

The Science Curriculum

The K-12 science curriculum is contained in the set of curriculum binders. Samples of student work, representing a range of performance levels and learning styles, are included.

Elementary School

The Science program for the Bedford Public Schools at the elementary level is based on both the “Guiding Principles” and on specific student outcomes outlined in the *Massachusetts State Frameworks*. Also reflected in our work are the *Benchmarks for Science Literacy* and the *National Science Education Standards*. Included in this document, you will find an outline of the topics covered at each year of our program from Grades K-5. You will also find the *Enduring Understandings* and *Essential Questions* used by teachers to focus student learning on the important concepts of science, the more discrete “*Unit Objectives*” and their relationship to components of the “*State Frameworks*.” While teachers are encouraged to add their own personal touches to our basic curriculum, as a system we have decided on a common core of activities we believe are critical for all students to experience. These include but are not limited to: visiting Cattail Corner wetlands at the Davis School to observe and record the impact of changing season; using different materials in Grade 3 to impact light and sound; examining the insides of small spinning coil motor; and discussing the role of magnets in helping the motor work. Additionally, we have included at each grade level opportunities for our students to investigate science *outside our school buildings*.

K – Kindergarten

- K.1 Seasons
- K.2 Bats
- K.3 Frogs

1. Grade 1

- 1.1. Solids and Liquids (Currently under review)
- 1.2. Weather
- 1.3. Organisms
- 1.4. Balancing and Weighing

2. Grade 2

- 2.1. Rocks and Minerals
- 2.2. Insects
- 2.3. Soils
- 2.4. Force and Motion

3. Grade 3

- 3.1 Water Cycle
- 3.2 Light and Sound
- 3.3 Plants
- 3.4 Chemistry

4. Grade 4

Rocks and Minerals
Food Chains
Simple Machines
Electricity

5. Grade 5

5.1 Magnets and Motors
5.2 The Changing Earth
5.3 Solar System
5.4 Weather

Middle School

The middle school curriculum binder is organized by course and contains specific course content and sample assessments. Below is the program of studies excerpt for science:

Grade Six Physical Science

Science is an important part of everyday life. In almost every aspect of daily life something scientific is encountered in one form or another, from sound waves created by the radio to molecules in a pencil. In 6th grade science, physical and chemical scientific concepts are explored as they relate to the students in their lives. These concepts include:

- Science Process Skills
- Steps of the Scientific Method
- Basics of chemistry, including physical and chemical changes, elements and compounds, atomic models, periodic table, and acids and bases
- Basics of physics, including motion, (speed, velocity, and Newton's First Law), and Heat (heat transfer and temperature)

This course uses the Holt, Rinehart, and Winston Holt Science and Technology unit books series.

Grade Seven Life Science

In Grade 7, students study biology. Many varied topics are covered including classifying all living organisms into the currently recognized kingdoms according to characteristics they share. Major systems of the human body are identified. Students learn about the cell as the basic unit of life in all living things. Heredity and genetics are discussed as they relate to the students' inherited traits that contribute to who they are as individuals. Natural variations that occur in individuals lead to a unit on evolution and how some organisms are better suited to changes that occur in environments. When studying the animal kingdom, students see how structures in the animal relate to the functions needed to survive in their unique ecological habitat

Grade Eight Earth Science

This course is designed to promote inquiry, investigation, and discovery while exploring aspects of earth and space science. Science process skills, as well as, water, weather, structure of the Earth, rocks and minerals, and, finally, the solar system are the major topics we will explore this year.

Projects and activities are used to enhance learning. Examples include modeling the earth and tectonic plate movement, analyzing a variety of maps to identify contour, elevation, structures, etc, and analyzing weather patterns to make forecasts.

High School

The high school curriculum binder is organized by course and contains specific course content and sample assessments. Below is the program of studies excerpt for science:

Physics

Level 4

Prerequisite: Grade Nine, Must take concurrently with Geometry Level 4 or 5 or Continuing Algebra I/Geometry Level 4.

- Course content emphasizes the fundamental laws and concepts that are used to describe the interaction of matter, including applications to technology and modern-day living; specific topics included are Newton's laws of motion and universal gravity, the laws of conservation of momentum and energy, the kinetic theory of heat, electricity and magnetism, optics, electromagnetic waves and sound. Students selecting this course should be adept at algebra and geometry. Skills that will be developed include relating mathematical laws to intuitive understanding of the physical world, using laws to explain and predict observations, problem solving techniques, and laboratory methods, including data analysis and drawing conclusions.

Physics

Level 3

Prerequisite: Grade 9, Must be taken concurrently with Algebra I

- This course introduces the student to the major concepts of physics, which include motion and force, vectors, electricity, magnetism, light, heat, sound, and concepts of the atom. Skills that will be developed in this course are: the gathering of scientific information through laboratory, field and library work; interpreting data and making inferences from the data presented in tabular and graphic form; selecting and applying mathematical relationships to scientific problems; and using mathematical relationships to describe results obtained by observation and experimentation.

Physics

Level 2

Prerequisite: Grade 9

- This course introduces the student to the basic concepts of physics, which include motion and force, vectors, electricity, magnetism, light, heat, sound, and concepts of the atom. Skills that will be developed in this course are: the gathering of scientific information through laboratory, field and library work; interpreting data and making inferences from the data presented in tabular and graphic form; selecting and applying mathematical relationships to scientific problems; and using mathematical relationships to describe results obtained by observation and experimentation.

Chemistry is a course where laboratory experiences are the primary method used to cover topics such as gases, atomic theory, chemical bonding, ionization, electrolytes, bases and acids, chemical equilibrium, introductory electrochemistry, characteristics of chemical reactions, and periodicity of chemical and physical properties. Students selecting this course should have reading skills at grade level and be able to solve problems by applying algebraic methods. Skills that will be developed include chemistry laboratory procedures, writing of laboratory reports, solving chemical problems, and applying chemical principles to everyday living.

Prerequisite: Physics 4 or Grade of 90% or higher in Physics 3 and Teacher recommendation.

- This course will include a more intensive and in-depth study of the topics listed above. The program assumes that students are adept at math that is involved. Students selecting this course should have reading skills at grade level and be able to solve problems by applying algebraic methods. For this reason, the instructor will assume that students will be able to solve quantitative problems independently. Students who work successfully in this course are encouraged to take the SAT II (Achievement) Test in Chemistry.

Prerequisites: Physics Level 3 or 90% in Physics Level 2

- This course and laboratory component is designed to provide a survey of chemical principles for students who are interested in the subject. It will serve as an important component of college preparatory study. For this reason, the instructor will assume that students will be able to solve problems independently.

Prerequisite: Physics

- This course and Laboratory component are designed for students who want a working knowledge of chemical principles. It will stress the basic concepts of chemistry on a conceptual level.

Prerequisite: Chemistry Level 4 or Grade of 90% in Chemistry Level 3 or teacher recommendation.

- Using an inquiry approach of instruction, this course offers students a thorough knowledge of basic biology concepts. The course encompasses chemical and cellular basis of life, energy transformations, genetics, evolution and biodiversity, and animal systems. In addition, emerging topics in biotechnology will be explored. Each topic will be supported by appropriate laboratory experiences.

Prerequisite: Chemistry Level 3 or Grade of 90% in Chemistry Level 2 or teacher recommendation.

- **This course explores the diversity and complexity of biological systems. Beginning with concepts at a micro-scale and ending with the macro-environment. It examines the intricate interaction of living things, from those of their atoms and molecules to those that occur in the largest of communities - the biomes - the entire world. Major topics include chemistry of life, structure and function of cells, genetics, evolution and biodiversity, and ecology.**

Biology **Level 2**

Prerequisite: Chemistry

- This laboratory-oriented course in biology will cover the basic concepts involved in biology. Topics include: the chemistry of life, structure and function of cells, genetics, evolution and biodiversity, and ecology. Students selecting this course should have standard reading and writing skills. Skills that will be developed in this course include: note taking, collecting data, writing a lab report, reporting on outside reading or projects and test taking.

Marine Biology **Level 3**

Marine Biology **Level 4**

Prerequisite: Passing grade of 70% or above in Chemistry and Physics **Grade 12 Only**

- Marine Biology surveys the plants and animals in the ocean, their habitats and how they relate to the changing geological, physical, and chemical properties of the sea. Students should have reading skills at grade level. Skills that will be developed include observation, interpretation and understanding of plant and animal behavior; critical analysis and synthesis of data; and seeking ways to solve problems relating to the marine environment.

Forensic Science **Level 4**

Prerequisite: Grade 12 and a grade of 75 or above in level 4 Biology & Chemistry or a grade of 85 or above in level 3 Biology & Chemistry

- This course will explore the science of forensic investigations. Students will investigate and discuss the methods of observing, identifying, collecting, and comparing physical evidence around a crime scene. Analytical techniques both in and out of the classroom will be utilized. Topics that will be addressed include: Crime Scene Investigations, Eyewitness Accounts, Fingerprint Analysis, Hair and Fiber Analysis, Serology, DNA Evidence, and Questioned Documents. This is a lab-based course.

Introduction to Engineering **Level 4 or 3**

Prerequisite: Passing grade of 70% or above in Chemistry, Physics and Biology.

- The course introduces students to the skills used in engineering. Students will study recent technological advances and the engineering process. Term projects will require independent research in various aspects of the engineering process and technology. As independent keystone project will identify a need and develop a product to meet that need.

A.P. Chemistry **Level 5**

Prerequisite: Grade of **90** in Chemistry, Level 4 and Algebra II, Level 4 &/or teacher recommendation. **This is a college level course.**

- This course is designed to be a college level course. Topics such as the structure of matter, kinetic theory of gases, chemical equilibrium, chemical kinetics and the basic concepts of thermodynamics will be covered in considerable depth. Meaningful laboratory work will help prepare a student for sophomore level chemistry courses in college.

A.P. Physics [C] **Level 5**

Prerequisite: Grade of 90 in Physics, Level 4 and taking Calculus concurrently &/or teacher recommendation. **This is a college level course.**

- Physics C covers mechanics, classical electricity and magnetism. These topics are covered in great depth with analytical and mathematical sophistication, including calculus applications. Laboratory experience is an integral part of this course. This college level course is suitable for students planning to specialize in a physical science or in engineering.

A.P. Physics [B] Level 5

Prerequisite: Grade of 90 in **Physics** Level 4, Algebra II & teacher Recommendation.

This is a college level course.

- This course provides a systemic introduction to the main principles of physics and emphasizes the development of problem-solving ability. Mechanics, electricity and magnetism, thermal physics, waves and optics, and atomic and nuclear physics are among the topics covered, including a laboratory component. Completion of the course allows the student to take the Advanced Placement Physics B exam.

A.P. Environmental Science Level 5

Prerequisite: Chemistry Level 4 and Biology Level 4 or 5- May be taken simultaneously &/or teacher recommendation.(Minimum Grade of 90). **This is a college level course.**

- The goal of the Advanced/AP Environmental Science is to provide students with the scientific principles, concepts, and methodologies required to understand the interrelationships of the natural world, and to identify and analyze environmental problems both natural and human made, to evaluate the relative risks associated with these problems, and to examine alternative solutions for resolving and/or preventing them.

A.P. Biology Level 5

Prerequisite: Grade of **90** or above in Chemistry Level 4 &/or teacher recommendation.

This is a college level course.

- AP biology is an advanced course that explores basic biology concepts in greater depth. Designed to cover the required course work prescribed by the College Board, this course is fast paced and requires students to be independent learners. Topics include cell biology, molecular genetics, organisms biology and behavior, evolution, ecology, and structure and function of plants. Related laboratory exercises are an integral component and are integrated throughout the course work. Students enrolling in AP Biology as a first year biology course are encouraged to complete a general biology summer program.

Anatomy & Physiology Level 5/4

Prerequisite: Biology, Level 4 & Chemistry, Level 4

- This course will concentrate on the anatomy, physiology, and histology of the human systems which include: the skeletal, muscular, integumental, nervous, respiratory, digestive, circulatory, excretory, reproductive systems, as well as endocrinology, and immunology. Students should have above average reading ability. Skills that will be developed in this course include: writing biological abstracts, doing independent research, making better observations, relating structure with function, improved techniques of dissection and microscopy.

Summary of Formal - Standard Assessments

Assessments of student work are either internal (for example, quizzes, end-of-unit tests, or midyear exams) or external (MCAS tests, APs, SATs). Appendix D contains tables and charts summarizing results on the MCAS, AP Exams and SAT II Tests; Curriculum Binders contains complete documentation and samples of the internal assessments used at each level.

MCAS

For each grade level, MCAS results are shared with the staff and analyzed for trends and concerns. The departments are asked to look at their particular grade level content and identify strengths and weaknesses. In addition, individual students are looked at to help in identifying students who may receive extra help from teachers and staff.

Grade Five - Science MCAS Summary

The results from the Grade 5 science exam have been statistically consistent over the entire history of the exam. Nearly all students rank in the advanced, proficient, or needs improvement category. With emphasis on ELA and Mathematics taking priority in the elementary grades, the results from this exam are not a clear indicator of how well the students will succeed later in their education. Science at the elementary level concentrates on developing skills and developing a love for learning and science that the test does not reflect.

Grade Eight - Science MCAS Summary

The results for grade eight have been statistically consistent over the last six years of testing. There have been minor fluctuations in students for each category. However, there has not been a significant rise in the percentage of students in the advanced and proficient categories. The department is still analyzing the reasons behind the trends and implementing strategies to address identified concerns.

Bedford students do very well on the multiple-choice questions for the exam. Overall, Bedford students achieve a seventy five percent correct average on the multiple-choice questions. The open response scores continue to be an issue with many students either scoring low on the open response questions or not responding at all. This was identified clearly in the early years of the exam. Beginning in 2006, two measures were instituted to address this concern. First, teachers began to use practice open response questions in assessing student knowledge throughout the year. The open response questions were both samples from MCAS exams and teacher generated. Second, the department reviewed concepts from the grade six and seven curriculum a month prior to the exam. This review was conducted by having the grade six and seven teachers rotate through the grade eight classes to conduct the review. The results have shown an upward trend in the open response results and currently students have a seventy percent correct standing overall on the open response questions.

Another issue is the timing of the exam. The grade eight science MCAS exam is the third MCAS exam given to students during the second half of the school year. The first exam is ELA in April, followed by Mathematics and Science in May. Success at each level follows with the completion of each exam. ELA has the highest number of students in advanced and proficient levels followed by Math and Science. In addition to possible test burnout, end of year activities for grade eight students begin immediately after the MCAS testing. The department is looking at methods to address the tests stresses that occur due to the timing of the test during the school year.

Throughout the process teachers have analyzed the test trends asking questions related to the Massachusetts Frameworks and have begun to provide review practice for specific content that has appeared on every exam for the past seven years.

SAT – II

Students taking SAT II content exams in science have performed above the national average on the SAT II tests for biology, chemistry and physics.

Advanced Placement Exams

The biology, chemistry, environmental science, physics B, physics C – mechanics, and physics C- E&M courses have all been approved by the College Board. After completing the course, students are encouraged, but not required to take the exam. On average more than fifty percent of the students enrolled in the courses complete the exam.

For the students who take the exam, Bedford students have consistently ranked much higher than the national averages.