OUTCOMES BASED LEARNING MATRIX

Course: **Biological Principles (BIOL121)** Department: **Biology**

Course Description
This course introduces basic principles of biology. Topics include scientific method, evolution, cellular and subcellular structure, basic cell chemistry, transport across cell membranes, mitosis, meiosis, metabolism, photosynthesis, DNA structure and replication, protein synthesis, and patterns of inheritance. This course is required as a prerequisite for most other four-credit Biology courses. Lecture: 3 hours; laboratory: 2 hours
Prerequisites: One unit of high school science, preferably Biology, and Preparing for College Reading II (ENGL092), Introductory Writing (ENGL099), and Fundamentals of Mathematics (MATH010), or waiver by placement testing results, or Departmental Approval.

The individual outcomes listed in the first column answer the question: **What must the learner know and be able to do at the end of the course?** Items in the third column should answer the question: **How do we know?** The second column is where teachers can be most creative; it's for pedagogy. Each rectangle in column one contains just one outcome; the corresponding rectangles in columns two and three, however, may contain more than one item.

The code indicates the core competencies being strengthened by the outcomes activities and the assessment tools.
Critical Thinking (CT); technology skills (TS); oral communications (OC); quantitative skills (QS); reading (R); writing (W).

*COURSE OUTCOMES	OUTCOMES ACTIVITIES	ASSESSMENT TOOLS
Scientific Method/Science (1 week but should continue through the course) Describe the general steps of the scientific method and use these steps in solving problems, in order to understand how scientists think and describe the natural world, to distinguish between pseudoscience and real science, and to critically evaluate scientific information in the popular press. To this end, students must be able to: • Demonstrate an understanding of the ethical component of experimental design and data interpretation, and be able to apply them in both a classroom and laboratory setting;	• Conduct experiments in lab, developing hypotheses, collecting data, interpreting data, drawing conclusions. (CT, R, W, TS, QS) • Attend lecture/discussion (W, OC, CT) • Conduct experiments stressing importance of controls. (CT, R, W, TS, QS) • Read text (CT, R) • Read articles in *Time*, *Newsweek*, *etc*. and evaluate (R, W, CT) • Complete study guide (R, W, CT) • Discussion using Powerpoint presentation regarding characteristics of pseudoscience vs. real science and bad science vs. good science (CT, TS, OC)	• Tests • Quizzes (CT, R, W) • Short papers (CT, R, W, TS) • Lab reports (CT, R, W, QS) • Article reviews (CT, R, W, TS) • Provide and discuss examples of model organisms used in cell biology (i.e., *E. coli*, *Saccharomyces*, *Arabidopsis*, *Drosophila*, *C. elegans, Danio rerio*, *Xenopus*/*Rana*, mouse)

• Explain concepts, hypotheses and experimental results in their own words and using appropriate terminology; • Conduct an experiment, collect and analyze data and draft a scientific research paper; • Demonstrate the ability to perform rudimentary data analysis, including calculation of means and graphing of datasets; and • Explain how scientists choose and use model organisms in order to appreciate the research process.		

Evolution (-1 week) • Explain why evolution is the central theme in biology in order to understand the unity and diversity of life • Explain *natural selection* and *descent from a common ancestor* in order to understand why organisms have certain characteristics in common.	• Use Powerpoint and laserdisc to demonstrate the similarities and differences between living organisms (CT, OC, TS) • Evolution used as a central theme over several lecture topics (CT, W) • Read text (CT, R) • Complete study guide (R, W, CT) • Attend lecture/discussion (W, OC, CT) • Watch *Evidence for Evolution* [VHS] (CT, W, OC)	• Short paper (CT, W, R, QS) • Quiz (CT, W, R) • Test (CT, W, R) • Create Concept Map (BILL) • Write Essay • Peppered Moth lab and Essay

Chemistry (3 weeks) Demonstrate knowledge of basic chemistry including the properties of atoms, ions, chemical bonding and chemical reactions in order to understand biologically important molecules and processes. To this end, students must be able to: • Diagram and discuss important features of	• Molecular model building (CT, OC, W, QS) • Read text (CT, R) • Attend lecture/discussion (W, OC, CT) • Complete study guide (R, W, CT) • Do Molecule ID paper (CT, R, W) • See videos (reinforcement) (CT) • Do Memory Matrix (CT, R, W) • Identification of biologically important molecules in common foods (CT, OC, R, W,	• Grade models (CT, W, QS) • Lab exams (CT, W, R) • Lab reports (CT, R, W, QS, TS) • Grade drawing (CT, W, QS) • Make predictions of how atoms will interact based on chemical properties (CT, W, QS)

the following: o Functional groups: amino, hydroxyl, carboxyl, carbonyl, phosphate and sulfhydryl o Monosaccharide (preferably glucose), including numbering scheme o Generalized amino acid (or glycine) • Describe the role of biologically important molecules in order to understand the correlation between cell structure and function. • Diagram the structure of water and explain how water's polar nature is the basis for many of its special properties. • Demonstrate an understanding of the theory and practical application of acids, bases and the pH scale. • Identify and provide chemical properties of the following functional groups: o amino, hydroxyl, carboxyl, carbonyl, phosphate and sulfhydryl • Demonstrate a rigorous understanding of the four major classes of organic molecules used by living systems (see below): • I. <u>Carbohydrates</u> o Describe the general structure and functions of monosaccharides, disaccharides, oligosaccharides and polysaccharides, including examples of each (see suggested examples below): o Monosaccharides: glucose, ribose, deoxyribose, fructose, galactose	TS) • Perform experiments that demonstrate the properties of acids, bases and water (CT, TS, OC, QS, R, W) • Describe the cell in terms of the molecular structure – draw a cell and label accordingly (cell membrane – phospholipids and proteins etc.) (CT, W, R) • Use CD-ROM animations to help students visualize what happens during chemical reactions (CT, TS, R) • Practice reading the periodic table (CT, R, OC) • Stress root words, suffixes and prefixes	

○ Disaccharides: sucrose, maltose, lactose ○ Oligosaccharides: blood group sugars ○ Polysaccharides: starch, glycogen, cellulose, chitin • II. <u>Lipids</u> ○ Describe the general structure and functions of triglycerides, steroids and phospholipids ○ Be able to classify molecules as hydrophilic or hydrophobic based on chemical structures • III. <u>Proteins</u>: ○ Analyze the structures of the twenty amino acid side chains and provide an explanation of the side chain's behavior in an aqueous solution ○ List the four levels of protein structure and describe the chemical interactions that are responsible for each of these levels of structure ○ Discuss the roles of proteins in membrane transport and as enzymes ○ Discuss examples of protein regulation (phosphorylation, GTP hydrolysis, glycosylation, *etc*.) • IV. <u>Nucleic acids</u>: ○ Nucleotide structure and function (building blocks of nucleic acid AND energy molecules – ATP and GTP) ○ Compare and contrast the structural and functional differences between DNA and RNA • Explain how chemical reactions occur and describe/diagram dehydration syntheses/condensations and hydrolysis reactions.		

Cell Structure (1+ weeks)
Distinguish between eukaryotic and prokaryotic cells, and identify and describe the structure and function of plant and animal cells and their organelles, in order to appreciate the fundamental role that the cell plays as the foundation of living organisms.
 	
To this end, students must be able to:
• Provide both a structural and functional survey of:
  o Organelles involved in protein synthesis (nucleus, nucleolus, bound and free ribosomes);
  o Organelles involved in endomembrane system (a.k.a. secretory pathway) (smooth & rough endoplasmic reticulum, Golgi apparatus, lysosomes, and transport & secretory vesicles);
  o Organelles involved in metabolism (mitochondria and plastids);
 	
• Describe the Endosymbiotic Theory, its supporting data, and its implication for the origin of eukaryotic cells;
 	
• Discuss cell surface area-to-volume ratios and their importance in placing upper limits on cell size; and
 	
• Understand the various roles that the cytoskeleton plays in the cell, that the cytoskeleton is a dynamic structure, and its role in the integrity of tissues in multicellular organisms.
 	
Membrane Structure and Function (1 week)
Describe the structure of the plasma membrane
	• Identify prokaryotic and eukaryotic cells from figures and slides (CT, TS, QS, W)
	• Attend lecture/discussion (W, OC, CT)
	• Read text (CT, R)
	• Complete study guide (R, W, CT)
	• Do Memory Matrix (CT, R, W)
	• Do Question Chart (CT, R, W)
	• See film (reinforcement) (CT)
	• Show video clips of cytoskeletal dynamics
	• Identify plant and animal cells from figures and slides (CT, TS, QS, W)
	• Build clay models of prokaryotic, plant and animal cells (CT, QS)
	• Lecture stressing importance of role of membranes in compartmentalization (CT, W)
	• Build models of the cell membrane (CT, TS, QS)
	• Conduct experiments on diffusion, osmosis and active processes (CT, R, W, OC, TS, QS)
	• Look at electron micrographs of various cell membrane junctions and specializations (CT, TS)
	• Construct models of junctions and specializations (CT, TS, W, QS)
		• Lab exam (CT, W, R)
		• Grade drawings (CT, W, QS)
		• Grade models (CT, QS)
		• Lab reports (CT, W, QS, R)
		• Quizzes (R, CT, W)
		• Tests (R, W, CT)

and relate it to its functions in permeability, transport, metabolism, and cell-cell interactions. To this end, students must be able to: • Discuss and diagram the phospholipid bilayer's structure; • Describe the membrane's role as a semi-permeable barrier; • Describe the role of cholesterol in membrane fluidity; • Discuss how membranes compartmentalize intracellular activities; • List and explain the types and functions of membrane proteins (enzymes, transport proteins, CAMs and receptors); • Define and explain the importance of the glycocalyx and the extracellular matrix (incl. the plant cell wall) • Describe the concept of self/non-self recognition as it pertains to cell surface markers and recognition; • Passive mechanisms of transport – passive/simple diffusion – facilitated diffusion • Active mechanisms of transport – active transport – vesicular transport • Use of membranes in maintaining gradients		

Metabolism (2+ weeks) Explain the principles of cellular respiration and photosynthesis* so that the students understand energy flow in living systems. • Bioenergetics – Provide a general overview of the concept of energy and basic thermodynamic principles	• Read text (CT, R) • Complete study guide (R, W, CT) • Attend lecture/discussion (W, OC, CT) • Perform labs on respiration and photosynthesis (CT, R, W, TS) • See two videos (reinforcement) (CT) • Use computer simulations to represent complex cellular processes (CT, TS, OC) • Complete concept maps and study matrix to	• Complete labs on respiration, fermentation and photosynthesis (CT, R, W, QS, TS, OC) • Quiz (CT, R, W) • Test (CT, R, W) • Assess concept map and study matrix (CT, R, W, QS)

– Articulate what is meant by the "work" of the cell. – Explain the role and structure of nucleotide triphosphates (ATP, GTP, *etc*.) – Discuss the importance of and constituents of redox and phosphorylation reactions.	demonstrate understanding of integration of metabolism (CT, W)	
• Metabolic pathways – Be able to define and identify reactants and products – Be able to identify redox vs. phosphorylation reactions in glycolysis and the citric acid cycle, using chemical structures		
• Discuss the organization of the electron transport chain, its role in ATP production, and its reliance on oxygen (or other terminal electron acceptor)		
• Be able to discriminate between aerobic and anaerobic respiration and fermentation		
• Compare and contrast mechanisms, reactants and products of alcoholic and lactic acid fermentation		
• *Only cover photosynthesis if time permits.		

Cell Division (1+ weeks) Compare and contrast mitosis and meiosis in order to understand the process of growth, reproduction and the importance of sexual reproduction to the evolution of the species.	• Use beads to demonstrate mitosis and meiosis (CT, W, OC, QS, R) • Read text (CT, R) • Attend lecture/discussion (W, OC, CT) • Complete study guide (R, W, CT) • See two films (reinforcement) (CT) • Draw and label stages of mitosis and meiosis on slides and in diagrams (CT, W, TS, QS, R) • Use laserdisc to observe cells dividing (CT, TS) • Diagram gametes and fusion to complete the cycle of mitosis and meiosis in growth and reproduction (CT, W) • Diagram and be able to explain the cell cycle (CT, OC, W)	• Observe and grade demonstration of mitosis and meiosis in lab (R, OC, CT, W) • Quiz (CT, R, W) • Test (CT, R, W) • Grade drawings (CT, R, W, QS) • Have students present a demonstration to the class (students are chromosomes etc.) and grade it (CT, OC) • Lab – Mitosis/Meiosis • Essay – Compare/contrast Mitosis/Meiosis
• Compare and contrast the eukaryotic cell cycle and binary fission in prokaryotes		
• Describe and diagram the steps in DNA replication, including a discussion of the following: – the roles of DNA polymerase, DNA ligase , and primase – antiparallelism of double-stranded DNA and its effect on discontinuous replication (lagging vs. leading strands) – the semi-conservative nature of DNA replication		
• Describe and diagram the phases of the eukaryotic cell cycle, including a discussion of the following: – mechanisms of cytokinesis – roles of cell cycle regulatory proteins (cyclins, Cdks) – the importance of the G_0 phase/senescence. – the antagonistic relationship between oncogenes and tumor-suppressor genes, and their role in cancer – mechanisms of cell death (necrosis/apoptosis)		
• Describe and diagram the phases of meiosis I and II, with emphasis on comparing and contrasting with the mitotic phases.		

• Explain the difference between haploid and diploid cells, and the role that meiosis plays in genetic diversity. • Discuss what is meant by homologous chromosomes.		

Molecular Biology (2 weeks) Describe the role of DNA in RNA and protein synthesis in order to understand the chemical basis of genetics and the use of DNA in genetic engineering and biotechnology. • Chromosome structure • Parts of a gene (promotors, enhancers, introns, exons) • Transcription – Role of polymerase – Sense vs antisense strands and the use of templates – Coding vs noncoding RNAs • mRNA processing/export – Functions of caps and tails – Splicing • Translation – Ribosome structure – tRNA structure and function – Steps of translation • Mutation – Types and causes – Alleles • Provide examples and mechanisms for gene regulation via: o transcriptional controls	• Read text (CT, R) • Attend lecture/discussion (W, OC, CT) • Complete study guide (R, W, CT) • See video (reinforcement) (CT) • Build a DNA model or construct a model from plastic parts (CT, W) • Use a simulation to construct a protein (CT, OC, W, R, QS) • Isolate DNA to make it more "real" (CT, R, OC, TS) • Human Genome projects from web (CT, TS, W, R) • Discuss genetic engineering and biotechnology and their social and economic implications (CT, OC, R, W)	• Quiz (CT, R, W) • Test (CT, R, W) • Oral presentation of "child's" phenotype (CT, OC, QS) • Short paper or oral presentation on misconceptions (CT, R, W, OC, TS,QS) • Grade model (CT, W) • Lab report (CT, R, W, QS) • Report on simulations (CT, R, W, TS, QS) • Discussion of recent breakthroughs in RNA interference (RNAi)

○ posttranscriptional controls ○ translational controls ○ posttranslational controls		

Transmission Genetics (1+ weeks) Demonstrate understanding of basic concepts in inheritance in order to solve simple genetic problems and recognize common misconceptions regarding human heredity. • Dominant vs recessive traits • Genotype vs Phenotype • Compare and contrast autosomal vs sex-linked inheritance • Compare and contrast simple (Mendelian) inheritance and codominance • Differentiate between expression at the cell vs at the organismal level • Demonstrate an understanding of Punnett squares and probabilities to predict outcomes of monohybrid and dihybrid crosses	• Coin toss phenotype exercise to develop a "child" (CT, QS, OC, W) • Read text (CT, R) • Attend lecture/discussion (W, OC, CT) • Complete study guide (R, W, CT) • See video (reinforcement) (CT) • Family pedigrees- Select common misconceptions –" traits skip a generation" etc and investigate and report on why this is what folks think – and what is actually going on (CT, OC, QS, R, W) • Do genotype/phenotype paper • Class assessment of phenotype distribution (CT, R, W) • Do genetics problems (CT, R, W, QS, OC) • Stress model-building as well as problem solving methods to understand patterns of inheritance (CT, R, W, TS, QS)	• Quiz (CT, R, W) • Test (CT, R, W) • Oral presentation of "child's" phenotype (CT, OC, QS) • Short paper or oral presentation on misconceptions (CT, R, W, OC, TS,QS) • Grade model (CT, W) • Lab report (CT, R, W, QS) • Report on simulations (CT, R, W, TS, QS)

Laboratory Skills To work safely in the laboratory and follow simple laboratory protocols in order to work cooperatively to complete laboratory exercises and conduct experiments using the scientific method. To be able to use the microscope to observe cell structure in order to develop good technique in preparation for more advanced courses. To be able to perform simple mathematical	• Read and sign the safety sheet (CT, R) • Follow directions carefully in the lab (CT, R) • Follow proper procedures for disposal of waste products (CT, R) • Focus the microscope, use it for an independent project and /or in several laboratory exercises (CT, R, TS, QS) • Use simple math where appropriate in lab exercises and papers (CT, QS, TS, R, W) • Stress the importance of data collection(R, TS, QS, W, CT)	• Observe student working safely in the lab (CT) • Lab quiz or assignment requiring each student to focus and use the microscope (CT, OC, W, R) • Evaluate use of math in reports (W, QS) • Tests (R, W, CT) • Quizzes (R, W, CT)

calculations and construct and interpret graphs in order to record and communicate the results of experiments. • Metric System • Use technology in order to collect and analyze data • Modeling • Write a scientific laboratory report		

Ethics	•	

Study Skills To apply a study skills method to learning biology in order to improve success in an academically rigorous course. • Use technology • Concept Mapping • Use of self testing to assess understanding • Use of roots, prefixes, and suffixes in order to understand terminology	• Teach students the SQ3R Study Skills method using power point demonstration (CT, OC, R, W, TS) • Attend lecture/discussion (W, CT, OC) • Develop note taking skills by progressively taking away class aids such as power point handouts, lecture outlines, questions to be answered, list of objectives(CT,R,W, TS) • Model use of interactive Study Guide (CD-ROM and website) (CT,TS,R) • Develop test taking skills by giving quizzes that model types of questions on exams(CT,R,W) • Recommend ARC as a resource (CT)	• Workshops (CT, TS, OC,R) • Collect class notes for grade (CT, W) • Quizzes (CT, R, W)

Strengthen Core Competencies in order to increase success in college courses and other courses in the workplace	Referenced above	Referenced above