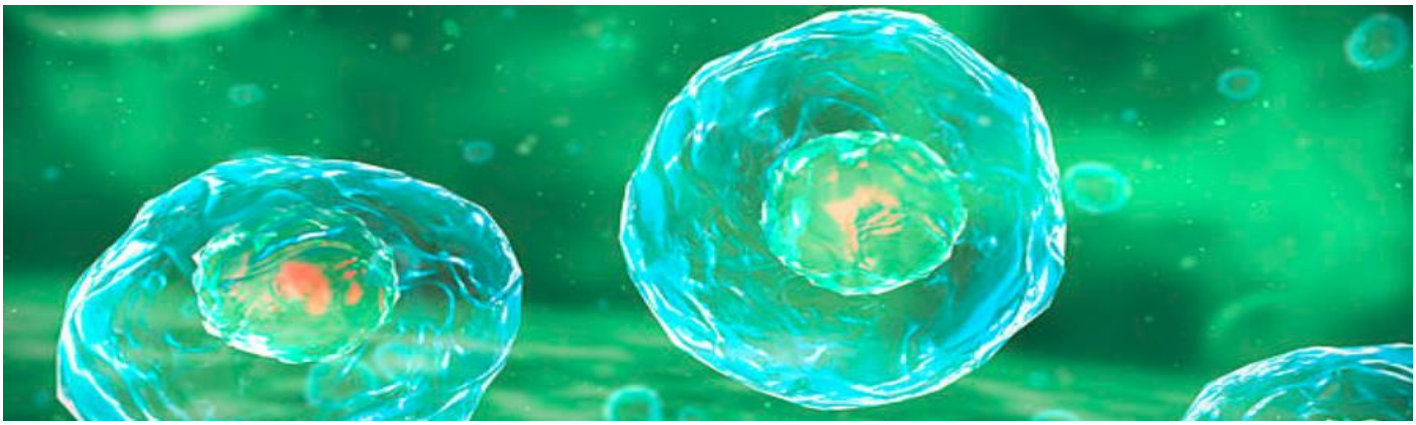

Welcome to **A**dvanced **P**lacement **B**iology

Dr. Terry Gaunt

Summer Assignment 2023

I am excited to have you in my AP Biology class!

Thank you for your interest in taking AP Biology. This course is designed to cover every topic area of biological sciences – including a good portion of evolution (I'll explain later). Some areas will be covered much more thoroughly than others. The course pace is quick, and the amount of material covered is well above what is covered in a typical high school biology course. Though not necessary, it is recommended for students to take this course if there is any interest in exploring any field of biological sciences or medical fields.

There are 8 Units that we will be covering prior to the AP Exam. In order to properly cover and prepare students, the first 2 units YOU will cover this summer on your own. These are most likely units you have covered more than once so far in your education so you will most likely be familiar with them already.

What you will need…

1. **To Purchase You Digital Textbook…**
   - The link for this purchase is www.savvas.com/privateschools
   - Enter in the school zip code, 92675.
   - Choose "Capistrano Valley Chrn School"
   - Use the drop-down menu to select the course (Course #333 AP Bio)
   - Add item to cart and proceed to checkout.
   - **Note: the student access code **is not immediately emailed**. The student access code will be emailed to the person making the purchase in 2-5 business days. If email is not received in 2-5 business days, alert your instructor (and provide the order number).

   ***The Textbook info is…** Modified Mastering Biology with Pearson eText for Campbell Biology, 12th Edition ©2021, AP Edition for Advanced Placement 1year Digital Delivery.
   Isbn10: **0137453000**; isbn13: 9780137453009

2. **To register or be able to log in to your College Board AP Classroom Account**. Go onto College Board AP Classroom **AP Bio 2023-24** and sign in. The code for this class is **GZ3GGD**

3. **Purchase 1 or more (more recommended) AP Review and Prep Guides**. Please see course syllabus for more info on these. There are many options listed at the end of the syllabus. I have listed them IN ORDER of what my preference would be.

SUMMER 2023 ASSIGNMENTS:

1. **Read & Review Chapter 2 "The Chemical Context of Life".**
   - Complete/Answer Concept Check questions 2.1, 2.2, 2.3; & 2.4
   - Read the "Scientific Skills Exercise" and answer "Interpret the Data" questions #1-4

2. **Unit #1 Chemistry of Life**
   - **Read Chapters 3-5 in Text**
     i. Answer ALL the "Concept Check" questions scattered through each chapter. (3.1, 3.2, 3.3, 4.1, 4.2, etc.)
     ii. Answer ALL "Scientific Skills Exercise" AND "Interpret the Data" questions for each chapter as well.
   - **AP Biology Unit 1 Chemistry of Life packet.**
     i. Answer EACH "Learning Objective" question found in each topic area through the packet. (example Topic 1.1, Topic 1.2, etc.)

3. **Unit #2 Cell Structure and Function (basically a repeat of the same types of things as previously**
   - **Read Chapters 6-7 in Text**
     i. Answer ALL the "Concept Check" questions scattered through each chapter.
     ii. Answer ALL "Scientific Skills Exercise" AND "Interpret the Data" questions for each chapter as well.
   - **AP Biology Unit 2 Cell Structure and Function packet.**
     i. Answer EACH "Learning Objective" question found in each topic area through the packet.

- These assignments may be submitted back to me as you go or turned into to me as we begin the school year.
- **I prefer the assignments to be typed**. However, if you choose to handwrite each, that is acceptable as I don't want to hinder your preference.
- I don't mind reviewing the assignments throughout the summer and providing feedback as well. You can email the assignments to me as an email attachment anytime.
- **Upon the start of the school year, we will review these 2 units to start and then you will be given a test to check your understanding of these 2 units.** The test will be sometime after the first few class periods, and we've had time to review the topics.

If you have any questions or need assistance, please contact me. I'll be checking emails quite regularly and will respond within a reasonable time frame.

Dr. Gaunt, tgaunt@cvcs.org

CAPISTRANO VALLEY CHRISTIAN SCHOOLS

Advanced Placement (AP) Biology

UC Approved Life Science Laboratory Course

2023-2024 Course Syllabus

Instructor	Dr. Terry Gaunt	Email	tgaunt@cvcs.org
Office Hours & Availability	Before & After School or by appointment	Phone	(949) 493-5683
Credentials Titles, etc.	B.A., Southern California College M.A., Education Ph. D., Education California Teaching Credential ACSI Credential – "Professional Lifetime"	Web page	www.cvcs.org

I. Course Description

This AP® Biology course is designed to offer students a solid curriculum in introductory college-level biology. The two main goals are to develop a conceptual framework for modern biology and to gain experience and appreciation of biology through experimentation and inquiry. The course presents a wide range of topics including, but not limited to; chemistry of life; cell structure & function; cell energetics (i.e. metabolic and biochemistry processes of photosynthesis and cell respiration); cell communication and cell cycle; heredity; gene expression and regulation; natural selection; and ecology. The course focuses on enduring conceptual understandings and the biological content that supports them. Science practices are employed to help students utilize inquiry-based learning that maximizes depth of learning. Therefore, the course is structured around big idea statements, enduring understandings, and science practices that allow students opportunities to develop an appreciation for the science of biology and to identify and understand unifying principles within a diversified biological world. The course will also expose students to the scope of Biology, with special emphasis on subjects and concepts that will affect their decisions about themselves and their spiritual standards. The process of inquiry and the development of critical thinking skills are important components of this AP Biology course.

II. Methods

In this course, students will be taught scientific principles and *details* will be used to support them. The course of study will be ***developed*** through classroom lectures, discussion, & interaction; FRQ's as reinforcement of concepts; in & out of class assignments, quizzes, and unit exams. The course of study will also be ***reinforced*** through classroom demonstration and actual hands-on lab experiences completed in both the classroom setting and as out of class projects.

III. Lab Investigations

- The course includes 13 Investigative Labs specific to the AP Biology Course. Some of these labs, and the concepts behind them, are included on the actual AP Biology Exam. Much of the class time will be used to reinforce science principles through lab experiences. Therefore, students MUST make the extra-effort "outside of class" to grasps concepts and learn the meaning of the course terminology as presented in their textbook.

- This AP Biology course is structured around inquiry in the lab and in the use of the six science practices throughout the course. Students are given the opportunity to engage in hands-on, inquiry-based investigations throughout the course for a minimum of 25% of the instructional time. Students will conduct a minimum of thirteen inquiry-based investigations. The course will provide opportunities for students to develop, record, and communicate the results of their laboratory investigations. Students will be required to maintain a laboratory portfolio that includes lab reports of their investigative work.
    - The laboratory portfolio will contain varied methods of written student presentation of investigative work, either original work, copy, or picture of the work (formal report, mini-poster, PowerPoint presentation, poster). Each method will require students to communicate and reflect on their investigative work through the following components: Testable question for the investigation; Hypothesis or prediction of the results of experimentation; Detailed methods (experimental variables, controls, constant variables); Description of data as shown in properly labeled tables and graphs; Statistical analyses as appropriate; and Discussion and conclusions using evidence from the investigation.

IV. Texts and Manuals

- **Text: Campbell Biology (AP Edition) 12th edition** (Urry, Cain, Wasserman, Minorsky) ISBN 9780136486879 (digital version)
- **Various AP Study and Exam Prep Manuals as requested by the instructor.**
    - ***SEE All AT THE END OF THIS SYLLABUS***

V. Requirements/Fees

- Each student is to bring to class the following… Computer; Pen AND pencil; colored fine-tip markers, and any additional materials the instructor requires for a specific class period.
- **A Lab Fee and AP Exam Fee will be charged at a later date.**

VI. Grading

- Grades will be determined based upon the following:
    1. Typical Homework and in-class assignments (20-40 points)
    2. Lab Participation, Lab Completion, Lab Investigative Work, etc. (150 points)
    3. Lab Portfolios (150 points)
    4. Quizzes (75 Points)
        - Periodic "pop" quizzes will be given as well. Be ready!!!
    5. Unit/Section Exams (200 points)
    6. Effort, lab participation, classroom discipline, cooperation, and attendance will also be considered in the final grade.

VII. Classroom Policies

- Cell phones will be collected at the start of each class. Students are to place phones in the cell phone holder located within the class. This is to be done automatically each day/class period.
- Classroom Discipline…shall be conducted in accordance with the CVCS student handbook. Disruptions hinder the concentration and education of others and will not be tolerated. Students may be asked to leave the class and consequences will be dealt as deemed necessary.
    - Hint: proper classroom behavior may have positive impact on your final grade.
- Academic Policies/Grading…will be based on correct responses, effort, completion of assignments. Grades/percentages will be based on school % policies.
- Completing Assignments… Assignments must be completed in their entirety. Assignments not completed entirely "may" receive partial credit. This is based on the assignment and level of completion.
    - Hint: thoroughness, additional effort, and detail are encouraged as bonus points could be added for that effort & time placed.
- Submitting Homework Assignments…Homework will only be accepted for possible full credit on the due date stated. Late assignments "may" be accepted. However, a deduction of points/% will be given. This will be based on the level of completion and the number of actual days of lateness. Students whose absences that are recorded as excused will be allowed according to handbook policy.
    - Late assignments will not be accepted from any previous quarter.
- Honesty and Integrity…Answers to assignments shall not be copied or plagiarized in any form from any other source. If found doing this all students involved will receive a "0" for the entire assignment and issued a discipline referral for cheating.

****Extra Credit**…**NO extra credit** "assignments" will be available to raise a grade or to gain points. However, from time to time "Bonus" point quizzes may be given and students may earn additional bonus points for time and additional effort on assignments.

VII. Course Outline

Introduction

****Textbook Chapters 1 - 2**

- 1. Themes of Biology and Scientific Inquiry
- 2. The Chemical Context of Life

SUMMER WORK 2023

1. **NOTE: Read & Review Chapter 2 "The Chemical Context of Life".**
    - **Complete/Answer Concept Check questions 2.1; 2.2; 2.3; & 2.4**
    - **Read the Scientific Skills Exercise and Answer Interpret Data questions #1-4**

2. **Unit 1: Chemistry of Life**
    - **Textbook Chapters 3 - 5**
        - 3. Water and Life 4. Carbon and the Molecular Diversity of Life 5. The Structure and Function of Large Biological Molecules
    - **Unit 1 Topics:** 1.1 Structure of Water and Hydrogen Bonding 1.2 Elements of Life 1.3 Introduction to Biological Macromolecules 1.4 Properties of Biological Macromolecules 1.5 Structure and Function of Biological Macromolecules 1.6 Nucleic Acids

3. **Unit 2: Cell Structure and Function**
    - **Textbook Chapters 6 – 7**
        - 6. A Tour of the Cell 7. Membrane Structure and Function
    - **Unit 2 Topics:** 2.1 Cell Structure: Subcellular Components 2.2 Cell Structure and Function 2.3 Cell Size 2.4 Plasma Membranes 2.5 Membrane Permeability 2.6 Membrane Transport 2.7 Facilitated Diffusion 2.8 Tonicity and Osmoregulation 2.9 Mechanisms of Transport 2.10 Cell Compartmentalization 2.11 Origins of Cell Compartmentalization

4. **Unit 3: Cellular Energetics**
    - **Textbook Chapters 8 – 10**
        - 8. An Introduction to Metabolism 9. Cellular Respiration and Fermentation 10. Photosynthesis
    - **Unit 3 Topics:** 3.1 Enzyme Structure 3.2 Enzyme Catalysis 3.3 Environmental Impacts on Enzyme Function 3.4 Cellular Energy 3.5 Photosynthesis 3.6 Cellular Respiration 3.7 Fitness

4. **Unit 4: Cell Communication and Cell**
    - **Textbook Chapters 11 – 12**
        - 11. Cell Communication 12. The Cell Cycle
    - **Unit 4 Topics:** 4.1 Cell Communication 4.2 Introduction to Signal Transduction 4.3 Signal Transduction 4.4 Changes in Signal Transduction Pathways 4.5 Feedback 4.6 Cell Cycle 4.7 Regulation of Cell Cycle

5. **Unit 5: Heredity**
    - **Textbook Chapters 13 – 15**
        - 13. Meiosis and Sexual Life Cycles 14. Mendel and the Gene Idea 15. The Chromosomal Basis of Inheritance
    - **Unit 5 Topics:** 5.1 Meiosis 5.2 Meiosis and Genetic Diversity 5.3 Mendelian Genetics 5.4 Non-Mendelian Genetics 5.5 Environmental Effects on Phenotype 5.6 Chromosomal Inheritance

6. **Unit 6: Gene Expression and Gene Regulation**
    - **Textbook Chapters 16 – 19**
        - 16. The Molecular Basis of Inheritance 17. Gene Expression: From Gene to Protein 18. Regulation of Gene Expression 20. DNA Tools and Biotechnology
    - **Unit 6 Topics:** 6.1 DNA and RNA Structure 6.2 Replication 6.3 Transcription and RNA Processing 6.4 Translation 6.5 Regulation of Gene Expression 6.6 Gene Expression and Cell Specialization 6.7 Mutations 6.8 Biotechnology

7. **Unit 7: Natural Selection**
    - **Textbook Chapters 22 - 26**
        - 22. Descent with Modification: A Darwinian View of Life 23. The Evolution of Populations 24. The Origin of Species 25. The History of Life on Earth 26. Phylogeny and the Tree of Life
    - **Unit 7 Topics:** 7.1 Introduction to Natural Selection 7.2 Natural Selection 7.3 Artificial Selection 7.4 Population Genetics 7.5 Hardy-Weinberg Equilibrium 7.6 Evidence of Evolution 7.7 Common Ancestry 7.8 Continuing Evolution 7.9 Phylogeny 7.10 Speciation 7.11 Extinction 7.12 Variations in Populations 7.13 Origin of Life on Earth

8. **Unit 8: Ecology**
    - **Textbook Chapters 51 – 55**
        - 51. Animal Behavior 52. An Introduction to Ecology and the Biosphere 53. Population Ecology 54. Community Ecology 55. Ecosystems and Restoration Ecology
    - **Unit 8 Topics:** 8.1 Responses to the Environment 8.2 Energy Flow Through Ecosystems 8.3 Population Ecology 8.4 Effect of Density of Populations 8.5 Community Ecology 8.6 Biodiversity 8.7 Disruptions to Ecosystems

IX. Miscellaneous

- Periodic progress checks will be made of each student. At times parents and coaches will be notified.
- Disruptions during class time ***will not*** be tolerated. Students will be evaluated individually, and consequences are dealt with accordingly.
- Answers to assignments shall not be copied or plagiarized in any form from another student or other sources unless directed by the teacher. If found doing this, **ALL** students involved will receive a "0" for the entire assignment, and a conference with the instructor will occur. Parents will also be notified.
- Detentions and/or a "0" may be issued for not having required materials in class. (Books, paper, pens, assignments, etc.)
    - No one will be allowed out of class for any reason after the tardy bell. (Unless you are called by the office or instructor sees necessary).

AP Biology Exam Prep Manuals & Guides. At least 3 should be obtained by students. We will not be using much of these as course material, they are only for your benefit if you so choose.

1. Pearson Education / AP Biology. (Holtzclaw)…
2. Barron's AP Biology 6th edition… ISBN 978-1-4380-0868-4
3. Kaplan AP Biology Prep Plus 2020 & 2021… ISBN 978-1-5062-4808-0
4. 5 Steps to a 5 AP Biology Elite Student Edition 2020… ISBN 978-1-260-45500-7
5. AP Biology Premium Prep 2021. The Princeton Review… ISBN 978-0-525-56942-8
6. AP Biology Review 2020. Sterling Test Prep/Premium Edition… ISBN 978-1-9475563-0-0

I have received and reviewed the **AP Biology Syllabus** for the 2023-2024 school year.

Student's Name: _____

Parent/Host Signature: _____

Date: _____

I have received and reviewed the **AP Biology Syllabus** for the 2023-2024 school year.

Student's Name: _____

Parent/Host Signature: _____

Date: _____

I have received and reviewed the **AP Biology Syllabus** for the 2023-2024 school year.

Student's Name: _____

Parent/Host Signature: _____

Date: _____

AP BIOLOGY

UNIT 1

Chemistry of Life

8–11%
AP EXAM WEIGHTING

~5–7
CLASS PERIODS

SUGGESTED SKILL

Visual Representations

2.A

Describe characteristics of a biological concept, process, or model represented visually.

TOPIC 1.1
Structure of Water and Hydrogen Bonding

Required Course Content

ENDURING UNDERSTANDING

SYI-1

Living systems are organized in a hierarchy of structural levels that interact.

LEARNING OBJECTIVE

SYI-1.A

Explain how the properties of water that result from its polarity and hydrogen bonding affect its biological function.

ESSENTIAL KNOWLEDGE

SYI-1.A.1

The subcomponents of biological molecules and their sequence determine the properties of that molecule.

SYI-1.A.2

Living systems depend on properties of water that result from its polarity and hydrogen bonding.

SYI-1.A.3

The hydrogen bonds between water molecules result in cohesion, adhesion, and surface tension.

TOPIC 1.2
Elements of Life

SUGGESTED SKILL

Visual Representations

2.A

Describe characteristics of a biological concept, process, or model represented visually.

Required Course Content

ENDURING UNDERSTANDING

ENE-1

The highly complex organization of living systems requires constant input of energy and the exchange of macromolecules.

LEARNING OBJECTIVE

ENE-1.A

Describe the composition of macromolecules required by living organisms.

ESSENTIAL KNOWLEDGE

ENE-1.A.1

Organisms must exchange matter with the environment to grow, reproduce, and maintain organization.

ENE-1.A.2

Atoms and molecules from the environment are necessary to build new molecules—

a. Carbon is used to build biological molecules such as carbohydrates, proteins, lipids, and nucleic acids. Carbon is used in storage compounds and cell formation in all organisms.

b. Nitrogen is used to build proteins and nucleic acids. Phosphorus is used to build nucleic acids and certain lipids.

SUGGESTED SKILL

Visual Representations

2.A

Describe characteristics of a biological concept, process, or model represented visually.

AVAILABLE RESOURCES

- Classroom Resources > **Visualizing Information**

TOPIC 1.3
Introduction to Biological Macromolecules

Required Course Content

ENDURING UNDERSTANDING

SYI-1

Living systems are organized in a hierarchy of structural levels that interact.

LEARNING OBJECTIVE

SYI-1.B

Describe the properties of the monomers and the type of bonds that connect the monomers in biological macromolecules.

ESSENTIAL KNOWLEDGE

SYI-1.B.1

Hydrolysis and dehydration synthesis are used to cleave and form covalent bonds between monomers.

- **EXCLUSION STATEMENT**—*The molecular structure of specific nucleotides and amino acids is beyond the scope of the AP Exam.*
- **EXCLUSION STATEMENT**—*The molecular structure of specific carbohydrate polymers is beyond the scope of the AP Exam.*

TOPIC 1.4
Properties of Biological Macromolecules

Required Course Content

ENDURING UNDERSTANDING

SYI-1

Living systems are organized in a hierarchy of structural levels that interact.

LEARNING OBJECTIVE

SYI-1.B

Describe the properties of the monomers and the type of bonds that connect the monomers in biological macromolecules.

ESSENTIAL KNOWLEDGE

SYI-1.B.2

Structure and function of polymers are derived from the way their monomers are assembled—

a. In nucleic acids, biological information is encoded in sequences of nucleotide monomers. Each nucleotide has structural components: a five-carbon sugar (deoxyribose or ribose), a phosphate, and a nitrogen base (adenine, thymine, guanine, cytosine, or uracil). DNA and RNA differ in structure and function.

b. In proteins, the specific order of amino acids in a polypeptide (primary structure) determines the overall shape of the protein. Amino acids have directionality, with an amino (NH_2) terminus and a carboxyl (COOH) terminus. The R group of an amino acid can be categorized by chemical properties (hydrophobic, hydrophilic, or ionic), and the interactions of these R groups determine structure and function of that region of the protein.

c. Complex carbohydrates comprise sugar monomers whose structures determine the properties and functions of the molecules.

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SUGGESTED SKILL

Concept Explanation

1.A

Describe biological concepts and/or processes.

AVAILABLE RESOURCES

- Classroom Resources > **Visualizing Information**

LEARNING OBJECTIVE

SYI-1.B

Describe the properties of the monomers and the type of bonds that connect the monomers in biological macromolecules.

ESSENTIAL KNOWLEDGE

d. Lipids are nonpolar macromolecules—

i. Differences in saturation determine the structure and function of lipids.

ii. Phospholipids contain polar regions that interact with other polar molecules, such as water, and with nonpolar regions that are often hydrophobic.

EXCLUSION STATEMENT—*The molecular structure of specific lipids is beyond the scope of the AP Exam.*

TOPIC 1.5
Structure and Function of Biological Macromolecules

Required Course Content

ENDURING UNDERSTANDING

SYI-1

Living systems are organized in a hierarchy of structural levels that interact.

LEARNING OBJECTIVE

SYI-1.C

Explain how a change in the subunits of a polymer may lead to changes in structure or function of the macromolecule.

ESSENTIAL KNOWLEDGE

SYI-1.C.1

Directionality of the subcomponents influences structure and function of the polymer—

a. Nucleic acids have a linear sequence of nucleotides that have ends, defined by the 3′ hydroxyl and 5′ phosphates of the sugar in the nucleotide. During DNA and RNA synthesis, nucleotides are added to the 3′ end of the growing strand, resulting in the formation of a covalent bond between nucleotides.

b. DNA is structured as an antiparallel double helix, with each strand running in opposite 5′ to 3′ orientation. Adenine nucleotides pair with thymine nucleotides via two hydrogen bonds. Cytosine nucleotides pair with guanine nucleotides by three hydrogen bonds.

c. Proteins comprise linear chains of amino acids, connected by the formation of covalent bonds at the carboxyl terminus of the growing peptide chain.

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SUGGESTED SKILL

Argumentation

6.E.b

Predict the causes or effects of a change in, or disruption to, one or more components in a biological system based on a visual representation of a biological concept, process, or model.

ILLUSTRATIVE EXAMPLE

- Cellulose versus starch versus glycogen

LEARNING OBJECTIVE

SYI-1.C

Explain how a change in the subunits of a polymer may lead to changes in structure or function of the macromolecule.

ESSENTIAL KNOWLEDGE

d. Proteins have primary structure determined by the sequence order of their constituent amino acids, secondary structure that arises through local folding of the amino acid chain into elements such as alpha-helices and beta-sheets, tertiary structure that is the overall three-dimensional shape of the protein and often minimizes free energy, and quaternary structure that arises from interactions between multiple polypeptide units. The four elements of protein structure determine the function of a protein.

e. Carbohydrates comprise linear chains of sugar monomers connected by covalent bonds. Carbohydrate polymers may be linear or branched.

TOPIC 1.6
Nucleic Acids

SUGGESTED SKILL

Visual Representations

2.A

Describe characteristics of a biological concept, process, or model represented visually.

Required Course Content

ENDURING UNDERSTANDING

IST-1

Heritable information provides for continuity of life.

LEARNING OBJECTIVE

IST-1.A

Describe the structural similarities and differences between DNA and RNA.

ESSENTIAL KNOWLEDGE

IST-1.A.1

DNA and RNA molecules have structural similarities and differences related to their function—

a. Both DNA and RNA have three components—sugar, a phosphate group, and a nitrogenous base—that form nucleotide units that are connected by covalent bonds to form a linear molecule with 5′ and 3′ ends, with the nitrogenous bases perpendicular to the sugar-phosphate backbone.

b. The basic structural differences between DNA and RNA include the following:

   i. DNA contains deoxyribose and RNA contains ribose.

   ii. RNA contains uracil and DNA contains thymine.

   iii. DNA is usually double stranded; RNA is usually single stranded.

   iv. The two DNA strands in double-stranded DNA are antiparallel in directionality.

AP BIOLOGY

UNIT 2

Cell Structure and Function

10–13%
AP EXAM WEIGHTING

~11–13
CLASS PERIODS

SUGGESTED SKILL

Concept Explanation

1.A

Describe biological concepts and/or processes.

ILLUSTRATIVE EXAMPLE

- Glycosylation and other chemical modifications of proteins that take place within the Golgi and determine protein function or targeting

TOPIC 2.1
Cell Structure: Subcellular Components

Required Course Content

ENDURING UNDERSTANDING

SYI-1

Living systems are organized in a hierarchy of structural levels that interact.

LEARNING OBJECTIVE

SYI-1.D

Describe the structure and/or function of subcellular components and organelles.

ESSENTIAL KNOWLEDGE

SYI-1.D.1

Ribosomes comprise ribosomal RNA (rRNA) and protein. Ribosomes synthesize protein according to mRNA sequence.

SYI-1.D.2

Ribosomes are found in all forms of life, reflecting the common ancestry of all known life.

SYI-1.D.3

Endoplasmic reticulum (ER) occurs in two forms—smooth and rough. Rough ER is associated with membrane-bound ribosomes—

a. Rough ER compartmentalizes the cell.

b. Smooth ER functions include detoxification and lipid synthesis.

EXCLUSION STATEMENT—*Specific functions of smooth ER in specialized cells are beyond the scope of the course and the AP Exam.*

SYI-1.D.4

The Golgi complex is a membrane-bound structure that consists of a series of flattened membrane sacs—

a. Functions of the Golgi include the correct folding and chemical modification of newly synthesized proteins and packaging for protein trafficking.

continued on next page

LEARNING OBJECTIVE

SYI-1.D

Describe the structure and/or function of subcellular components and organelles.

ESSENTIAL KNOWLEDGE

EXCLUSION STATEMENT—*The role of the Golgi in the synthesis of specific phospholipids and the packaging of specific enzymes for lysosomes, peroxisomes, and secretory vesicles are beyond the scope of the course and the AP Exam.*

SYI-1.D.5

Mitochondria have a double membrane. The outer membrane is smooth, but the inner membrane is highly convoluted, forming folds.

SYI-1.D.6

Lysosomes are membrane-enclosed sacs that contain hydrolytic enzymes.

SYI-1.D.7

A vacuole is a membrane-bound sac that plays many and differing roles. In plants, a specialized large vacuole serves multiple functions.

SYI-1.D.8

Chloroplasts are specialized organelles that are found in photosynthetic algae and plants. Chloroplasts have a double outer membrane.

SUGGESTED SKILL

Argumentation

6.A

Make a scientific claim.

TOPIC 2.2
Cell Structure and Function

Required Course Content

ENDURING UNDERSTANDING

SYI-1

Living systems are organized in a hierarchy of structural levels that interact.

LEARNING OBJECTIVE

SYI-1.E

Explain how subcellular components and organelles contribute to the function of the cell.

ESSENTIAL KNOWLEDGE

SYI-1.E.1

Organelles and subcellular structures, and the interactions among them, support cellular function—

a. Endoplasmic reticulum provides mechanical support, carries out protein synthesis on membrane-bound ribosomes, and plays a role in intracellular transport.
b. Mitochondrial double membrane provides compartments for different metabolic reactions.
c. Lysosomes contain hydrolytic enzymes, which are important in intracellular digestion, the recycling of a cell's organic materials, and programmed cell death (apoptosis).
d. Vacuoles have many roles, including storage and release of macromolecules and cellular waste products. In plants, it aids in retention of water for turgor pressure.

SYI-1.F

Describe the structural features of a cell that allow organisms to capture, store, and use energy.

SYI-1.F.1

The folding of the inner membrane increases the surface area, which allows for more ATP to be synthesized.

SYI-1.F.2

Within the chloroplast are thylakoids and the stroma.

continued on next page

LEARNING OBJECTIVE

SYI-1.F

Describe the structural features of a cell that allow organisms to capture, store, and use energy.

ESSENTIAL KNOWLEDGE

SYI-1.F.3

The thylakoids are organized in stacks, called grana.

SYI-1.F.4

Membranes contain chlorophyll pigments and electron transport proteins that comprise the photosystems.

SYI-1.F.5

The light-dependent reactions of photosynthesis occur in the grana.

SYI-1.F.6

The stroma is the fluid within the inner chloroplast membrane and outside of the thylakoid.

SYI-1.F.7

The carbon fixation (Calvin-Benson cycle) reactions of photosynthesis occur in the stroma.

SYI-1.F.8

The Krebs cycle (citric acid cycle) reactions occur in the matrix of the mitochondria.

SYI-1.F.9

Electron transport and ATP synthesis occur on the inner mitochondrial membrane.

SUGGESTED SKILLS

Statistical Tests and Data Analysis

5.A.d

Perform mathematical calculations, including ratios.

Visual Representations

2.D.a

Represent relationships within biological models, including mathematical models.

ILLUSTRATIVE EXAMPLES

SA/V Ratios and Exchange

- Root hair cells
- Guard cells
- Gut epithelial cells

ILLUSTRATIVE EXAMPLES

- Vacuoles
- Cilia
- Stomata

TOPIC 2.3
Cell Size

Required Course Content

ENDURING UNDERSTANDING

ENE-1

The highly complex organization of living systems requires constant input of energy and the exchange of macromolecules.

LEARNING OBJECTIVE

ENE-1.B

Explain the effect of surface area-to-volume ratios on the exchange of materials between cells or organisms and the environment.

ESSENTIAL KNOWLEDGE

ENE-1.B.1

Surface area-to-volume ratios affect the ability of a biological system to obtain necessary resources, eliminate waste products, acquire or dissipate thermal energy, and otherwise exchange chemicals and energy with the environment.

RELEVANT EQUATIONS

Volume of a Sphere: $V = \frac{4}{3}\pi r^3$

Volume of a Cube: $V = s^3$

Volume of a Rectangular Solid: $V = lwh$

Volume of a Cylinder: $V = \pi r^2 h$

Surface Area of a Sphere: $SA = 4\pi r^2$

Surface Area of a Cube: $SA = 6s^2$

Surface Area of a Rectangular Solid: $SA = 2lh + 2lw + 2wh$

Surface Area of a Cylinder: $SA = 2\pi rh + 2\pi r^2$

r = radius
l = length
h = height
w = width
s = length of one side of a cube

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LEARNING OBJECTIVE	ESSENTIAL KNOWLEDGE
ENE-1.B Explain the effect of surface area-to-volume ratios on the exchange of materials between cells or organisms and the environment.	**ENE-1.B.2** The surface area of the plasma membrane must be large enough to adequately exchange materials— a. These limitations can restrict cell size and shape. Smaller cells typically have a higher surface area-to-volume ratio and more efficient exchange of materials with the environment. b. As cells increase in volume, the relative surface area decreases and the demand for internal resources increases. c. More complex cellular structures (e.g., membrane folds) are necessary to adequately exchange materials with the environment. d. As organisms increase in size, their surface area-to-volume ratio decreases, affecting properties like rate of heat exchange with the environment.
ENE-1.C Explain how specialized structures and strategies are used for the efficient exchange of molecules to the environment.	**ENE-1.C.1** Organisms have evolved highly efficient strategies to obtain nutrients and eliminate wastes. Cells and organisms use specialized exchange surfaces to obtain and release molecules from or into the surrounding environment.

SUGGESTED SKILL

Visual Representations

2.A

Describe characteristics of a biological concept, process, or model represented visually.

TOPIC 2.4
Plasma Membranes

Required Course Content

ENDURING UNDERSTANDING

ENE-2

Cells have membranes that allow them to establish and maintain internal environments that are different from their external environments.

LEARNING OBJECTIVE	ESSENTIAL KNOWLEDGE
ENE-2.A Describe the roles of each of the components of the cell membrane in maintaining the internal environment of the cell.	**ENE-2.A.1** Phospholipids have both hydrophilic and hydrophobic regions. The hydrophilic phosphate regions of the phospholipids are oriented toward the aqueous external or internal environments, while the hydrophobic fatty acid regions face each other within the interior of the membrane. **ENE-2.A.2** Embedded proteins can be hydrophilic, with charged and polar side groups, or hydrophobic, with nonpolar side groups.
ENE-2.B Describe the Fluid Mosaic Model of cell membranes.	**ENE-2.B.1** Cell membranes consist of a structural framework of phospholipid molecules that is embedded with proteins, steroids (such as cholesterol in eukaryotes), glycoproteins, and glycolipids that can flow around the surface of the cell within the membrane.

TOPIC 2.5
Membrane Permeability

SUGGESTED SKILL

Questions and Methods

3.D

Make observations or collect data from representations of laboratory setups or results.

Statistical Tests and Data Analysis

5.D.b

Use data to evaluate a hypothesis (or prediction), including supporting or refuting the alternative hypothesis.

Required Course Content

ENDURING UNDERSTANDING

ENE-2

Cells have membranes that allow them to establish and maintain internal environments that are different from their external environments.

LEARNING OBJECTIVE	ESSENTIAL KNOWLEDGE
ENE-2.C Explain how the structure of biological membranes influences selective permeability.	**ENE-2.C.1** The structure of cell membranes results in selective permeability. **ENE-2.C.2** Cell membranes separate the internal environment of the cell from the external environment. **ENE-2.C.3** Selective permeability is a direct consequence of membrane structure, as described by the fluid mosaic model. **ENE-2.C.4** Small nonpolar molecules, including N_2, O_2, and CO_2, freely pass across the membrane. Hydrophilic substances, such as large polar molecules and ions, move across the membrane through embedded channel and transport proteins. **ENE-2.C.5** Polar uncharged molecules, including H_2O, pass through the membrane in small amounts.
ENE-2.D Describe the role of the cell wall in maintaining cell structure and function.	**ENE-2.D.1** Cell walls provide a structural boundary, as well as a permeability barrier for some substances to the internal environments. **ENE-2.D.2** Cell walls of plants, prokaryotes, and fungi are composed of complex carbohydrates.

SUGGESTED SKILL

Questions and Methods

3.E.b

Propose a new/next investigation based on an evaluation of the design/methods.

TOPIC 2.6
Membrane Transport

Required Course Content

ENDURING UNDERSTANDING

ENE-2

Cells have membranes that allow them to establish and maintain internal environments that are different from their external environments.

LEARNING OBJECTIVE	ESSENTIAL KNOWLEDGE
ENE-2.E Describe the mechanisms that organisms use to maintain solute and water balance.	**ENE-2.E.1** Passive transport is the net movement of molecules from high concentration to low concentration without the direct input of metabolic energy. **ENE-2.E.2** Passive transport plays a primary role in the import of materials and the export of wastes. **ENE-2.E.3** Active transport requires the direct input of energy to move molecules from regions of low concentration to regions of high concentration.
ENE-2.F Describe the mechanisms that organisms use to transport large molecules across the plasma membrane.	**ENE-2.F.1** The selective permeability of membranes allows for the formation of concentration gradients of solutes across the membrane. **ENE-2.F.2** The processes of endocytosis and exocytosis require energy to move large molecules into and out of cells— a. In exocytosis, internal vesicles fuse with the plasma membrane and secrete large macromolecules out of the cell. b. In endocytosis, the cell takes in macromolecules and particulate matter by forming new vesicles derived from the plasma membrane.

TOPIC 2.7
Facilitated Diffusion

SUGGESTED SKILL

Argumentation

6.E.b

Predict the causes or effects of a change in, or disruption to, one or more components in a biological system based on a visual representation of a biological concept, process, or model.

Required Course Content

ENDURING UNDERSTANDING

ENE-2

Cells have membranes that allow them to establish and maintain internal environments that are different from their external environments.

LEARNING OBJECTIVE

ENE-2.G

Explain how the structure of a molecule affects its ability to pass through the plasma membrane.

ESSENTIAL KNOWLEDGE

ENE-2.G.1

Membrane proteins are required for facilitated diffusion of charged and large polar molecules through a membrane—

a. Large quantities of water pass through aquaporins.
b. Charged ions, including Na^+ and K^+, require channel proteins to move through the membrane.
c. Membranes may become polarized by movement of ions across the membrane.

ENE-2.G.2

Membrane proteins are necessary for active transport.

ENE-2.G.3

Metabolic energy (such as from ATP) is required for active transport of molecules and/or ions across the membrane and to establish and maintain concentration gradients.

ENE-2.G.4

The Na^+/K^+ ATPase contributes to the maintenance of the membrane potential.

SUGGESTED SKILL

Representing and Describing Data

4.A

Construct a graph, plot, or chart.

AVAILABLE RESOURCES

- Classroom Resources > **Investigation 4: Diffusion and Osmosis**
- Classroom Resources > **Visualizing Information**

ILLUSTRATIVE EXAMPLES

- Contractile vacuole in protists
- Central vacuoles in plant cells

TOPIC 2.8
Tonicity and Osmoregulation

Required Course Content

ENDURING UNDERSTANDING

ENE-2

Cells have membranes that allow them to establish and maintain internal environments that are different from their external environments.

LEARNING OBJECTIVE

ENE-2.H

Explain how concentration gradients affect the movement of molecules across membranes.

ESSENTIAL KNOWLEDGE

ENE-2.H.1

External environments can be hypotonic, hypertonic or isotonic to internal environments of cells—

a. Water moves by osmosis from areas of high water potential/low osmolarity/low solute concentration to areas of low water potential/high osmolarity/high solute concentration.

RELEVANT EQUATION

Water Potential:

$\Psi = \Psi_p + \Psi_s$

Ψ_p = pressure potential

Ψ_s = solute potential

ENE-2.I

Explain how osmoregulatory mechanisms contribute to the health and survival of organisms.

ENE-2.I.1

Growth and homeostasis are maintained by the constant movement of molecules across membranes.

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LEARNING OBJECTIVE

ENE-2.I

Explain how osmoregulatory mechanisms contribute to the health and survival of organisms.

ESSENTIAL KNOWLEDGE

ENE-2.I.2

Osmoregulation maintains water balance and allows organisms to control their internal solute composition/water potential.

SOLUTE POTENTIAL OF A SOLUTION

$$\Psi_s = -iCRT$$

where:

i = ionization constant

C = molar concentration

R = pressure constant

$$\left(R = 0.0831 \ \frac{L \cdot bars}{mol \cdot K}\right)$$

T = temperature in Kelvin (°C + 273)

SUGGESTED SKILL

Concept Explanation

1.B

Explain biological concepts and/or processes.

TOPIC 2.9
Mechanisms of Transport

Required Course Content

ENDURING UNDERSTANDING

ENE-2

Cells have membranes that allow them to establish and maintain internal environments that are different from their external environments.

LEARNING OBJECTIVE

ENE-2.J

Describe the processes that allow ions and other molecules to move across membranes.

ESSENTIAL KNOWLEDGE

ENE-2.J.1

A variety of processes allow for the movement of ions and other molecules across membranes, including passive and active transport, endocytosis and exocytosis.

TOPIC 2.10
Compartmentalization

SUGGESTED SKILL

Argumentation

6.E.a

Predict the causes or effects of a change in, or disruption to, one or more components in a biological system based on biological concepts or processes.

Required Course Content

ENDURING UNDERSTANDING

ENE-2

Cells have membranes that allow them to establish and maintain internal environments that are different from their external environments.

LEARNING OBJECTIVE	ESSENTIAL KNOWLEDGE
ENE-2.K Describe the membrane-bound structures of the eukaryotic cell.	ENE-2.K.1 Membranes and membrane-bound organelles in eukaryotic cells compartmentalize intracellular metabolic processes and specific enzymatic reactions.
ENE-2.L Explain how internal membranes and membrane-bound organelles contribute to compartmentalization of eukaryotic cell functions.	ENE-2.L.1 Internal membranes facilitate cellular processes by minimizing competing interactions and by increasing surface areas where reactions can occur.

SUGGESTED SKILL

Argumentation

6.B

Support a claim with evidence from biological principles, concepts, processes, and/or data.

TOPIC 2.11
Origins of Cell Compartmentalization

Required Course Content

ENDURING UNDERSTANDING

EVO-1

Evolution is characterized by a change in the genetic makeup of a population over time and is supported by multiple lines of evidence.

LEARNING OBJECTIVE

EVO-1.A

Describe similarities and/or differences in compartmentalization between prokaryotic and eukaryotic cells.

ESSENTIAL KNOWLEDGE

EVO-1.A.1

Membrane-bound organelles evolved from once free-living prokaryotic cells via endosymbiosis.

EVO-1.A.2

Prokaryotes generally lack internal membrane-bound organelles but have internal regions with specialized structures and functions.

EVO-1.A.3

Eukaryotic cells maintain internal membranes that partition the cell into specialized regions.

EVO-1.B

Describe the relationship between the functions of endosymbiotic organelles and their free-living ancestral counterparts.

EVO-1.B.1

Membrane-bound organelles evolved from previously free-living prokaryotic cells via endosymbiosis.