

B R O O K D A L E C O M M U N I T Y C O L L E G E

Biology 215 Syllabus

Cell and Molecular Biology

Biology Program
STEM INSTITUTE
FALL 2024



DIVISION: STEM Institute **DEPARTMENT:** Biology

COURSE DESCRIPTION: BIOL 215 is a 200-level course that will survey contemporary understandings of the cellular and molecular basis of living things and the biological laboratory techniques available to gain these insights. Topics include the structure and functioning of proteins, gene expression and regulation, recombinant DNA technology, cell signaling, cytoskeleton, cell reproduction, cell communities, stem cells and cancer.

PREREQUISITES: Grade of “C” or higher BIOL 102 and CHEM 102

CREDITS: 4 **LECTURE HOURS:** 3 **LAB/STUDIO HOURS:** 3

REQUIRED MATERIALS: **TEXT:** Essential Cell Biology, Fifth Edition. **Authors:** Alberts, Hopkin, Johnson, Lewis, Morgan, Roberts and Walter. **Copyright** 2019, **Publisher:** W.W. Norton & Company

Laboratory Manual: Biology 215 Laboratory manual

ADDITIONAL TIME REQUIREMENTS:

Additional weekly lab time in the Independent Study Laboratory (MAS 041) usually necessary for successful completion of the course.

COURSE LEARNING OUTCOMES:

The student will be able to:

- Demonstrate comprehension of basic concepts in cell and molecular biology:
 - Cellular ultrastructure
 - Protein structure and functioning
 - Genomics, gene technology and the molecular basics of genetics
 - Cell signaling
 - Cytoskeletal construction and action
 - Cellular reproduction
 - Cell communities, stem cells and cancer
- Apply basic concepts in molecular biology to human health issues.
- Apply principles of the Scientific Method to discoveries in cell and molecular biology.

COURSE CONTENT:

UNIT ONE: INTRODUCTION TO CELL BIOLOGY
UNIT TWO: THE CHEMISTRY OF PROTEINS
UNIT THREE: DNA REPAIR AND RECOMBINATION
UNIT FOUR: HOW CELLS READ THE GENOME
UNIT FIVE: CONTROL OF GENE EXPRESSION
UNIT SIX: HOW GENES AND GENOMES EVOLVE
UNIT SEVEN: MODERN RECOMBINANT DNA TECHNOLOGY
UNIT EIGHT: CYTOSKELETON
UNIT NINE: CELL SIGNALLING
UNIT TEN: THE CELL DIVISION CYCLE
UNIT ELEVEN: CELL COMMUNITITES, STEM CELLS AND CANCER

Department Policies:

Attendance during class and laboratory sessions is strongly recommended for optimum performance in biology courses.

Laboratory practical will be given during laboratory sessions, in accordance with schedules provided by the instructional assistants. Exams and practicals must be taken at the times designated by the instructor or instructional assistant. A student who misses a lecture exam or laboratory practical must provide prior notification and proper documentation in order to take the exam or laboratory practical. The acceptance of said prior notification and proper documentation will be determined by the instructor.

Documentation must be provided within one week of the student's return to the classroom for a make-up exam or laboratory practical to be scheduled. A student who is unable to provide proper documentation for a missed exam or laboratory practical will be given a grade of zero for that exercise. Students may not re-take exams or laboratory practicals on which they perform poorly.

Requirements for the completion of laboratory are listed in the laboratory responsibility sheets provided by the instructional assistant. Requirements for course completion are listed in individual instructor syllabi.

Grading Standard:

A student must have an average of 65% or better for the classroom component of the course and an average of 65% or better for the laboratory component of the course in order to earn a final passing grade for the course.

Upon completion of the course, grades will be assigned as follows:

A	=	92 - 100%
A-	=	89 - 91%
B+	=	86 - 88%
B	=	82 - 85%
B-	=	79 - 81%
C+	=	76 - 78%
C	=	70 - 75%
D	=	65 - 69%
F	=	<65%

Unit examination results will be reported as the grade assigned by the faculty calculated to the first decimal place. These grades will be weighed according to course grading policy. In calculating the course grade, 0.5 will round up to the next numerical grade and 0.4 will round down to the next lower numerical grade.

A grade of C or better is required in all pre-requisite courses. Career studies courses must have a grade of C or better to count toward the Mathematics / Science Program – Biology Option. Students are permitted to withdraw from the course without penalty until approximately 80% of the semester is complete. Please see term schedule for the exact deadline.

At the end of the semester, application for an Incomplete may be made if a student with proper documentation needs to complete no more than one lecture exam and/or one laboratory practical. The granting of an Incomplete is at the discretion of the instructor.

College Policies:

As an academic institution, Brookdale facilitates the free exchange of ideas, upholds the virtues of civil discourse, and honors diverse perspectives informed by credible sources. Our college values all students and strives for inclusion and safety regardless of a student's disability, age, sex, gender identity, sexual orientation, race, ethnicity, country of origin, immigration status, religious affiliation, political orientation, socioeconomic standing, and veteran status. For additional information, support services, and engagement opportunities, please visit www.brookdalecc.edu/support.

For information regarding:

- Academic Integrity Code
- Student Conduct Code
- Student Grade Appeal Process

Please refer to the [student handbook](#) and [catalog](#).

Notification for Students with Disabilities:

Brookdale Community College offers reasonable accommodations and/or services to persons with disabilities. Students with disabilities who wish to self-identify must contact the Accessibility Services Office at 732-224-2730 (voice) or 732-842-4211 (TTY) to provide appropriate documentation of the disability and request specific accommodation or services. If a student qualifies,

reasonable accommodations and/or services, which are appropriate for the college level and are recommended in the documentation, can be approved.

Mental Health:

24/7/365 Resources:

- Monmouth Medical Center Psychiatric Emergency Services at (732) 923-6999
- 2nd Floor Youth Helpline – Available to talk with you about any problem, distress, or hardship you are experiencing. Call or text at 888-222-2228 or visit the website at <https://www.2ndfloor.org/>

Faculty Counselors:

- Students who need to make an appointment with a faculty counselor can do so by calling 732-224-1822 (non-emergency line) during business hours. Faculty counselors are licensed mental health professionals who can assist students and refer them to other mental health resources.

Diversity Statement:

Brookdale Community College fosters an environment of inclusion and belonging. We promote a safe and open culture, encourage dialogue respecting diverse perspectives informed by credible sources, and uphold the virtues of civil discourse. We celebrate all identities with the understanding that ultimately, diversity, equity, and inclusion cultivate belonging and make us a stronger Brookdale community.

Additional Support/Labs:

Course Website:

Biology Department information and BIOL 101 resources are available on the Brookdale website:

<https://www.brookdalecc.edu/stem-institute/biology/>

**The syllabus is intended to give student guidance in what may be covered during the semester and will be followed as closely as possible. However, the faculty member reserves the right to modify, supplement, and make changes as the need arise.*

<u>BIOL 215</u>	<u>Cell and Molecular Biology</u>	<u># 1 of 12 Units</u>	<u>4</u>
Course	Title		Credits

Name of Unit: **INTRODUCTION TO CELLS**

Chapter : ONE

Method of Evaluation: Unit Exam, articles/reports, and laboratory exercises

Estimated Time To Achieve: One week

Learning Objectives

Recommended Learning Experiences

The Student Will Be Able To:

Class Discussion
Textbook Readings:

1. Describe the fundamental similarities among and differences between cells.
Discuss how cells vary enormously in appearance and function.
Explain how present day cells have similar basic chemistry and apparently evolved from the same ancestral cell. Explain how genes provide the instructions for cell form, function and complex behavior. pages 2-5
2. Review the two basic types of cells of the domains Bacteria and Eukarya. Explain how prokaryotes are divided into two domains-Bacteria and Archaea. Study different organelles such as mitochondria, chloroplast, the cytoskeleton, the cytoplasm, nucleus, etc. pages 12-21
3. Understand the uses of *E. coli* and Yeast as model organisms page 27
4. Successfully complete assigned laboratory experiments.

BIOL 215
Course

Cell and Molecular Biology
Title

2 of 12 Units

4
Credits

Name of Unit: **THE CHEMISTRY OF PROTEINS**

Chapter: **FOUR**

Method of Evaluation: Unit Exam, articles/reports, and laboratory exercises

Estimated Time To Achieve: One and half weeks

Learning Objectives	Recommended Learning Experiences
The Student Will Be Able To:	Class Discussion Textbook Readings:
1. Describe the various shapes and structures of proteins. Explain how the shape of the protein is specified by amino acid sequence and how proteins have a wide variety of complicated shapes, several levels of organization are classified into families. Further discuss how proteins can assemble into sheets, filaments, spheres, etc.	pages 123-140
2. Describe the mode of action of proteins and how they bind to other Molecules. Identify their roles as antibodies, enzymes and drugs inhibitors.	pages 141-149
3. Describe how proteins are studied from purified cells and tissues. Explain how protein structures can be determined by their amino acid sequences. Discuss various genetic engineering techniques, and how relatedness of protein aids the prediction of protein structure.	pages 157-168
4. Successfully complete assigned laboratory experiments.	

BIOL 215
Course

Cell and Molecular Biology
Title

3 of 12 Units

4
Credits

Name of Unit:

DNA REPLICATION, REPAIR AND RECOMBINATION

Chapter:

FIVE, SIX

Method of Evaluation: Unit Exam, articles/reports, and laboratory exercises

Estimated Time To Achieve: One week

Learning Objectives

Recommended Learning Experiences

The Student Will Be Able To:

Class Discussion
Textbook Readings:

1. Review the structure of DNA and indicate how this Structure provides a mechanism of heredity. Briefly describe the following : eukaryotic DNA is packaged into multiple chromosomes, chromosomes contain genes, specialized sequences and its requirement for DNA replication and chromosome segregation, interphase chromosomes, highly condensed DNA chromosomes, nucleosomes and chromosome packaging. pages 171-188
2. Review the replication of DNA and explain base pairing, replication origins, replication forks, DNA polymerase, RNA primers for DNA synthesis, proteins at replication forks and telomerase. pages 197-211
3. Describe DNA damage, the importance and mechanisms of DNA repair, damage, mechanisms for DNA repair, homologous recombination in DNA double strand breaks, failure to repair DNA and its consequences, and fidelity of DNA replication and repair. pages 211-215
4. Describe DNA Recombination. pages 216-219
5. Successfully complete assigned laboratory experiments.

BIOL 215
Course

Cell and Molecular Biology
Title

4 of 12 Units

4
Credits

Name of Unit: **HOW CELLS READ THE GENOME**

Chapter: SEVEN

Method of Evaluation: Unit Exam, articles/reports, and laboratory exercises

Estimated Time To Achieve: One Week

Learning Objectives**Recommended Learning Experiences**

The Student Will Be Able To:

Class Discussion
Textbook Readings:

1. Describe the Transcription of DNA to form RNA.
2. Describe the Translation of RNA to form protein and include the role of inhibitors of prokaryotic protein synthesis (antibiotics).
3. Successfully complete assigned laboratory experiments.

Pages 223-237

Pages 238 – 252

BIOL 215
Course

Cell and Molecular Biology
Title

5 of 12 Units

4
Credits

Name of Unit:

CONTROL OF GENE EXPRESSION

Chapter:

EIGHT

Method of Evaluation: Unit Exam, articles/reports, and laboratory exercises

Estimated Time To Achieve: One week

Learning Objectives**Recommended Learning Experiences**

The Student Will Be Able To:

Class Discussion
Textbook Readings:

1. Describe the functions of gene expression control.
Explain how different cell types of organisms contain the same DNA, different cell types produce different proteins and how cells can change gene expression in response to external signals.
2. Describe how transcriptional switches work and how gene expression is regulated at various levels from DNA to RNA to protein. Explain the functioning of transcription regulators, transcription switches, repressors, activators and operons.
3. Describe the post-translational control of gene expression. Define regulatory RNAs, MicroRNAs and small interfering RNAs.
4. Successfully complete assigned laboratory experiments.

pages 261-271

pages 265-271

pages 280-284

BIOL 215
Course

Cell and Molecular Biology
Title

6 of 12 Units

4
Credits

Name of Unit:

HOW GENES AND GENOMES EVOLVE

Chapter:

NINE

Method of Evaluation: Unit Exam, articles/reports, and laboratory exercises

Estimated Time To Achieve: One week

Learning Objectives

Recommended Learning Experiences

The Student Will Be Able To:

Class Discussion
Textbook Readings:

- | | |
|--|---------------|
| 1. Describe the generation of Genetic Variation, changes in germ line pass on to progeny, point mutation, DNA duplications, globin gene family, exon shuffling, novel genes and horizontal gene transfer. | pages 289-300 |
| 2. Describe how genetic analysis can help reconstruct evolutionary relationships between organisms. Explain gene selection, islands of conserved DNA sequences, rapid genome gain and loss in vertebrates, DNA rapidly and tracing of evolutionary relationships with conserved sequences. | pages 300-306 |
| 3. Describe mobile genetic elements of transposons and viruses: Describe transposable sequences and movement of viruses between cells and organisms. Explain how retroviruses can reverse the normal flow of genetic information. | pages 307-310 |
| 4. Examine the human genome and describe its impact in the present world. Demonstrate an understanding of nucleotide sequences in the human genome to show how our genes are arranged. Describe how genome variation contributes to individuality. Explain how differences in gene regulation depict how animals with similar genomes can be so different. | pages 311-322 |
| 5. Successfully complete assigned laboratory experiments. | |

BIOL 215
Course

Cell and Molecular Biology
Title

7 of 12 Units

4
Credits

Name of Unit: **MODERN RECOMBINANT DNA TECHNOLOGY**

Chapter: TEN

Method of Evaluation: Unit Exam, articles/reports, and laboratory exercises

Estimated Time To Achieve: One and one half Weeks

Learning Objectives

Recommended Learning Experiences

The Student Will Be Able To:

Class Discussion
Textbook Readings:

- | | |
|--|---------------|
| 1. Describe how DNA is analyzed and manipulated: | pages 325-329 |
|--|---------------|

restriction nucleases, gel electrophoresis, visualization of DNA bands by fluorescent dyes or radioisotopes, hybridization.

2. Describe DNA cloning procedures in bacteria: fragmentation, production of recombinant DNA, insertion into plasmid vectors, copying recombinant DNA, isolation of genes from DNA library, cDNA library. pages 330-334

3. Describe the cloning of DNA by PCR: amplification of DNA sequences using DNA polymerase and uses of PCR. pages 335-338

4. Describe the concepts of sequencing, microarray & RNAi: next generation sequencing techniques make genome sequencing faster and cheaper, analysis of mRNAs by microarray or RNA-seq provides a snapshot of gene expression, RNA interference (RNAi) inhibits the activity of specific genes. pages 341, 346 and 349

5. Successfully complete assigned laboratory experiments.

BIOL 215
Course

Cell and Molecular Biology
Title

8 of 12 Units

4
Credits

Name of Unit: **INTRACELLULAR COMPARTMENTS AND PROTEIN TRANSPORT**

Chapter: FIFTEEN

Method of Evaluation: Unit Exam, articles/reports, and laboratory exercises

Estimated Time To Achieve: One Week

Learning Objectives

Recommended Learning Experiences

The Student Will Be Able To:

Class Discussion
Textbook Readings:

1. Describe the construction of membrane enclosed organelles. Compare the various membrane-enclosed organelles of eukaryotic cells. Discuss the evolutionary pages 488-491

origins of membrane-bound organelles in the evolution of eukaryotic cells.

2. Describe the process of protein sorting in cells. Explain the role of signal sequence in directing proteins to the correct compartments in the nucleus, mitochondria, and peroxisomes. Explain how soluble proteins made on the ER are released into the ER lumen. pages 492-499
3. Describe the process of vesicular transport. pages 503-504
4. Describe the secretory pathways of the cell. Explain how proteins are modified in the ER and in the Golgi bodies, and how secretory proteins are released from the cell by exocytosis. pages 507-511
5. Describe the pathways of endocytosis in the cell. Differentiate the processes pinocytosis, receptor mediated endocytosis. pages 515 -517
6. Successfully complete assigned laboratory experiments.

BIOL 215
Course

Cell and Molecular Biology
Title

9 of 12 Units

4
Credits

Name of Unit: **CELL SIGNALING**

Chapter: SIXTEEN

Method of Evaluation: Unit Exam, articles/reports, and laboratory exercises

Estimated Time To Achieve: One Week

Learning Objectives

Recommended Learning Experiences

The Student Will Be Able To:

Class Discussion
Textbook Readings:

1. Describe the general principles of cell signaling. Describe how signals act over a long or short range. Explain how cells responds to a limited set of extracellular signals. Describe how cell responses to signals vary in time of response, binding to intracellular receptors and direct enzyme activation. Describe how cell

pages 525-538

surface receptors relay extracellular signals, including intracellular pathways and molecular switches. Describe how ion channel receptors convert chemical signals into electrical ones.

2. Describe the action of G-Protein-Coupled Receptors(GPCR) in activating G-protein subunits. Explain how some bacterial toxins cause disease in altering the activity of G-Proteins. Describe how some G proteins directly regulate ion channels. Explain how the cyclic AMP signaling pathway can activate enzymes and turn on genes. pages 539-544

3. Describe the action of enzyme coupled receptors. Describe how the RTKs recruit a complex of intracellular signaling proteins, including the monomeric GTPase Ras. Explain how RTKs activate PI 3-Kinase to produce lipid docking sites in the plasma membrane. Explain how some receptors activate a fast track to the nucleus. Discuss the evolution of cell-cell communication in plants and animals. pages 551-563

4. Successfully complete assigned laboratory experiments.

BIOL 215
Course

Cell and Molecular Biology
Title

10 of 12 Units

4
Credits

Name of Unit: **CYTOSKELETON**

Chapter: SEVENTEEN

Method of Evaluation: Unit Exam, articles/reports, and laboratory exercises

Estimated Time To Achieve: One Week

Learning Objectives

Recommended Learning Experiences

The Student Will Be Able To:

Class Discussion
Textbook Readings:

1. Describe the structure and function of intermediate filament. Explain how their structural features strengthen cells against mechanical stress. Describe how the nuclear envelope is supported by a meshwork of intermediate filaments. pages 565-570

2. Describe the structure and function of microtubules. Describe how the ends of microtubules are structurally distinct. Describe how the centrosome is the major microtubule organizing center in animal cells. Explain how microtubules organize the cell interior. Describe how stable microtubules are involved in the functioning of cilia and flagella. pages 571-573, 576, 579

3. Describe the structure and function of actin filaments. Describe the polymerization of actin in filament formation. Describe how the basis of cell crawling depends upon on cortical actin. Describe how muscle contraction depends on interacting filaments of actin and myosin. pages 583-585, 588, 592

4. Successfully complete assigned laboratory experiments.

BIOL 215
Course

Cell and Molecular Biology
Title

11 of 12 Units

4
Credits

Name of Unit: **THE CELL DIVISION CYCLE**

Chapter: EIGHTEEN

Method of Evaluation: Unit Exam, articles/reports, and laboratory exercises

Estimated Time To Achieve: One Week

Learning Objectives

Recommended Learning Experiences

The Student Will Be Able To:

Class Discussion
Textbook Readings:

1. Describe the overall cell cycle. Describe the four phases of a typical cell-cycle control system. Discuss the triggers involved in the processes of the cell cycle. Compare cell cycle in various eukaryotes.

pages 603 – 606

2. Describe the control system of the cell cycle. Explain the action Cyclically Activated Protein Kinases called Cdks, and how different Cyclin-Cdk complexes trigger

pages 607-612

different steps in the cell cycle.

Explain how the activity of Cyclin-Cdk complexes depends on phosphorylation and dephosphorylation.

3. Describe the activities of the G1 phase of the cell cycle: Cdk's are stably inactivated in G1, mitogens promote the production of the cyclins that stimulate cell division, DNA damage can temporarily halt progression through G1, cells can delay division for prolonged periods by entering specialized non-dividing states. pages 613-615
4. Describe the activities of the S phase of the cell cycle. Explain how S-Cdk initiates DNA replication and blocks re-replication. Describe how incomplete replication can arrest the cell cycle in G2. pages 616-618
5. Describe the activities of the M phase of the cell cycle. Describe the role of: M-Cdk in M-phase and mitosis. Explain how different cytoskeletal assemblies carry out mitosis and cytokinesis. pages 618-620
6. Describe the processes which occur during Mitosis: Prophase, Prometaphase, Metaphase, Anaphase, Telophase. pages 621-629
7. Describe the activities which enable cytokinesis to occur. Describe the structure and action of contractile ring of animal cells. Describe cytokinesis in plant cells and how the new cell wall forms. pages 630-632
8. Describe how cell number and sizes are controlled. Discuss the role of apoptosis in the regulation of animal cell numbers. Discuss the intracellular proteolytic cascade which regulates apoptosis. Describe the regulation of apoptosis by the Bcl2 family of intracellular proteins. Describe survival factors which suppress apoptosis. Describe how mitogens stimulate cell division by promoting entry into the S phase. Explain the stimulation of cell growth by growth factors. pages 633-641
9. Explain the processes of meiosis and fertilization. Describe the processes of DNA replication followed by two rounds of cell division in meiosis. Describe the meiotic pairing of homologous chromosomes, crossing over, and the production of haploid daughter cells. pages 648-654
10. Successfully complete assigned laboratory experiments.

<u>BIOL 215</u>	<u>Cell and Molecular Biology</u>	<u># 12 of 12 Units</u>	<u>4</u>
Course	Title		Credits

Name of Unit: **CELL COMMUNITIES: TISSUES, STEM CELLS AND CANCER**

Chapter: TWENTY

Method of Evaluation: Unit Exam, articles/reports, and laboratory exercises

Estimated Time To Achieve: One and one half Weeks

Learning Objectives

Recommended Learning Experiences

The Student Will Be Able To:

Class Discussion
Textbook Readings

1. Describe the extracellular matrix and its function in creating connective tissue. Describe the formation of plant external walls from cellulose microfibrils. Explain how walls give plant cells tensile strength. Describe the extracellular matrix of animal connective tissue. Describe the functions of collagen in providing tensile strength to the tissue. Describe the role of integrins in coupling the matrix outside a cell to the cytoskeleton. Describe the role of polysaccharides and proteins in filling spaces and resisting compression.
2. Describe the formation of epithelial sheets utilizing cell junctions. Describe how epithelial polarization, the basal lamina, and tight

pages 683-692

pages 692-700

junctions make an epithelium leak-proof, and distinguishes its apical and basal surfaces. Describe cytoskeleton-linked junctions and their function in binding epithelial cells robustly to one another and to the basal lamina. Describe how Gap junctions allow cytosolic inorganic ions and small molecules to pass from cell to cell.

3. Explore the study of stem cells and therapeutic cloning. Explain the use of specific signals to maintain stem cell populations. Describe the use of stem cells to repair lost or damaged tissues. Describe the use of therapeutic cloning and reproductive cloning. Explain how induced pluripotent stem cells provide a convenient source of human embryonic stem-like cells. pages 707-710

4. Describe the genetic causes, characteristics and treatment of cancer. Describe the two main categories of cancer linked genes: oncogenes and tumor suppressor genes. Describe how cancer cells can proliferate, invade and metastasize. Describe the epidemiologically identified preventable causes of cancer. Explain the link of cancer to mutation accumulation. Discuss the adaptability of cancer cells, and how they gain an increasingly competitive advantage. Explore how an understanding of cancer biology opens the way to new treatments. pages 712-717, 720

5. Successfully complete assigned laboratory experiments.