids
10. Examine the primary, secondary, tertiary, and quaternary structures of proteins and differentiate between each level of complexity
11. Explain why protein denaturation affects protein function
12. Define: DNA, nucleotide, gene, and chromosome
13. Analyze nucleotide structure: nitrogenous base, deoxyribose sugar, and phosphate group
14. Explore the sugar/phosphate backbone in a DNA helical polymer
15. Practice using base complementation (A:T G:C) to determine the second strand of DNA given one strand
16. Analyze data from a series of experiments on enzyme action (lab)
17. Perform a series of experiments to determine the chemical composition of substances (lab)
18. Determine the independent variable, dependent variables, and controlled variables in a laboratory exercise on biomolecules (lab)

Objectives Chapter 6: Cell Biology (Course Goals 1, 2, 3, 11, 12)
1. Examine cells as the fundamental units of life
2. Contrast the utility of light microscopes, scanning electron microscopes, and transmission electron microscopes
3. Compare the architecture of prokaryotic and eukaryotic cells
4. Distinguish between a nucleoid region and a nucleus
5. Describe the architecture of the phospholipid bilayer of cell membranes and explain how this structure is a selectively permeable
6. Explain why a high surface area to volume ratio is advantageous for cells
7. Detail the components of eukaryotic nuclear membrane including double layer, pores.
8. Find and describe the nucleolus, chromatin
9. View cellular locations of ribosomes (bound and free), describe role in protein synthesis
10. List components of endomembrane system: endoplasmic reticulum, Golgi apparatus, lysosomes, vacuoles
11. Examine cellular location of smooth ER, rough ER and describe the general functions of each
12. Explain why RER is both membrane factory, protein modifier, and maker of vesicles
14. View the Golgi and a protein modifier and its synthesis of transport vesicles
15. Analyze the lysosome with respect to its role in degradation and recycling of macromolecules
16. Associate phagocytosis and the formation of a food vacuole with lysosome activity
17. Discuss utility of contractile vacuoles in the regulation of water in some Protista
18. View a plant central vacuole and note its size and role in storage of molecules, water, and isolation of harmful materials from the cell
19. Examine the architecture and function of mitochondria
20. Identify photosynthesis as the reaction that occurs within the plant chloroplast
21. Locate peroxisomes in the cytoplasm and examine their role in the detoxification of cellular toxins.
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22. Discuss the role of the cytoskeleton in the maintenance of cellular structure, organization, and movement (motor proteins)
23. Contrast microtubules, microfilaments, and intermediate filaments
24. Locate cellular centrosomes and examine the 9 microtubule-based double centrioles
25. View sperm and cilia as motile structures employing microtubule architecture
26. Examine extracellular structures of cell wall (plants), extracellular matrix and cell junctions
27. Describe the function of glycoprotein and integrins in the extracellular matrix
28. Examine living cells using light microscopy from the animal, plant, and fungi kingdoms of life (lab)
29. Discuss the structure of each organelle found in a plant and animal cell using models (lab)

Objectives Chapter 7: The Plasma Membrane (Course Goals 1, 2, 3, 4, 12)
1. Examine the fluid mosaic model of plasma membrane including membrane fluidity
2. Examine role of fatty acids, cholesterol, and phospholipids in the plasma membrane
3. Discuss features of membrane proteins: peripheral, integral, transmembrane, amphipathic
4. Analyze how the plasma membrane enables the cell to be selective
5. Provide an example of a receptor protein embedded in the plasma membrane
6. Describe how transport proteins, aquaporins, carrier proteins, and channel proteins allow the passage of certain molecules through the plasma membrane and provide examples of these molecules
7. Discuss the role of glycoproteins in cell-cell recognition
8. Discuss diffusion as a passive transport process and its importance in the passage of molecules across cell membranes
9. Detail the importance of osmosis to cells and the difference in cellular response to isotonic, hypertonic, and hypotonic solutions in animal and plant cells
10. Describe facilitated diffusion as a passive process that uses transport proteins and provide an example of a molecule transported by facilitated diffusion
11. Contrast active and passive transport processes
12. Describe in detail the sodium/potassium pump as an active transport process and the role of electrochemical gradients in membrane potential
13. Examine the bulk transport processes of endocytosis and exocytosis
14. Examine the role of the lysosome in phagocytosis
15. Contrast pinocytosis and phagocytosis
16. Generate and analyze data from experiments on diffusion and osmosis (lab)
17. Expose cells to hypertonic and hypotonic environments and view via microscopy (lab)

Objectives Chapter 8: Metabolism (Course Goals 1, 5, 12)
1. Define metabolism
2. Detail a metabolic pathway and explain the role of enzymes in metabolism
3. Compare catabolic and anabolic processes
4. Define terms: energy, kinetic energy, heat energy, potential energy, chemical energy
5. Explain the first law of thermodynamics, principle of conservation of energy, and relationship to metabolism
6. Explain the second law of thermodynamics and its importance in biology
7. Define free energy and compare exergonic and endergonic reactions in terms of $\Delta G$
BIO101

8. Describe the characteristics of a spontaneous reaction
9. Examine cellular respiration, \( \text{C}_6\text{H}_{12}\text{O}_6 + 6 \text{O}_2 \rightarrow 6 \text{CO}_2 + 6 \text{H}_2\text{O} \) as exergonic reaction
10. Examine photosynthesis, \( 6\text{CO}_2 + 6\text{H}_2\text{O} (+ \text{light energy}) \rightarrow \text{C}_6\text{H}_{12}\text{O}_6 + 6\text{O}_2 \)
    endergonic reaction
11. Describe the cell as an open system not in equilibrium
12. Analyze the ability of cells to couple reactions to do work
13. View structure of ATP and hydrolysis of terminal phosphate to make energy available for work
14. Examine the cellular mechanism of phosphorylation
15. Show how ADP is phosphorylated to regenerate ATP
16. Explain how enzymes speed up metabolic reactions by lowering energy barriers \( E_a \)
17. Analyze a graph comparing a reaction with, and without, an enzyme. View the transition state.
18. Examine the effect of temperature and pH on enzyme activity
19. Define: substrate, reactant, product, enzyme, active site, induced fit, ES complex
20. View the role of cofactors and coenzymes in enzyme activity
21. Compare competitive inhibitors and non-competitive inhibitors in enzyme action
22. Explain how allosterically regulated enzymes have active and inactive forms
23. Discuss the mechanism of feedback inhibition in the regulation of metabolic processes

Objectives Chapter 9: Cellular Respiration (Course Goals 1, 6, 12)
1. Examine the connectedness between photosynthesis and cellular respiration
2. Compare the exergonic breakdown of molecules in fermentation, aerobic respiration, and anaerobic respiration
3. Discuss 3 processes in cellular respiration: glycolysis, the citric acid cycle, and oxidative phosphorylation, relative amounts of ATP production, and cellular location
4. Examine the oxidation of glucose to pyruvate in glycolysis and explain the fate of each reactant in this reaction
5. Understand that glycolysis includes 10 enzymatic steps and occurs in the cytoplasm of all cells
6. Examine the mechanism of the 8 enzymatic steps in the citric acid cycle (Krebs cycle)
7. Explain how pyruvate enters the mitochondria and is modified prior to the first step of the citric acid cycle
8. Describe (in general) the role of NADH and FADH2 generated from glycolysis and the citric acid cycle in the electron transport chain
9. Review the role of the electron transport chain in the mitochondrial cristae
10. Describe the role of H+ ions and ATP synthase in the generation of ATP
11. Relate the sequence glucose → NADH → electron transport chain → proton-motive force → ATP to cellular respiration
12. Describe conversion of pyruvate to ethanol in alcohol fermentation in yeast
13. Describe conversion of pyruvate to lactic acid in fungi, bacteria, and muscle cells
14. Contrast facultative anaerobes, obligate aerobes, and obligate anaerobes
15. Conduct experiments and analyze data from animals, plants, and yeast experiments in the generation of CO2 from cellular respiration or fermentation (lab)
**Glycolysis** cytoplasm
Glucose oxidized: 1 glucose $\rightarrow$ 2 ATP and 2 pyruvate
NAD+ reduced to NADH
No O$_2$ required, no CO$_2$ produced
Energy investment and energy payoff phases (net gain 2 ATP)

**Citric Acid cycle** mitochondrial matrix
2 ATP per 1 glucose (2 pyruvate)
CO$_2$ generated
NADH and FADH2 (electron donors) generated
Pyruvate converted to acetyl CoA prior to cycle

**Oxidative phosphorylation** Occurs in mitochondrial cristae
NADH and FADH2 donate electrons to electron transport chain
Cytochrome proteins involved
Oxygen required
H+ gradient drives ATP synthase
~36 ATP per glucose total for cellular respiration

**Fermentation** Occurs in cytoplasm
Anaerobic
Uses pyruvate
Generates alcohol (or lactic acid)
Generates NAD+ to be used in sustaining glycolysis

**Objectives Chapter 12: The Cell Cycle** (Course Goals 1, 7, 12)
1. Examine the role of binary fission in the reproduction of unicellular organisms
2. Explain reasons why somatic cells undergo cellular reproduction
3. Distinguish between somatic and gamete cells
4. Differentiate diploid from haploid
5. Contrast mitosis and cytokinesis
6. Examine in detail interphase and mitosis phases of the cell cycle
7. Compare the G1, S, G2, and Go phases of interphase in terms of cellular events
8. Follow formation of sister chromatids during interphase and mitosis (P,M,A,T)
9. Describe the formation and role of mitotic spindle in mitosis
10. Examine centrosomes and the centrioles contained within them
11. Describe how microtubule polymerization and depolymerization moves chromosomes
12. Contrast interphase, prophase, metaphase, anaphase, telophase and cytokinesis
13. Contrast a cleavage furrow observed in animal cells with a cell plate in plant cells
14. Compare cell cycle length in an embryonic cell and a brain cell
15. Describe the role of cell cycle checkpoints
16. Examine whitefish blastula and onion root tips to uncover hallmarks of cell cycle phases (lab)
17. Complete a series of online interactive exercises to analyze the role of organelles and other cellular structures in the cell cycle (lab)

**Objectives Chapter 13: Meiosis** (Course Goals 1, 7, 8)
1. Define heredity, variation, and genetics
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2. Examine human somatic cells with 46 chromosomes as homologous pairs in a karyotype
3. View a karyotype to recognize autosomes and sex chromosomes
4. \(23 + 23 = 46\) represents human fertilization and review behavior of chromosomes in human life cycle
5. Distinguish between diploid and haploid cell, somatic and germ cells
6. Compare mitosis and meiosis in terms of role and cellular outcomes
7. Describe Interphase I including DNA replication
8. Describe Prophase I: chromosome condensation, crossing over and synapsis, chiasmata, kinetochores
9. Describe Metaphase I including the homologs on the metaphase plate
10. Describe Anaphase I including separation of homologous chromosomes with sister chromatids joined
11. Describe Telophase I and cytokinesis, haploid chromosomes in daughter cells
12. Describe Prophase II, Metaphase II, Anaphase II and Telophase II to explain how 4 haploid and unique cells are produced via meiosis

Objectives Chapter 14: Genetics (Course Goals 1, 8, 9, 11, 12)
1. Describe the work of Gregor Mendel (1800s)
2. Explain the characteristics of Pisum sativum that make it a useful genetic model
3. Differentiate between a character (gene) and a trait (allele)
4. Explain how Mendel’s ability to cross fertilize or self-fertilize pea plants enabled him to control mating
5. Distinguish between a true-breeding parental, f1, and f2 generation in a Mendelian monohybrid cross
6. Discuss the principle of dominance
7. Examine phenotypes that result from particular genotypes
8. Contrast between homozygous recessive, heterozygous, homozygous dominant genotypes
9. Discuss the principle of random segregation of alleles into gametes
10. Employ the Punnett square in one gene crosses
11. View two gene crosses to illustrate the principle of independent assortment of genes into gametes (assume genes on different chromosomes)
12. Use a dihybrid cross to illustrate independent assortment. Construct a Punnett square to examine genotypic and phenotypic frequencies of offspring
13. Explain codominant relationship between the \(I^A\) and \(I^B\) alleles in humans
14. Examine blood alleles \(I^A\) and \(i\) alleles in humans to illustrate multiple alleles. Use Punnett square to determine frequencies of blood types in offspring
15. Contrast single gene traits with polygenic traits and provide examples of each
16. View albinism as an example of a recessively inherited trait
17. View achondroplasia as an example of a dominantly inherited trait
18. List examples of disorders that have a multifactorial component (genetics + environment)
19. Provide and example of a phenotype that results from the interaction of many gene products (polygenic trait)

Objectives Chapter 15: Chromosomes (Course Goals 1, 8, 9, 12)
1. Describe chromosome theory of inheritance and how it differs from Mendel's work
2. Outline Morgan’s experiments with Drosophila eye color at Columbia U.
3. Explain why most sex-linked genes are located on X chromosome rather than Y
4. Describe human XY sex determination system
5. Compare heterozygous and homozygous females for X-linked traits with hemizygous males
6. Examine colorblindness as example of an X-linked gene and compare its prevalence in males and females.
7. Compute the expected number of Barr bodies in a somatic cell nucleus and explain the relationship between X inactivation and this structure
8. Explain why unlinked genes assort independently into gametes
9. Relate crossing over between homologous non-sister chromatids during meiosis to genetic recombination
10. Correlate non-disjunction of chromatids during meiosis to chromosomal number changes in offspring
11. Provide an example of a viable human monosomy (2n-1)
12. Provide an example of a viable human trisomy (2n+1)
13. Contrast duplications, deletions, inversions, and translocations
14. Explain the maternal inheritance of extranuclear mitochondrial DNA

Objectives Chapter 16: DNA (Course Goals 1, 8, 10, 12)
1. Examine composition of DNA including Chargaff’s observations concerning relative concentrations of purines and pyrimidines
2. Identify the 4 nucleotide building blocks of DNA
3. Describe in detail the Watson and Crick model of DNA based on X-ray diffraction data including complementary base pairing, antiparallel strands, sugar phosphate backbone, and hydrogen bonds
4. Be able to determine the complementary strand of DNA given a template strand
5. Describe semiconservative replication of DNA. Include enzymes and other proteins and role of each (helicase, topoisomerase, SSB, DNA polymerase, primase, ligase)
6. State the importance of the origin of replication in the initiation of DNA replication
7. Examine a replication fork and label components that interact with it
8. Review 5’ -> 3’ polymerase activity of DNA pol and difference between continuous synthesis on leading strand and discontinuous synthesis on lagging strand
9. Examine that DNA pol requires an RNA primer and template DNA to operate
10. Describe Okazaki fragments generation and attachment by DNA ligase
11. Note that telomeres shorten with each round of DNA replication and examine preservation of telomeres by telomerase

Objectives Chapter 17: From Gene to Protein (Course Goals 1, 10, 12)
1. Define gene expression, gene, transcription, translation
2. Explain the one gene-one polypeptide hypothesis
3. Note that uracil, is used in RNA and that RNA molecules single stranded
4. View ribosomes as assembly units for polypeptides. Note large and small subunits
5. Provide evidence for differences in gene expression between prokaryotes and eukaryotes
6. Describe the genetic code including: triplet code, codon, start codon, stop codons, redundancy, non-overlapping and become familiar with the use of a codon table
7. Explain initiation of transcription and role of the promoter. View upstream and downstream regions of gene
8. Examine elongation of the mRNA transcript by RNA pol in 5’->3’ direction
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9. View termination of transcription and release of the mRNA transcript
10. View transfer RNA - structure and function in translation - anticodon, amino acid site
11. Describe initiation of translation and the role of the AUG
12. Trace the steps in elongation of the polypeptide chain in protein synthesis including the P site of the ribosome and peptide bonds between amino acids
13. View termination and release of the polypeptide chain
14. Describe in brief post translational processing
15. View coupled transcription and translation in bacteria in contrast to compartmentalization of activities in eukaryotes