## Foundations of Biology for Biological Science Majors I

### Course Philosophy and Overall Goals

Biology 2002 and 2003/2004 comprise a year-long course sequence designed to prepare biological sciences majors for advanced studies in biology, including ecology, evolution, biochemistry, cell biology, genetics, and organismal biology. Because of its importance for understanding all other areas of biology, evolution is the central unifying concept of both of these foundational courses.

In Biol 2002/03/04, you will learn biological principles by working individually and in teams to solve problems, analyze data, explore case studies, and conduct laboratory investigations. The Foundations courses emphasize the relationships among biological fields of study, as well as the relationships among biology, chemistry, and other physical sciences. We also emphasize the development and application of quantitative skills, concepts, and tools to biological problems.

Your work in these courses will help you learn to approach real-world problems from a scientific perspective and develop skills for independent learning, critical thinking, problem solving, communication, and scientific reasoning. In this way, these courses will help prepare you for success in your future career, especially in biology-related fields.

An important aspect of a liberal education is learning how widely different subjects allow us to interpret events and situations that affect our lives as individuals, societies, global citizens.  As students who have professed an interest in biology, it probably comes as no surprise to you that understanding biological phenomena is at the heart of grasping and ultimately solving many problems such as environmental pollution, evolution of "superbugs," loss of biodiversity, and numerous infectious and chronic diseases.  One aim of this course is to illuminate how biologists think and perform their work so that, whatever your ultimate career path, you can appreciate how the discipline of biology complements the ways in which social scientists, physical scientists or mathematicians approach the same problems.

**What biological concepts will I learn in this course?**

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|  | Biology 2002 focuses on major concepts in **evolution and genetics**. For detailed information about specific learning outcomes in Biology 2002, please see the tables and outline at the end of the syllabus. |

**What major skills will I gain or strengthen?**

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|  | **Scientific reasoning & process:** This course will improve your ability to think like a scientist. You will gain experience following scientific protocols and using modern research equipment and strategies. You will learn how to make observations, develop hypotheses, design experiments, and interpret data. **Quantitative reasoning:** You will gain additional experience using mathematical concepts and tools to analyze, evaluate, and present data.**Information literacy:** You will learn how to find information and data, evaluate it, and synthesize it to solve problems or make decisions.**Communication skills:** You will gain experience communicating in a biological context and presenting your work in an oral, written, and graphic format.**Preparation for life after college:** You will strengthen your time management skills, your understanding of ethical issues in science, and your ability to work effectively as a team member with others who may be quite different from you in personality, strengths, or cultural background. |

### II. Instructor Information

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| **David Matthes**Genetics, Cell Biology & Development | 5-110 MCBdmatthes@umn.edu612-626-5474 (office)Office Hours – after class or by appointment  | Welcome! It is an honor to be working with you in this cutting edge biology course, and to work as instructor and guide for you and your peers as you begin this journey to master introductory genetics and evolutionary biology, develop skills important for all biologists, and pursue questions that interest us as biologists. I hope that you find this course to be a transformative experience.I earned a Bachelors degree in Human Biology (with a concentration in Human Ecology) and a Masters degree in Biological Sciences at Stanford University, and a PhD in Molecular and Cellular Biology from the University of California, Berkeley. I have been a professor for the last 16 years doing research on the semaphorin protein family and cell migration in the immune system and teaching genetics, cell biology and bioinformatics. At the University of Minnesota I enjoy working with undergraduates, pursuing the scholarship of teaching and learning, and collaborating with my colleagues in the Biology Program. |
| **Sue Wick**Plant Biology, Director of Undergraduate Studies for the Biology major | 726 Biosciences & 6-142 MCBswick@umn.edu 612-625-4718 651-488-0063 (home – emergencies only, please)Office Hours – after class 12:30-1:30 in MCB 3-149 or by appointment. I really enjoy talking with students. Please come see me! | Welcome, indeed! I very much enjoy teaching this class and getting to know you individually. I was a Botany undergrad at Oregon State University, earned a PhD in Biological Sciences at Stanford University, and then went to The Australian National University as a postdoc and a research faculty member before making my way to UM. My undergraduate interests were in evolution and ecology, but I diverted into cell and developmental biology for many years, doing research on the plant cytoskeleton, particularly microtubules. I have taught at all levels from freshmen through postdocs, including a freshman seminar on emergent human viruses such as Ebola virus. In this class we use data from research on how people learn deeply and retain information to help you approach the enormous field of modern biology. I very much enjoy this kind of interactive teaching and the opportunity to help you grow into new scientific colleagues. Come talk with me outside of class sometime! |
| **Vanessa Pompei**Biology Program, Head laboratory instructor | 354 Biosciencespomp0012@umn.edu612-626-2544 (office) | I have a B.S. in Zoology from the University of California at Santa Barbara, and a M.S. in Conservation Biology from the University of Minnesota.  Prior to coming to CBS, I taught non-majors biology laboratories in the General College and Department of Postsecondary Teaching and Learning.  I have been an Assistant Education Specialist in the Biology Program since 2007, and was fortunate to come on board when 2002 was just starting!  It has been a thrill to teach and interact with such wonderful, motivated students. |

### III. Course Logistics

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| **What are the prerequisites for Biology 2002?** | Chemical Principles I (i.e. Chemistry 1021 or equivalent) is required; calculus I (i.e. Math 1271, 1281 or equivalent) is recommended. We expect you to be comfortable with algebra and to know (and be able to use) basic principles of atomic properties and chemical bonds (including electronegativity), molarity, the properties of water, and the properties of carbon. |

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| **Where and when does class meet?** | **M, W & F** | **Concept Lab**  | 312 STSS, East Bank, Minneapolis. The third class meeting each week provides time for skill building and team work for your team project.  |
| **M&W or****Tu&Th** | **Research Lab**  | See your individual schedule for times and locations; all in BioSci, St. Paul |

### IV. Course Expectations:

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| **What do you expect from me as a student in this course?** | 1. **Preparation**: Come to class with an open mind, prepared to learn (i.e. having completed the reading and other assignments; bringing your notes, lab manual, etc.)
2. **Courtesy & respect**: Interact with the instructors, teaching assistants and your fellow students in a professional, courteous way (be on time, refrain from side conversations during class time, contact us if an emergency arises, etc.) All laptops, cell phones, and other electronics are to be turned off and put away during class except when you are specifically working in your team on class assignments and activities. Studying chemistry or other coursework during class time is not acceptable.
3. **Time on task**: To earn a C in this class, we expect you to spend AT LEAST 15 hours total *each* week on class activities (concept lab, research lab, working on your own or with your team, and studying course material) outside of class.
4. **Curiosity**: Ask questions whenever something isn’t clear or you want to know more.
5. **Honesty**: In accordance with university policy, a student who commits academic dishonesty (cheating, plagiarism, etc.) will receive appropriate penalties, including a 0 on the exam, quiz, or assignment, and the possibility of receiving an F for the course.
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| **What can I expect from my instructors and TAs in this course?** | 1. **Preparation**: We will prepare activities and assignments that will help you master the material and improve your skills.
2. **Courtesy & respect**: We will treat you in a professional, courteous way in lecture, laboratory, and interactions outside of class.
3. **Availability**: We will be accessible to you during office hours or by appointment to help you learn the material.
4. **Enthusiasm**: We are professionals who have spent years learning many different facets of biology; we will share with you our love of biology.
5. **Fairness**: We will prepare exams, quizzes, and assignments that fairly represent the material and that are fairly graded.
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### V. Text & Lab Manual

Our text is “Biology” by Brooker, Widmaier, Graham, & Stiling, 2nd ed. You may buy or rent it at campus bookstores or elsewhere. The research lab manual is available at Books Underground (St. Paul Student Center) and in the Coffman Union bookstore. You need it for the first day of lab (second week of the semester). You can call either bookstore to hold a copy for you. We recommend that you use a loose-leaf notebook to organize your notes, handouts, references, protocols, etc., for both concept lab and research lab. For the Intellectual Property notebook in concept lab you need good records of your contributions to your team’s project.

### Evaluation & Grades

All parts of this course are interwoven and interdependent. Consequently, your grade in this course is determined by your performance both in concept lab (aka “lecture”) and in research laboratory: approximately 65% of the grade is determined by evaluation of your mastery of knowledge based on concept lab and discussion-related activities; approximately 35% of the grade is determined by research laboratory activities and knowledge. **To pass the course, you MUST PASS both the lab and the lecture portions of the class (i.e. earn greater than 60% of the available points in each).**

The basis of determining grades in the course is outlined below:

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| Graded component | Percentage of grade | Notes |
| **Individual Performance \*** | **40%** |  |
| * Learning Readiness Quizzes† – Individual Component
* 300 points total
 | 15% | 13 LRQ, 30 points each; keep the highest 10 scores; missed LRQ= 0; each LRQ typically 15 multiple choice questions worth 2 points each |
| * Exams*,* 470 points total

Exam 1 – 120 pointsExam 2 – 150 pointsFinal Exam – 200 points\*\*Weekly reflections, 30 points | 22%3% | In-class exams with small take-home component; short answer, essay. *Questions related to research laboratory concepts may be included.*On exams 1 and 2, you have the option of earning back ¼ of the points you missed by doing a post-exam analysis. |
| **Team Performance**  | **25%** |  |
| * Learning Readiness Quizzes – Team Component
* 75 points total
 | 3.75% | 13 LRQ, 7.5 points each; keep the highest 10 scores; typically 15 LRQ questions worth ½ point each  |
| * Team Project
* 300 points total
 | 15% | 1 multi-part project with individual parts worth 10-30 points each– 300 points  |
| * Team Maintenance
* 125 points total
 | 6.25% | Peer evaluation of team members’ contributions |
| **Laboratory Performance** * 700 points total
 | **35%** |  |

\* There will be an opportunity at the end of the semester to earn 5 bonus points for taking a course survey. \*\*These involve submitting (on Moodle) a reflection of, e.g., what you have learned that week, what was most interesting, and how it fits the CBS Student Learning Outcomes and the foundational knowledge to be uncovered in the course. If you complete all 13 reflections you will earn the 30 points; 3 points will be subtracted from 30 for each number less than 13 submitted. Research indicates that this type of reflection is correlated with higher course grades.

† The Ultimate Quiz in Week 14 is cumulative; if your score on the Ultimate Quiz is higher than the score on your best ten LRQs, then the Ultimate Quiz score will replace your individual LRQ scores. If not, we will use your best ten LRQs in calculating your final grade. Thus, the Ultimate Quiz *cannot* lower your final grade.

**Grading scale:** We will assign grades based on the standard grading system:

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| **Grade** | **Percentage of total points** | **Plus/minus**  |
| A range | 90% and above | Plus/minus designations will be based on overall student performance in the class and may not be awarded in every category, depending on the range of scores.  |
| B range | 80% - 89% |
| C range | 70% - 79% |
| D range | 60% - 69% |
| Not passing | Less than 60% |

**University Grading Standards:**

A - achievement that is outstanding relative to the level necessary to meet course requirements.

B - achievement that is significantly above the level necessary to meet course requirements.

C - achievement that meets the course requirements in every respect.

D - achievement that is worthy of credit even though it fails to meet fully the course requirements.

S - achievement that is satisfactory, which is equivalent to a C- or better.

F (or N) - represents failure (or no credit) and signifies that the work was either (1) completed but at a level of achievement that is not worthy of credit, or (2) was not completed and there was no agreement between the instructor and the student that the student would be awarded an I.

I (Incomplete) - assigned at the discretion of the instructor when, due to extraordinary circumstances (e.g., hospitalization), a student is prevented from completing the work of the course on time.

**Incomplete policy:** A grade of Incomplete will be given only if all of the following conditions are met:

1. The instructor believes that legitimate reasons due to extraordinary circumstances exist to justify extending the deadline for course completion. Examples of extraordinary circumstances include extended illnesses, serious accidents or other emergencies. The student must provide documentation such as a letter from his/her physician to support the claim of extraordinary circumstances.
2. The instructor has a reasonable expectation that the student can successfully complete unfinished course work within a specified time frame.
3. The student and instructor acknowledge that the "I" is not given to help a student improve his/her grade in the course.
4. The student and instructor have signed a contract (available in the Biology Program Office 3-104 MCB) agreeing to the work yet to be completed and the timeframe for this completion.

If an incomplete is given, the work must be completed within the agreed timeframe or it will automatically convert to an F.

**Make-up work:** We do not expect to provide opportunities for any make-up work except in those cases in which we are required to do so by university policy. However, requests that are supported by documentation (e.g., letters from university offices, doctors, police reports) will be considered. You must contact the instructor either before the activity that you will miss or in a timeframe after the activity that is consistent with the reason for missing the work (exam, assignment, etc.). The format of the makeup activity is at the discretion of the instructor and for exams may be in an oral or essay format.

**Grading errors**: Any errors or problems with grading should be brought to the instructor's attention *in writing* within one week of the return of the item. For exams, please put only the number of the question(s) you want to be re-graded (no explanations, please) on a Post-it note, attach to the exam, and wait for the re-grade decision before you submit your post-exam analysis. (More information about this post-exam analysis opportunity will be provided in class.)

### Resources for Success

**Biology Tutorial Room:** If you are looking for a place in Minneapolis to study or work on group projects, try the tables in the Tutorial Room in MCB 3-149 or the CBS student computer room in the BioCommons area of Moos (opens with your UCard). In addition, there are upper division undergraduates available in the Tutorial Room who could help you with study strategies or with questions about course topics. If you identify the topic (evolution, cell structure, meiosis, general genetics, molecular genetics, etc.), you can be directed to the tutors most suited to helping you. This room opens the second week of classes and its hours of operation will be posted on the door of the room.

**Writing:** Good writing is a very important skill, and can make a difference in your grade as a student and in your success in your career, whether in the sciences or elsewhere. In the lecture, you will be using your writing skills on problem sets, exams, and papers; in lab, you will be writing lab reports. You may want to take advantage of writing resources at the Center for Writing (<http://writing.umn.edu/index.html>). You can also visit Student Writing Support in 10 Nicholson Hall and 5 Appleby Hall (http://writing.umn.edu/sws/index.html)

**University Counseling and Consulting Services:** Sometimes you just need someone to talk to confidentially. UCCS is a great place to talk with trained professionals about personal issues, career planning, and other concerns. Besides individual consultation and counseling, they provide a wide variety of resources including instruction, workshops and testing services, all to help you develop or strengthen skills needed for academic success. You can find out more at <http://www.uccs.umn.edu> or drop by their offices at 340 Appleby Hall (8:00-4:30) or 199 Coffey Hall (8:00-4:00). Phone for both is 612-624-3323.

**Mental Health Concerns:** As a student you may experience a range of issues that can cause barriers to learning, such as strained relationships, increased anxiety, alcohol/drug problems, feeling down, difficulty concentrating and/or lack of motivation. These mental health concerns or stressful events may lead to diminished academic performance or reduce a student’s ability to participate in daily activities. University of Minnesota services are available to assist you with addressing these and other concerns you may be experiencing. You can learn more about the broad range of confidential mental health services available on campus via the Student Mental Health Website at <http://www.mentalhealth.umn.edu>. Urgent crisis counseling services are available. A student who is having a crisis and feeling unable to cope can call UCCS or come in to speak to a receptionist about seeing a counselor.

**The SMART Learning Commons:** These centers offer academic consultation in the McGrath, Walter and Wilson Libraries. You can find a tutor, prepare for exams, and access on-line learning resources. See <http://smart.umn.edu/> for more information.

**MCAE:** Located in 140 Appleby Hall, the Multicultural Center for Academic Evidence provides walk-in one-on-one tutoring in effective study skills, math, writing, and library research. They also have final exams with answer keys for lots of math courses. See <http://www.mcae.umn.edu/acadsupport/index.html> for more information.

### Academic Integrity

Professional standards in science, health professions, teaching, and research are based on the expectation that scientists, clinicians, and teachers will conduct their professional work with the highest level of academic and personal integrity. Similarly, we expect you, as future scientists, researchers, teachers, and health care providers, to display to the highest standards of academic integrity in this class. The grade in a course is to be a reflection of what you have learned in the course. We cannot tell what you have learned unless you express what ***you*** have learned, through tests, quizzes, written and oral reports. Therefore, on individual assignments and exams, the expression must be entirely YOURS.

On take-home exams, you may ask questions of your instructors but you must not communicate with any other individual about the exam, including current or former class members. You will be required to sign a statement of your adherence to academic integrity standards on the exam. If the instructors observe or find evidence of any collaboration on the exam, all students involved risk receiving a zero for the entire exam. In addition, the instructors will report the academic misconduct to your College and to the University of Minnesota’s Office for Student Conduct and Academic Integrity (OSCAI). You have the right to contest the instructor’s decision with the OSCAI and can contact that office to schedule a hearing. If you do not contest the penalty or are found guilty of academic misconduct by the OSCAI review committee, information about your misconduct will remain a part of your official University of Minnesota record. Such a record will adversely affect your application to graduate or professional schools, including medical school and law school. Cheating is not worth the risk of permanently damaging your career options.

Note that this class has a significant amount of team work, with 25% of your grade a result of team performance. We will do our best to make sure you know what kinds of activities are team vs. individual effort. If you have any questions about what degree of interaction with team members is appropriate for a particular assignment, please ask.

### Accommodations

Students with disabilities that might hinder their ability to participate in the full range of class activities should contact the lecture or lab instructor as soon as possible. Additional information on accommodation is also available from Disability Services in 230 McNamara Alumni Center (V/TTY) 624-4037.

###  Information for Honors Students

Biology 2002H honors students will design and complete a project that helps them develop additional strengths in one or more areas: leadership service, global perspectives, or interdisciplinary connections.

Examples of potential projects include:

* Work with faculty to develop a learning aid that helps students in the class master a complex topic
* Take part in a service project at a local school or at the Science Museum of Minnesota
* Analyze contributions of scientists outside the United States in an area of biology discussed in class
* Evaluate a research seminar *outside* biological sciences that relates to topics in the course

Each student will meet with Biology 2002 faculty to develop a specific plan for their project no later than the end of the **fourth week** of the class. Based on that consultation, the students will draft a plan for their project, which is to be completed by the end of the semester.

If you are enrolled in Biol 2002H and decide you do not want to take the course for honors credit, you must drop the course within the first two weeks of class and re-enroll in Biol 2002. If you remain enrolled in Biol 2002H and do not satisfactorily complete the honors requirements, your final grade for the course will be one half grade lower than what would be determined by your percentage of total course points.

### Student Learning Outcomes and Biology Knowledge

Because of the nature of concept lab in Biol 2002, students sometimes lose track of how much biology and how many professional skills they are learning in the class. Based on the outcomes outlined in the following two charts, we will ask you to reflect briefly on, e.g., what you have learned each week, how it relates to your education, and what questions you still have. This process is part of what is called metacognition. Research indicates that metacognition increases learning. Doing these reflections on a regular basis will earn you points towards your final course grade.

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| ***A University of Minnesota graduate demonstrates:*** | ***CBS Learning Outcome*** | ***When you successfully complete the Foundations of Biology courses (Biol 2002 & 2003), you will be able to*** | ***Examples of types of assessments to measure mastery of learning outcome*** |
| 1. **mastery of a body of knowledge and mode of inquiry**
2. **the ability to identify, define, and solve problems**
 | Understanding and application of scientific reasoning and process | *See foundational knowledge outcomes* | * Exam questions; projects in lab; case studies; Concept lab activities
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| * Demonstrate an increased awareness of and interest in biology from molecules to ecosystems
 | * Entrance/exit survey
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| * Demonstrate an increased ability to formulate questions, and to critically evaluate what you know and need to know to find the answers
 | * Reflection papers/one-minute papers; lab exercise structure; Lab reports; Concept lab activities
 |
| * Apply what you know to solve a new problem
 | * Exam questions; experimental design in labs; concept lab activities; team projects
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| * Demonstrate that all fields of biology (e.g. genetics, ecology, biochemistry) are inter-related and are strengthened by integrating knowledge from other natural sciences (mathematics, statistics, chemistry, and physics)
 | * Exam questions; case studies and laboratory activities that require integration; exam questions/reflection paper
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| * Use the scientific method (develop an hypothesis based on observations, design and carry out experiments with appropriate controls to test the hypothesis, manage statistical and graphical data, analyze and evaluate results)
 | * Exam questions; laboratory research projects; Concept lab activities
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| 1. **the ability to locate and evaluate information**
 | Effective use of technology to obtain and evaluate information and data  | * Locate, evaluate, and credit information in books, journals, library resources, web pages, and biological databases
 | * References in papers & lab reports; exercises using databases; library workshops/tutorials; Concept lab activities
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| 1. **an understanding of diverse philosophies and cultures in a global society**
 | Understanding of diverse cultures and philosophies | * Give examples of the impact of history and society on biological discoveries and approaches
 | * Exam questions; case studies; papers; in class responses; presentations
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| * Give examples of human impact on the world and take a reasoned, scientific position concerning the causes and effects of these impacts
 | * Exam questions; case studies; papers; in class responses; presentations
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| 1. **the ability to communicate effectively**
 | Ability to communicate effectively  | * Communicate scientific results in written, oral, and visual presentations to diverse audiences
 | * Presentations in class and lab; discussions in research and concept lab
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| 1. **skills for effective citizenship and life-long learning**
 | Preparation for effective citizenship and life after college | * Know the professional and ethical standards of science
* Identify ways in which knowledge of biology enriches your life
* Develop a personal strategy for effectively managing time
* Explain the basic features of successful team work and understand how your own personality affects team work
 | * Exam questions; lab assignments; papers; case studies
* Exam questions; papers; discussions; demonstrations
* Make plan in semester 1 & reflection in semester 2; plans for exam study; plans for paper/presentation
* Lab exercises; research teams; reflection papers; self analysis; discussions
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# Foundational Biology Knowledge

### Science, including biology, is an evidence-based, logical process by which humans can discover natural explanations for natural phenomena.

### All life on earth is related through evolution from a common ancestor. As a result, life on earth is very diverse, but has many features in common.

1. Living organisms are composed of molecules that interact according to the laws of chemistry and physics.
	1. The major macromolecules in cells are proteins, nucleic acids, lipids, and carbohydrates.
	2. Synthesis of these molecules is catalyzed by enzymes. The synthesis of proteins and nucleic acids also requires a nucleic acid template.
2. The origin and diversification of life can be scientifically studied through observations of fossil and living organisms and through direct experimentation. Through these studies, we know that the vast majority of species that have evolved are now extinct but new species continue to evolve.
3. All life is composed of one or more cells that evolved from a common ancestor. This ancestral cell appeared on Earth ~ 3.5 billion years ago.
	1. All cells have many common structural features and processes that reflect their common descent.
	2. Each of the three major cellular lineages (eubacteria, archaea, and eukaryotes) has distinctive features that reflect divergent or convergent evolution.
		* Eukaryotic cells are composed of four interacting compartments: nucleus, cytoplasm, endomembrane system, and semiautonomous organelles.

### III. Information stored in DNA produces traits on which natural selection acts.

1. Genetic information in all cells is stored within the DNA sequence (genome) of the cell.
	1. To have an effect on an organism’s phenotype, information in DNA must be transcribed into RNA and, in many cases, translated into protein. Most genes are units of DNA that can be transcribed.
	2. Natural selection acts on phenotypes, which are determined by genes and the environment.
	3. Changes in gene expression are critical for the growth, development, and maintenance.
	4. Mutations are changes in the DNA sequence of genes that produce gene variants called alleles. Mutations may have no effect, be deleterious, or confer a fitness advantage to the organism.
	5. The frequency of a particular allele within a population changes through generations; this is evolution.
2. The patterns by which genes are passed from parent to progeny are predictable, and follow the rules of statistics and probability.
	1. DNA replication is the process by which copies of DNA in cells are synthesized, in preparation for cell division. Replication is critical for passing genetic information from generation to generation.
	2. Through mitosis and other forms of asexual reproduction, exact copies of the parental cell’s DNA are passed to the progeny cells, producing two genetically identical progeny cells.
	3. Meiosis produces gametes that combine during sexual reproduction to produce offspring that are genetically different from their parents.
3. Evolution is the change of genotype frequencies within populations. Mutation, gene transfer, natural selection, and chance events are important processes of evolutionary change.
	1. Evolution occurs at different time scales. Microevolution occurs on relatively short time scales within populations and species. Macroevolution occurs on relatively long time scales and refers to the diversification and extinction of lineages as a result of micro-evolutionary processes.
	2. The evolutionary history (phylogeny) of life is revealed by differences among lineages in genetic, cellular, anatomical, developmental, and physiological traits. This information is used to classify organisms.

### Quantitative Skills, Tools, and Concepts

* You will develop or strengthen the ability to explain biological processes using mathematical concepts, such as elementary probability & statistics and basic calculus.
* You will study the diversity of life by accessing and using genome databases, doing sequence alignments and analysis, building phylogenetic trees (molecular phylogeny) and analyzing models of evolution.
* You will gain experience with data analysis and modeling, using computational tools such as spreadsheets, analytical, and modeling tools/software.

### Laboratory and Field Research Skills

* You will develop or strengthen your research skills including how to make observations, keep complete and accurate records, troubleshoot experiments, analyze data, and prepare graphs and figures to represent the results
* You will become familiar with instrumentation and methods for data acquisition and analysis, such as counting and measuring, microscopy, electrophoresis, spectroscopy, and methods for the separation, detection, and amplification of nucleic acids and proteins.