KINGSBOROUGH COMMUNITY COLLEGE
CITY UNIVERSITY OF NEW YORK
DEPARTMENT OF BIOLOGICAL SCIENCES

GENERAL BIOLOGY (BIO 01300) SYLLABUS

Course Co-Coordinators
Dr. Emral Devany S217 and Dr. Azure Faucette S216

COURSE DESCRIPTION:

BIO 1300 – GENERAL BIOLOGY I (4 credits. 6 hrs. each semester) A one-semester course for students who plan to major in biological sciences or prepare for a preprofessional program. Classroom and laboratory sessions focus on biological topics as they apply to all life, to recent scientific findings and how they advance understanding of classical concepts, and the interaction of environmental and biological forces to produce life.
Prerequisites for BIO 1300: Passing scores on the CUNY Reading and Writing exams and the COMPASS Math

A.S BIOLOGY PROGRAM LEARNING OUTCOMES

- Apply the methods and process of life science, including common laboratory techniques
- Demonstrate proficiency in quantitative reasoning as it relates to life science data
- Demonstrate an understanding of evolution
- Demonstrate an understanding of the relationship between structure and function
- Demonstrate an understanding of genetics
- Demonstrate an understanding of the pathways of energy and matter that maintain a particular environment
- Demonstrate an understanding of the levels of biological organization and the interactions among these levels
- Develop and test hypotheses

COURSE LEARNING OUTCOMES

Upon completion of the course, students should be able to:

- Describe fundamental concepts in chemistry and biochemistry, including atoms, chemical bonds, and important organic molecules.
- Demonstrate knowledge of the structure, function, and biological processes associated with the different levels of organization in biology.
- Identify and apply commonly used equipment and techniques in biology.
- Design experiments to test, support, or refute formulated research questions and hypotheses.
- Analyze biological data to develop conclusions using scientific reasoning.

GRADES

The General Biology I course will be graded as follows:

50% Lecture (20% of which will be the final examination)
50% Laboratory

Additional details regarding examinations, assignments, *etc*. will be provided by your lecture instructor; details regarding quizzes, papers, other assignments, *etc.* will be provided by your laboratory instructor.

ATTENDANCE

Refer to the policies in college catalog. To gain access to the college catalog click at the following link: Academic Information, Examinations, and Grades website.

TEXTBOOKS

The required textbook readings and lab manual for this course are both provided online by the instructor.

ADDITIONAL REQUIREMENTS

Students must purchase a knee-length laboratory coat, disposable gloves & goggles. Laboratory coats will be worn at all times during classes in the laboratory. Students that do have a laboratory coat will not be allowed into a biology laboratory. Gloves will not be provided but may be purchased by students if they wish to use gloves.

ACCESSIBILITY

Access-Ability Services (AAS) serves as a liaison and resource to the KCC community regarding disability issues, promotes equal access to all KCC programs and activities, and makes every reasonable effort to provide appropriate accommodations and assistance to students with disabilities. Please contact this office if you require such accommodations and assistance. Your instructor will be glad to make the accommodations you need, but you must have documentation from the Access-Ability office for any accommodations.

CIVILITY

The following statement is from KCC's Website on Civility: "Kingsborough Community College is committed to the highest standards of academic and ethical integrity, acknowledging that respect for self and others is the foundation of educational excellence. Civility in the classroom and respect for the opinions of others is very important in an academic environment. It is likely you will not agree with everything that is said or discussed in the classroom. Courteous behavior and responses are expected. Therefore, in this classroom, any acts of harassment, and/or discrimination based on matters of race, gender, sexual orientation, religion, and/or ability is not acceptable. Whether we are students, faculty, or staff, we have a right to be in a safe environment, free of disturbance and civil in all aspects of human relations."

ACADEMIC INTEGRITY

Academic Dishonesty is prohibited in The City University of New York and is punishable by penalties, including failing grades, suspension, and expulsion, as provided herein. Additional information can be found in the College catalog (http://www.kingsborough.edu/sub-registration/Pages/catalog.aspx)

Plagiarism as a violation of academic integrity

Students will be asked to write papers and laboratory assignments. During this endeavor, they should be careful to avoid plagiarism. Plagiarism is the intentional theft(s) of someone else's intellectual property without attribution (proper credit). Determination and penalty – ranging from grade reduction to course failure – will be decided by the instructor.
Internet plagiarism includes submitting downloaded term papers or parts of term papers, paraphrasing or copying information from the internet without citing the source, and "cutting & pasting" from various sources without proper attribution.

VISION AND CHANGE

This course has been aligned with National Science Foundation's Vision and Change. To this end, creative teaching strategies have been developed to facilitate student learning. The objectives of the course are structured to achieve the course learning outcomes. Assessment of some or all course learning outcomes is done every semester, the results are analyzed, and suggestions for improving student learning, and meeting the course learning outcomes, are discussed. In addition, suggestions are provided on assessment strategies. Finally, the incorporation of the following lecture and lab activities, which are important in developing competencies that last beyond the classroom, are encouraged:

1. Lab activities that are inquiry-based
2. Activities that foster critical thinking
3. Activities that promote quantitative competencies
4. Activities that relate the scientific information to real world practices

Recommendations to the Student:

- Textbook pages as well as laboratory assignments should be read before class.
- Observe all safety precautions as instructed in the laboratory. They are for your protection.
- Each student is responsible for the proper and safe maintenance of their laboratory work area. Bench tops and microscopes must be properly cleaned before and after use.

LECTURE TOPIC OUTLINE

BIOLOGY 13

LECTURE TOPICS

1. **Introduction to biology**
   Evolution, the Themes of Biology, and Scientific Inquiry

2. **Chemistry of Life**
   The Chemical Context of Water and Life
   Carbon and the Molecular Diversity of Life

3. **Important Biological Macromolecules**
   The Structure and Function of Large Biological Molecules

4. **Cellular Structure and Cell membranes**
   A Tour of the Cell
   Membrane Structure and Function

5. **Metabolic Pathways: Metabolism and cellular respiration**
   An Introduction to Metabolism
   Cellular Respiration and Fermentation

6. **Metabolic Pathways: Photosynthesis**
   Photosynthesis

7. **The cell cycle, mitosis and meiosis**
   The Cell Cycle
   Meiosis and Sexual Life Cycles

8. **Classical genetics – Trait Inheritance**
   Mendel and the Gene Idea
   The Chromosomal Basis of Inheritance

9. **Molecular biology – DNA Structure and Replication**
   DNA Structure and Replication

10. **Gene expression – DNA Transcription and Translation**
    Gene Expression: From Gene to Protein

11. **Modern Biology – Techniques used in molecular biology**
    DNA Tools and Biotechnology

LABORATORY OUTLINE BIOLOGY 13

Laboratory Exercises are Provided Online by the Instructor

Week	Topic	Exercises
1	Laboratory Safety Rules and Guidelines The Metric System: Measurements and Laboratory Equipment	Handout Lab Topic 1A
2	The Process of Scientific Inquiry Scientific Inquiry Experiment	Lab Topic 2A Lab Topic 2B
3	Basic Chemistry: Atoms, Molecules, Electrolytes, Acids, Bases, pH, Buffers, Organic Chemistry Macromolecules	Lab Topic 3 Exercises 3.1-3.3, 3.5, 3.7-3.10 Lab Topic 4 Part 2 Exercises 4.1A, 4.1B, 4.2-4.4
4	Microscopy: Theory and Practice	Lab Topic 4 Part 1 Protozoan Wet Mount
5	Structure and Function of Living Cells Diffusion, Osmosis and the Functional Significance of Biological Membranes.	Lab Topic 5A Lab Topic 5B Exercises 5.2, 5.3A-5.3D
6	Enzymes: Catalysts of Life	Lab Topic 6 Exercises 6.1-6.4
7	Cellular Respiration	Lab Topic 8 Exercise 8.1
8	Photosynthesis: Capture of Light Energy	Lab Topic 7 Exercises 7.1, 7.4-7.8
9	Chromosomes and Cell Division	Lab Topic 9 Exercises 9.1, 9.2
10	The Process of Meiosis Heredity: Classic Genetics	Lab Topic 9 Exercise 9.3 Lab Topic 10 Exercise 10.1
11	Heredity: Classic Genetics The Dissection Microscope	Lab Topic 10 Exercises 10.2, 10.3 Lab Topic 11B, 11C Lab Topic 10 Exercise 10.4A, 10.4B
12	Molecular Biology: Forensics	Lab Topic 11

Bio 13 COURSE OBJECTIVES

INTRODUCTION TO BIOLOGY AND THE SCIENTIFIC METHOD

1. Define the following terms: (a) biodiversity; (b) biology.
2. Briefly state 1 unifying theme that characterize the biological sciences.
3. Name 3 characteristics of life shared by all cells.
4. State whether a given object is living or non-living based on the characteristics of life it possesses.
5. Draw a diagram showing the hierarchy of structural levels in biological organization.
6. Define and give an example of each of the following levels of biological organization: (a) biosphere; (b) ecosystem; (c) community; (d) population; (e) organism; (f) organ system; (g) organ; (h) tissue; (i) cell; (j) organelle; (k) molecule; (l) atom.
7. Give 1 example of how novel properties of life emerge from complex organization.
8. Distinguish between prokaryotic and eukaryotic cells.
9. List and distinguish between the 3 domains of life.
10. List and distinguish between the 3 kingdoms of multicellular, eukaryotic life.
11. State 3 major criteria used by the biologist to classify organisms.
12. Name the 6 kingdoms starting from the most primitive to the most evolved following the criteria used to classify them.
13. Draw a flow chart that illustrates the steps of the scientific method.
14. Define each step of the scientific method from the flow chart drawn in objective #13.
15. Distinguish between a null hypothesis and an alternate hypothesis.
16. Define the following terms: (a) independent variable; (b) dependent variable; (c) extraneous variable.
17. Distinguish between a hypothesis and a theory.

REVIEW OF BASIC CHEMISTRY AND PROPERTIES OF WATER

1. Distinguish between the following: (a) element; (b) atom; (c) compound; (d) molecule.
2. Identify the four elements that make up 96% of living matter.
3. Define the following terms: (a) neutron; (b) proton; (c) electron; (d) atomic number; (e) mass number; (f) atomic weight; (g) isotope.
4. Draw and label a shell diagram for an atom of each of the four elements identified in objective #2.
5. Distinguish between covalent, ionic and hydrogen bonds.
6. State how the structure of water leads to its properties.
7. Draw and label a diagram that shows the structure of two water molecules held together with hydrogen bonds.
8. State and define the 4 properties of water that allow life on Earth to exist.
9. Given a diagram of the pH scale, identify the following: (a) acid region; (b) neutral point; (c) basic (alkaline) region; and relate these regions to hydrogen ion and hydroxide ion concentrations.

MACROMOLECULES

1. State the number of bonds formed in organic molecules by carbon, nitrogen, oxygen, and hydrogen atoms.
2. State two properties of carbon that enable it to se serve as a “backbone” for the formation of an almost limitless variety of organic molecules.
3. Draw a diagram to illustrate variation in the carbon skeleton between two molecules.
4. Label the following functional groups in a molecule if given its molecular structure: (a) hydroxyl; (b) carbonyl; (c) carboxyl; (d) amino; (e) sulfhydryl; (f) phosphate; (g) methyl.
5. State the 4 types of macromolecules.
6. State the difference between a monomer and a polymer
7. In 1-2 sentences, explain the difference between a dehydration synthesis reaction and a hydrolysis reaction
8. State the monomers for each of the 4 types of macromolecules.
9. For each of the 4 types of macromolecules, state the specific bond used to join two monomers together to create a polymer.
10. Distinguish between a monosaccharide, disaccharide, and polysaccharide.
11. Provide 2 examples each of a monosaccharide, disaccharide, and polysaccharide.
12. Compare and contrast the structure of a fat and a phospholipid.
13. Compare and contrast the structure of a saturated and unsaturated fatty acid.

14. State one function each of a fat, a phospholipid, and a steroid.
15. State the 3 types of amino acid R-groups.
16. Provide 2 functions of proteins.
17. State and define the 4 levels of protein structure.
18. State the 3 types of molecules that make up a nucleotide.
19. Provide the complementary sequence for the following DNA sequence: 5′ CCCATGCCATCGCTATAGCC 3′
20. State 3 differences between the structures of DNA and RNA.

CELL STRUCTURE AND FUNCTION

1. State 2 structures/features common to all cells.
2. In 2-3 sentences, explain the advantages of compartmentalization in eukaryotic cells.
3. Given a diagram of a generalized cell, identify the following cellular structures and organelles: (a) cell membrane; (b) cell wall; (c) centriole; (d) chloroplast; (e) cilia; (f) cytoplasm; (g) endoplasmic reticulum (rough and smooth); (h) flagella; (i) Golgi apparatus; (j) lysosome; (k) microfilaments; (l) microtubules; (m) mitochondria; (n) nucleoli; (o) nucleus; (p) peroxisome; (q) ribosome; (r) vacuole.
4. State one major function for each of the cell structures in objective #4.
5. Define the following terms: (a) hydrophilic; (b) hydrophobic.
6. State the 2 major molecules that make up the cell membrane.
7. Draw and label a diagram showing the "fluid mosaic" model of the cell membrane.
8. In 2-3 sentences, explain the structure of the cell membrane drawn in objective #7.
9. In 2-3 sentences, explain how the cell membrane controls transport into and out of a cell.
10. In 2-3 sentences, explain how the cell membrane contributes to "recognition" and "communication" with other cells and cell products.
11. Define the following term: diffusion.
12. In a paragraph, compare diffusion with facilitated diffusion and active transport.
13. Define the following terms: (a) osmosis; (b) isotonicity; (c) hypertonicity; (d) hypotonicity.
14. Compare the osmotic effect of placing animal cells in distilled water versus sea water.
15. Compare the osmotic effect of placing plant cells in distilled water versus sea water.
16. In 2-3 sentences, describe the process of endocytosis (phagocytosis and pinocytosis) and the formation of food vacuoles.
17. In 2-3 sentences, describe the process of exocytosis and formation of a new cell membrane.
18. Cite 1 type of cell junction and state an essential feature of each.

METABOLISM AND CELLULAR RESPIRATION

1. Define the following terms: (a) metabolism; (b) anabolism; (c) catabolism; (d) endergonic reaction; (e) exergonic reaction.
2. Using the following chemical reaction, identify the reactants and the products: $CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O + \text{Energy}$
3. Write chemical reactions for the anabolism of: (a) carbohydrates; (b) lipids; (c) proteins; (d) nucleic acids.
4. Write chemical reactions for the catabolism of: (a) carbohydrates; (b) lipids; (c) proteins; (d) nucleic acids.
5. Define the following terms: (a) enzymes; (b) coenzymes; (c) cofactors.
6. State the metabolic function for the molecules defined in objective #5 and provide an example of each.
7. Define the following terms: (a) oxidation reactions; (b) reduction reactions.
8. State the function of redox reactions in metabolism.
9. Using the following chemical reaction, identify compound being oxidized and the compound being reduced and the products: $CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O + \text{Energy}$
10. Explain the function of glycolysis, Krebs cycle and electron transport in cellular respiration.
11. Identify the locations within a eukaryotic cell where glycolysis, Krebs cycle, and electron transport take place.
12. Identify the locations within a prokaryotic cell where glycolysis, Krebs cycle, and electron transport take place.
13. Distinguish oxidative phosphorylation from substrate level phosphorylation.
14. Explain the difference between an anaerobic process and anaerobic respiration.
15. Explain the difference between aerobic respiration and anaerobic respiration.
16. Define the following term: fermentation.
17. Give 2 examples of types of fermentation.

PHOTOSYNTHESIS

1. In 3-4, provide a general summary of the process ofphotosynthesis.
2. Write a generalized equation of photosynthesis that shows the raw materials, energy source, and end products of the process.
3. List the raw materials, energy sources and end products ofphotosynthesis
4. Explain the relationship of the following membrane structures to the overall process of photosynthesis within the structure of the chloroplast: (a) grana; (b) stroma; (c) thylakoid discs; (d) thylakoid spaces.
5. Write a paragraph summarizing the steps of the light dependent reaction of photosynthesis.
6. Describe the role of the following in the light dependent reactions of photosynthesis: (a) H_2O; (b) chlorophyll; (c) $NADP^+$; (d) ADP; (e) Pi; (f) electron carriers.
7. State the products of the light dependent reactions of photosynthesis.
8. Write the steps of the Calvin Cycle, show the raw materials and end products of this process.
9. State the importance and relationship between the light dependent phase and light independent (Calvin Cycle) phase of photosynthesis.
10. State the purpose of the pigments, other than chlorophyll, found in cellular chloroplasts.
11. Compare cyclic and non-cyclic photophosphorylation, and describe how cyclic photophosphorylation benefits some plant cells under certain conditions.
12. Describe the differences between and importance of both C-3 and C-4 plants as it relates to photosynthesis.
13. Explain the overall importance and significance of photosynthesis to life as weknow it on our planet.

THE CELL CYCLE, MITOSIS AND MEIOSIS

1. Write a series of steps to describe the process ofcell division.
2. Define the following term: (a) genome.
3. Distinguish between somatic cells and gametes.
4. List the phases of the cell cycle.
5. In 2-3 sentences each, explain the major events for each of the phases of the cell cycle listed in objective #5.
6. In 2-3 sentences, explain the importance of the cell cycle control system.
7. Draw and label a diagram showing the structure of achromosome.
8. Define the following terms: (a) mitotic spindle; (b) centrosome; (c)kinetochore.
9. State the mitotic phases in the order they occur and list the events occurring in each phase.
10. Draw a diagram showing the phases of mitosis in a diploid cell with 4 chromosomes.
11. State the importance ofmitosis.
12. Define the following term: (a) sexual reproduction.
13. State the significance of meiosis insexual reproduction.
14. Define the following terms: (a) homologous chromosomes; (b) sex chromosomes; (c) autosomes; (d) diploid cells; (e) haploid cells.
15. State the meiotic phases in the order they occur and list the events occurring in each phase.
16. Draw a diagram showing the phases of meiosis in a diploid cell with 4 chromosomes.
17. State the importance ofmeiosis.
18. Compare and contrast mitosis and meiosis.
19. Define the following terms: (a) crossing over; (b) recombination
20. List 2 events in meiosis that lead to genetic variation.
21. State how each event in objective #20 leads to genetic variation.

CLASSICAL GENETICS

1. Define the following terms: (a) character; (b) trait; (c) gene; (d) allele; (e) dominant allele; (f) recessive allele; (g) genotype; (h) phenotype; (i) heterozygous; (j) homozygous.
2. Draw a diagram to illustrate Mendel's Law of Segregation.
3. Draw a diagram to illustrate Mendel's Law of Independent Assortment.
4. Define the following terms: (a) monohybrid cross; (b) dihybrid cross.
5. Given that red flowers (R) are dominant over with white flowers (r), use a Punnett square to show the results of a parental cross between true-breeding parents.
6. List the genotypes and genotype frequencies in the F1 generation for the parental cross in objective #4.
7. List the phenotypes and phenotype frequencies in the F1 generation for the parental cross in objective #4.

8. Use a Punnett square to show the results of a cross using the offspring from the F1 generation obtained from the cross in objective #5.
9. List the genotypes and genotype frequencies in the F2 generation for the parental cross in objective #7.
10. List the phenotypes and phenotype frequencies in the F1 generation for the parental cross in objective #7.
11. Given the yellow peas (Y) and round pea pods (r) are dominant a green peas (y) and wrinkled pea pods (r) are recessive, use a Punnett to show the results of the following dihybrid cross: YyRr × YyRr.
12. List the genotypes and genotype frequencies for the dihybrid cross in objective #11.
13. List the phenotypes and phenotype frequencies for the dihybrid cross in objective #11.
14. Distinguish between complete dominance, codominance, and incomplete dominance.
15. Define the following terms: (a) epistasis; (b) pleiotropy.
16. Given that red eye color (R) in flies is dominant over white eye color (r) and that eye color is sex linked, perform the following cross: true-breeding red-eyed females crossed with white eyed males.
17. List the genotypes and genotype frequencies for the cross in objective #16.
18. List the phenotypes and phenotype frequencies for the cross in objective #16.
19. Define the following term: genetic linkage.
20. State the importance of pedigree analysis for human genetics,
21. State 2 human disorders that follow Mendelian inheritance.

MOLECULAR BIOLOGY

1. State one reason that scientists originally thought protein, not DNA, was the hereditary material.
2. In a series of steps, describe the experiments performed by (a) Griffith; (b) Avery, McCarty and MacLeod; and (c) Hershey and Chase and explain how these experiments show DNA is the hereditary material.
3. Prepare a drawing that illustrates the structure of DNA and label the following: (a) 5′ end; (b) 3′ end; (c) phosphate group; (d) deoxyribose; (e) nitrogenous base; (f) nucleotide; (g) hydrogen bond.
4. Define the following term: semiconservative replication.
5. State the function of each of the following in the process of DNA replication: (a) origin of replication; (b) RNA primer; (c) DNA polymerase.
6. In a series of steps, describe the process of DNA replication.
7. Distinguish between the leading strand and the lagging strand.
8. Explain the differences between DNA proofreading, mismatch repair, and nucleotide excision repair.
9. Define the following terms: (a) telomeres; (b) telomerase
10. State the role of telomerase in replicating the ends of chromosomes.

GENE EXPRESSION

1. In a series of steps, describe the experiment performed by Beadle and Tatum.
2. In a 3-4 sentences, explain how Beadle and Tatum's experiment led to the *one gene–one polypeptide hypothesis*.
3. Give 1 example of a gene that does not lead to the production of a polypeptide.
4. Draw a flow chart to illustrate the flow of genetic information, the central dogma of molecular biology.
5. Distinguish between the flow of genetic information in bacterial cells and eukaryotic cells.
6. Explain the process of transcription using the following terms: (a) RNA polymerase; (b) promoter; (c) initiation; (d) elongation; and (e) termination in your explanation.
7. Using the following DNA sequence, write the sequence of the mRNA produced by transcribing this DNA. 3′ CCCATGCCATCGCTATAGCC 5′
8. Define the following terms: (a) exon; (b) intron; (c) RNA splicing.
9. Name three types of post-transcriptional modifications of pre-RNA that occur in eukaryotes.
10. Define the following terms: (a) codon; (b) anticodon.
11. Distinguish between the function of the codon and the anticodon in the process of translation.
12. Describe the role of each of the following in the process of translation: (a) mRNA; (b) tRNA; (c) rRNA.
13. In a series of steps, describe the process of translation.
14. Using the following DNA sequence and the codon table in your biology textbook, write the sequence of the polypeptide produced by transcribing and translating this DNA: 3′ CCCATGCCATCGCTATAGCC 5′
15. Define the following term: mutation.
16. Use the DNA sequence in objective #14 to illustrate the effect of the following types of point mutations: (a) frameshift mutation; (b) insertion mutation, on the polypeptide sequence produced by transcribing and translating the mutated DNA sequence.

TECHNIQUES USED IN MOLECULAR BIOLOGY

1. Define the following terms: (a) recombinant DNA; (b) plasmid; (c) restriction enzyme.
2. Explain how restriction enzymes are used to produce recombinant DNA.
3. In a series of steps, describe how plasmids are used to clone genes in bacteria.
4. Prepare a diagram that illustrates how a specific region of DNA is copied and amplified using the polymerase chain reaction.
5. Distinguish between cloning a gene and cloning an organism.
6. List one specific technique used to study gene expression
7. List one specific technique used to study gene function.
8. Define the following term: (a) stem cell.
9. State one difference between a stem cell and a cell that is not a stem cell.
10. Describe one medical application of DNA technology.
11. State one practical application of DNA technology in bacteria.
12. State one practical application of DNA technology in plants.
13. State one practical application of DNA technology in animals.
14. In 2-3 sentences, explain what is meant by the following term: genetically modified organism.
15. List 2 ethical concerns of genetically modifying bacteria, plants or animals.