

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

**GENERAL BIOLOGY I  
BIOLOGY 13**

**COURSE OUTLINE:**

Biology 13 is a 4 credit, 6 hour course, with a laboratory component, open to students who have passing scores on the CUNY Reading, Writing and Mathematics FSA tests or the equivalent.

The first semester of the General Biology course will be graded as follows:

50% Lecture, 20% of which will be the final examination, and  
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.

The required textbooks for this course are:

**Lecture:**

BIOLOGY Eighth Edition (2008)

By Neil A. Campbell and Jane B. Reece.

Benjamin Cummings Publishing Co. New York.

**Laboratory:**

GENERAL BIOLOGY I - LABORATORY EXERCISES (Pilot 5<sup>th</sup> Edition 2009)

C. Beeber, C. Biermann, C. Hinkley, M. Lakrim, P. Lanzetta, G. Lind,

T. Markus, M. Ortiz, P. Pilchman, K. Polizzotto, A. Stavroulakis.

KCC Custom Reproduction, New York.

(If Requested by Instructor) A PHOTOGRAPHIC ATLAS FOR THE BIOLOGY

LABORATORY (5<sup>TH</sup> or 6<sup>TH</sup> ED) K. M. Van De Graaff and J. L. Crawley,

Morton Publishing Company, Englewood, CO,

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.
- Laboratory coats will be worn at all times during classes in the laboratory. Each student must purchase goggles and non-latex gloves. These will be required for some laboratory exercises, as specified by your instructor.

Feb 09

### **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.

**LECTURE TOPIC OUTLINE BIOLOGY 13 2009**

<u>WEEK</u>	<u>LECTURE TOPIC</u>	<u>TEXTBOOK</u>	
		<u>READING ASIGNMENTS</u>	
		Chapter	Pages
1	The Scientific Method	1	19-25
	The Characteristics of Life	1	1 – 10
2-4	Basic Chemistry	2 ; 3	32-44 ; 47-55
	Water	(4)	(58 - 65)
	Carbon	5	68 - 89
	Biological Chemistry:		
	Carbohydrates, Fats and Lipids,		
	Proteins, Nucleic Acids		
	The Cell : A Tour of the Fundamental Unit of Life	6	94 - 120
	Prokaryotes and Eukaryotes		
	Maintaining Homeostasis and the Cell Perimeter.	7	124 - 138
	The Plasma Membrane, Import and Export.		
5-7.5	The Rules for Handling Chemicals and Energy:	8	141 – 157
	Metabolism, Thermodynamics & Enzymology		
	The Cell as a Producing Factory	10	181 – 198
	Photosynthesis		
	The Cell is a Processing Factory	9	160 - 178
	ATP, Cellular Respiration		
7.5-11	Cell Division: The Cell Cycle and Mitosis	12	218 – 233
	Classical Mendelian Genetics:	14	251 – 270
	Observable Patterns of Inheritance. Meiosis	13	238 – 249
	The Chromosomal Basis of Inheritance	15	274-290
	Meiosis Errors and Exceptions		
	The Molecular Basis of Cellular Inheritance: DNA	16	293 – 308
	Gene Expression: Transcription, Translation and	17	309 -- 330
	Protein Synthesis.		
	Organization and Control of Eukaryotic Genomes	(19)	(359 – 380)
	Genetic Engineering	20	384 – 408
12	Exploring Life on its Many Levels		
	Evolution, Unity and Diversity	1	10 -18
	Systematics and Taxonomy	25	491 - 508

**LABORATORY OUTLINE Biology 13 2009**

<u>Week</u>	<u>Topic</u>	<u>Exercise Number(s)</u> <u>Laboratory Manual-Pilot Edition</u>
1	Laboratory Safety Rules and Guidelines Characteristics of Life Metric Measurement and Equipment	Handout Exercise 1 Exercise 1A, 1B
2	Scientific Inquiry Experiment	Exercise 2A, 2B
3	Basic Chemistry Computer Exercise - Acids, Bases and Buffers	Exercise 3
4	The Compound Microscope I : Basics Macromolecules	Exercise 4 Part 1 Exercise 4 Part 2
5	Structure and Function of Living Cells The Compound Microscope II : Cells Diffusion, Osmosis and the Functional Significance of Biological Membranes.	Exercise 5A Exercise 5B
6	Enzymology	Exercise 6
7	Photosynthesis Fluorescence	Exercise 7
8	Cellular Respiration	Exercise 8
9	Chromosomes and Cell Division Mitosis and Meiosis	Exercise 9
10	Heredity: Classic Genetics The Dissection Microscope The Fruit Fly Molecular Genetics – Drosophila Eye Pigments	Exercise 10
11	Molecular Biology: Forensics How Genetics is Done: Dihybrid Cross in Corn The Chi Square Test	Exercise 11
12	Biodiversity	Exercise 12

As part of the CUNY-wide investment in quality teaching and learning, during the course of the semester you will also participate in up to three assessment exercises. These are not graded tests, but attempts to see how well you have mastered the techniques of biology. Further information will be provided by your instructor.

## **COURSE GOALS    STUDENT OUTCOMES**

1. Students should demonstrate practical and theoretical understanding of the scientific method.
2. Students should understand the content of the six taxonomic kingdoms.
3. Students should be able to describe the identity and function of typical cells and organelles, including cellular homeostasis.
4. Students should demonstrate an understanding of tissues.
5. Students should recognize the important concepts of basic cellular biochemistry and the processes of DNA and protein synthesis.
6. Students should demonstrate an understanding of enzymology, photosynthesis, and cellular respiration.
7. Students should demonstrate an understanding of concepts of classical and modern genetics and biotechnology.
8. Students should develop familiarity and expertise with technical equipment and, laboratory techniques important to biologists, including use of microscopes and computers.
9. Students should develop the skills they need to interpret, analyze and present biological data (e.g. graphs, tables and written sources).

## **COURSE OBJECTIVES**

### **Week 1**

- ◆ Define biology.
- ◆ List the major characteristics of life.
- ◆ Given the life characteristics possessed or once possessed by an object, state whether the object is living, non-living or dead.
- ◆ Outline the levels of organization in the biotic world (biological hierarchy).
- ◆ Distinguish between heterotrophy and autotrophy.
- ◆ Explain how scientists approach a problem – include the five parts of a scientific investigation.
- ◆ Describe the organization of a typical scientific paper.
- ◆ Define and show your ability to prepare the parts of a laboratory report in proper scientific format, including introduction, hypothesis, experimental design, methods and materials, results, analysis, discussion and conclusions.
- ◆ Demonstrate your ability to properly prepare and present data in graphs and tables.
- ◆ Using proper resources and format be able to prepare a bibliography to accompany a

research paper.

### **Week 2-4**

- ◆ Define an atom and its parts: nucleus, electron cloud, proton, neutron, electron.
- ◆ Define atomic number, atomic mass, isotope.
- ◆ Explain the relationship between matter, element, atom, compound, molecule, ion.
- ◆ Define ionic bond, covalent bond, hydrogen bond, electrolyte, non-electrolyte, acid, base, pH, neutralization, salt, buffer.
- ◆ Given a diagram of the pH scale, identify the following: acid region, neutral point, basic (alkaline) region, and relate these regions to hydrogen ion and hydroxyl ion concentrations.
- ◆ State the properties of water that allow it to be an almost universal polar solvent, to be liquid at room temperature and to freeze from the top down.
- ◆ State two properties of carbon that enable it to serve as a “backbone” for the formation of an almost limitless variety of organic molecules.
- ◆ Given their molecular structures, identify the following organic molecules: saturated and unsaturated hydrocarbons, alcohols, organic acids, aldehydes, amino acids, nucleotides, and simple sugars.
- ◆ Be able to briefly sketch or describe the component chemical parts of the four types of biochemical molecules: carbohydrates, fats, proteins and nucleic acids.
- ◆ List two to three cellular locations where you would find each of the four types of biochemical molecules listed above.
- ◆ Describe the major cellular functions of each of the four types of biochemical molecules.
- ◆ Give three characteristics that would allow you to identify a cell.
- ◆ Compare and contrast prokaryotic and eukaryotic cells; give an example of each.
- ◆ Know the name and function of the major parts of the microscope.
- ◆ Be able to focus on a specimen using all appropriate lenses of the microscope.
- ◆ Be able to make a proper record of an object observed under the microscope.
- ◆ Given a diagram of a generalized cell, identify the following cellular structures and organelles: cell coatings, cell membrane, centriole, chloroplasts, cilia, cytoplasm, DNA, endoplasmic reticulum (rough and smooth), flagella, Golgi apparatus, lysosomes, microfilaments, microtubules, mitochondria, nucleoli, nucleus, vacuoles.
- ◆ Define hydrophilic and hydrophobic.
- ◆ Discuss the molecular construction of the plasma membrane and how it controls transport into and out of the cells as well as how it contributes to “recognition” and “communication” with other cells and cell products.
- ◆ Define osmosis, isotonicity, hypertonicity and hypotonicity.
- ◆ Explain the osmotic effect of placing *Elodea* and red blood cells in distilled water versus seawater.
- ◆ Compare the process of diffusion with facilitated diffusion and active transport.
- ◆ Define dialysis.
- ◆ Describe the process of endocytosis (phagocytosis and pinocytosis) and the formation of food vacuoles.
- ◆ Describe the process of exocytosis and the secretion of cell products and the formation of a new plasma (cell) membrane.
- ◆ Cite three kinds of cell to cell junctions, and state the essential feature of each.

## Week 5-7.5

### Thermodynamics and Enzymology

- ◆ Explain in your own words the First and Second Laws of Thermodynamics.
- ◆ Define anabolism and catabolism, exothermic and endothermic reactions.
- ◆ Define enzyme, coenzyme, cofactor, and activation energy.
- ◆ Explain how the three-dimensional shape of a protein (1<sup>o</sup>, 2<sup>o</sup>, 3<sup>o</sup>, and sometimes 4<sup>o</sup> structure) contributes to its biological activity. Include definitions of active site, allosteric site, and substrate.
- ◆ State how extremes of temperature and pH and both competitive and noncompetitive metabolic inhibitors affect the function of enzymes (and other biologically active proteins).
- ◆ State how organic molecules listed above can be linked together to form the following macromolecules: fats, polysaccharides, polypeptides and proteins, nucleic acids.
- ◆ Define ATP, ADP, AMP, Pi, and explain how ATP stores energy.
- ◆ Explain the concept of paired enzymatic reactions.

### Photosynthesis

- ◆ Explain the relationship of the following membrane structures to the overall structure and function of chloroplasts: grana, stroma, thylakoid discs, thylakoid spaces.
- ◆ Describe, in general, the steps of the light dependent reaction of photosynthesis.
- ◆ Describe the role played by H<sub>2</sub>O, chlorophyll, NADP<sup>+</sup>, ADP, P<sub>i</sub>, and electron carriers in the light dependent reactions of photosynthesis.
- ◆ State the products of the light dependent reactions of photosynthesis.
- ◆ Discuss the concept of oxidation and reduction in cellular metabolism and the mechanism of action of the coenzymes NAD<sup>+</sup>, NADP<sup>+</sup>, FAD.
- ◆ Given the following 5 molecular structures (a-e) list them in oxidative order from the most reduced to the most oxidized. a) saturated and unsaturated hydrocarbons, b) alcohols, c) aldehydes, d) organic acids, e) carbon dioxide.
- ◆ Describe, in general, the steps of the light independent reaction of photosynthesis using the terms CO<sub>2</sub>, ATP, NADPH·H<sup>+</sup> (NADPH<sub>2</sub>), PGA, PGAL, 5-carbon compound, 6-carbon compound, glucose.
- ◆ State the purpose of the pigments other than chlorophyll found in cellular chloroplasts.
- ◆ Describe in very general terms cyclic photophosphorylation and how it benefits some plant cells under special conditions.

### Cellular Respiration

- ◆ Describe the anaerobic catabolism of glucose using the following terms: glucose, PGAL, pyruvic acid, ethanol, CO<sub>2</sub>, lactic acid, NAD<sup>+</sup>, NADPH·H<sup>+</sup> (NADPH<sub>2</sub>), ADP, ATP.
- ◆ Describe the aerobic catabolism of glucose using the terms above and these additional terms: acetyl CoA, citric acid, ketoglutaric acid, succinic acid, malic acid, oxaloacetic acid, FAD, FADH<sub>2</sub>, GDP, GTP.
- ◆ Explain the relationship of the following membrane structures to the overall structure and function of mitochondria: inner and outer mitochondrial membranes, inner mitochondrial space, cristae, Na<sup>+</sup>/K<sup>+</sup> ATPase.
- ◆ Describe electron transport and oxidative phosphorylation: include the effect of cyanide

and dinitrophenol on the processes.

- ◆ Compare substrate phosphorylation and oxidative phosphorylation.
- ◆ Explain how fats and proteins can be used as energy sources.
- ◆ State the fate of the amino group from oxidized amino acids.
- ◆ Compare the energy output of one mole of glucose, one mole of a 16 carbon fatty acid and one mole of the amino acid alanine.

## **Week 7.5-11**

### **Cell Division and Genetics**

- ◆ Define and describe the following: chromosome, chromatid, centromere, telomere, spindle, centriole (centrosome), nuclear envelope, nuclear pore.
- ◆ Diagram the cell cycle and list the phases of mitosis in the order in which they occur.
- ◆ Describe the activities that occur in each stage of the cell cycle and in the phases of mitosis. Arrange photomicrographs, models and/or diagrams of cells in the various stages of mitosis in the order in which they normally occur.

### **Mendelian Genetics**

- ◆ Define the following terms: gene, allele, dominant, recessive, codominant,  $F_1$ ,  $F_2$ , genotype, phenotype, heterozygous, homozygous, hemizygous, Punnett square.
- ◆ Diagram and illustrate Mendel's Law of Segregation.
- ◆ Diagram and illustrate Mendel's Law of Independent Assortment.
- ◆ Construct a Punnett square for a given cross.
- ◆ Given the data of a genetic cross, determine which traits are dominant, which are recessive and which are codominant.
- ◆ Given parental genotype and phenotype, determine by Punnett square the genotypes and phenotypes (and the genotypic and phenotypic ratios) of the  $F_1$  and  $F_2$  generations produced from a monohybrid cross.
- ◆ Given the data, show the inheritance pattern of two non-linked genes in a dihybrid cross.
- ◆ Given the data, show the inheritance patterns of sex-linked traits in fruit flies and mammals (using the Punnett square method).
- ◆ List the phases of meiosis I and II and describe the activities that occur in each phase, distinguishing between reductional and equational division.
- ◆ Define linkage, crossing over, parental type, recombinant type and relate those terms to the chiasmata found in late meiotic prophase I.
- ◆ Define and illustrate with an example: dominant and recessive inheritance, X-linked inheritance, codominance, incomplete dominance, epistasis, pleiotropy, multi-allelic inheritance and sex-influenced inheritance.
- ◆ Compare and contrast mitosis to meiosis. Cite the two processes that occur during meiosis which make it unlikely that any two gametes from a given parent will be identical.
- ◆ State how the events of meiosis are related to segregation and independent assortment.
- ◆ Describe the relationship that exists between meiosis and gametogenesis.
- ◆ Compare oogenesis with spermatogenesis.
- ◆ Describe the process of fertilization.
- ◆ Define nondisjunction, and show how it can lead to chromosomal conditions known as trisomy and monosomy (e.g.: Turner's, Klinefelter's and Down syndrome) and relate to parental age.
- ◆ Discuss and diagram the consequences of primary and secondary nondisjunction.

## DNA as the Genetic Material

- ◆ Describe the experiments (Griffith, Avery *et al.*, Hershey and Chase) that demonstrate that DNA is the genetic material rather than protein.
- ◆ State how deoxyribose, phosphate, purines and pyrimidines can be assembled first as nucleotides, and then into DNA molecules.
- ◆ Draw a DNA double helix that illustrates the antiparallel structure of the polynucleotide strands.
- ◆ With the aid of a diagram, describe semiconservative replication.
- ◆ Explain how a molecule of DNA can contain information and mutate.

## Transcription

- ◆ Name and describe the location and function of the four types of RNA.
- ◆ Explain how a molecule of DNA can be transcribed into RNA. Include: RNA polymerase, promoter, initiation, elongation and termination in the explanation.
- ◆ Define spliceosome, exons, introns, poly(A) tail, 5' 7-methylguanosine cap.
- ◆ Describe post-transcriptional modifications in eukaryotes and contrast this with prokaryotes.

## Translation

- ◆ Describe the role of mRNA, tRNA and rRNA in protein synthesis.
- ◆ Define codon, anticodon, initiation codon, termination codon.
- ◆ Outline the steps by which mRNAs are used to produce proteins. Use the words: initiation, elongation, codon, anticodon, start and stop signals, ribosomes, tRNAs, amino acid, and polypeptide chain in your answer.
- ◆ Given a DNA segment representing a gene, use the codon table to write the peptide sequence that would result.

## Mutation

- ◆ Define mutation.
- ◆ Explain the differences between chromosomal and point mutations and provide an example of each.
- ◆ Define and illustrate a frameshift mutation, and describe how it will affect the protein product.

## Regulation of Gene Expression

- ◆ Diagram and describe the *lac* operon including: promoter, operator, structural genes, repressor protein.
- ◆ Describe the positive and negative feedback control of the *lac* operon.
- ◆ Explain both an inducible and a repressible system and include operon, regulator gene, regulator protein and operator.
- ◆ Name and describe four (or more) levels of control of gene expression in eukaryotes, and give an example. Explain why it is necessary/advantageous to control gene expression.
- ◆ Discuss the role of the rough endoplasmic reticulum and the Golgi apparatus in some of the post-translational modifications of proteins

## **Genetic Engineering**

- ◆ Define the purpose of recombinant DNA technology.
- ◆ Define and describe the terms plasmid, vector, restriction endonuclease, probe, hybridization, polymerase chain reaction (PCR).
- ◆ Describe examples of practical applications of DNA technology in bacteria, plants and animals.
- ◆ Define a transgenic organism, and provide a plant and an animal example.
- ◆ List two ethical concerns of genetically modifying bacteria, plants or animals.

## **Week 12**

- ◆ List the taxonomic categories from the most general to the most specific.
- ◆ Briefly outline in very general terms the taxonomic categorization of two closely related species – timber wolf and dog; two much less closely related species – timber wolf and Tasmanian wolf; two very distantly related species – timber wolf and wolf spider; two unrelated species – timber wolf and wolf berry.
- ◆ Diagram the path of energy through a typical ecosystem, from the sun to heat.
- ◆ Explain the purpose of a cladogram, and on what basis it relates one organism to another.

## **General Review**

- ◆ Draw a “typical” plant and animal cell. Include all studied structures and organelles.
- ◆ State the function(s) of each of the cellular structures and organelles in your drawing.