Project-Based Science

An overview of the three-year cycle as designed for the adolescent aged 12-15 (grades 7-9)

The Montessori School of Winston-Salem—Adolescent Program
Project-Based Science Curriculum Description

The Adolescent Program at The Montessori School of Winston-Salem builds upon the previous work of Elementary and Children’s House programs in fostering students’ strong development and understanding in all the areas of science. Over the course of three years, the adolescents are engaged in studies related to the four science disciplines:

- **Earth and Space Sciences**: cosmology, including astronomy; geology and physical geography, including the geology and geography of prehistoric periods
- **Biological Sciences**: biology, including studies in botany, zoology, ecology, physiology, comparative anatomy and health sciences
- **Physical Sciences**: physics and chemistry
- **Contemporary Sciences**: mechanics and engineering, history of science and technology, including genetics

Science studies are project-based, and often referred to as Occupations. Occupations are projects, tasks, and courses of study that arise from the needs of the adolescent community and local environment. This work can either grow from the adolescents’ vision of how they want to use the land or can stem from nature imposing its will upon the land. The community’s vision may be to raise chickens, grow food for their meals, or create a place for quiet reflection and social gatherings; while nature may impose its force and create problems such as a tree falling on the compost bin, local wildlife killing the chickens, or a fungus destroying the gardens.

These projects present the students with real-life, purposeful work which leads them to acquiring key knowledge and skills in the disciplines of science. These projects also help them to develop a sense of worth and belonging because they are making meaningful contributions to their community. Through these projects the adolescents engage in direct instruction, research and lab work, and the application of acquired knowledge and skills. In addition, science and math studies are often interwoven, where each inspires and supports the knowledge and work of the other.

All of these problems generate meaningful engagement in the process of scientific inquiry, in which the adolescents identify and investigate key questions, engage in research and experimentation, and gather and collate evidence-based conclusions which lead to solutions. During the process of this work, the adolescents come to realize the need to reach out to scientists working in relevant fields so to use them as a source of expertise and a model for finding scientific solutions to their problems. In addition to this, the adolescents take part in field study excursions to observe, collect data, and become familiar with the ecology of their region.

As these projects unfold, the adolescents will meet often as a community to discuss scientific knowledge, skills and understandings, to share their individual and group findings from their
scientific inquiries, and to engage in seminars and debates around cultural and social issues that need to be taken into consideration when making decisions.

Studying great scientists of the past and present, their discoveries, their insights and contributions to the scientific body of knowledge is another aspect of the Montessori adolescent science curriculum. These discussions enable the adolescents to explore and investigate the genesis of scientific knowledge and understandings by researching biographies of great scientists, past and present, as well as the history of scientific concepts and ideas.

**Forms of Evaluation and Assessment**

As is consistent with the Montessorian approach in the Upper and Lower Elementary programs at TMS, students actively participate in their own assessment and evaluation. Frequent self-evaluations and peer and guide coaching sessions keep the adolescents apprised of their own progress in both efforts and achievements. Guides will also provide feedback and constructive criticism based on rubrics and other holistic forms of assessment to provide an adult perspective and foster the adolescents’ confidence in engaging in constructive dialogue about strengths and challenges in their work. There is a continued de-emphasis on letter grades; however, in the Ninth Year, end of course letter grades will be awarded to record progress for students’ high school transcripts. Assessment tools include:

- Self-evaluations, including the use of rubrics and guiding questions
- Lab reports
- Teacher evaluations, using rubrics with specific standards
- Conferencing
- Ongoing coaching, discussion and feedback
- Quizzes and Tests
- Assigned questions and written reflections
- Seminar discussions
- Demonstration of mastery over subject matter as expressed through a variety of written and oral presentations, artistic expressions, or other culminating projects
- Portfolio development
- Application of science skills
The TMS Adolescent Science Curriculum is closely aligned with North Carolina State Standards. In the 9th year of this program, the adolescents will take a high school level Biology class that will meet all graduation requirements for any public or private high school.

7th and 8th Year Science Concepts

- **Forces and Motions**: Understand motion, the effects of forces on motion and the graphical representations of motion
- **Energy: Conservation and Transfer**:
  - Understand forms of energy, energy transfer and transformation and conservation in mechanical systems
  - Explain the environmental implications associated with the various methods of obtaining, managing and using energy resources
- **Earth Systems, Structures and Processes**:
  - Understand how the cycling of matter (water and gases) in and out of atmosphere relates to Earth’s atmosphere, weather, climate and the effects of the atmosphere on humans
  - Understand the Hydrosphere and the impact of humans on local systems and the effects of the hydrosphere on humans
- **Earth History**: Understand the history of Earth and its life forms based on evidence of change recorded in fossil records and landforms
- **Structures and Functions of Living Organisms**:
  - Understand the processes, structures and functions of living organisms that enable them to survive, reproduce and carry out basic functions of life
  - Understand the structure and hazards caused by agents of disease that effect living organisms
- **Evolution and Genetics**:
  - Understand the relationship of the mechanisms of cellular reproduction, patterns of inheritance and external factors to potential variation and survival among offspring
  - Understand the evolution of organisms and landforms based on evidence, theories, and processes that impact the Earth over time
- **Matter: Properties and Change**: Understand the properties of matter and changes that occur when matter interacts in an open and closed container.
- **Ecosystems**: Understand how organisms interact with and respond to the biotic and abiotic components of their environment
- **Molecular Biology**: Understand the composition of various substances as it relates to their ability to serve as a source of energy and building materials for growth and repair of organisms
9th Year Biology Concepts (Biology Honors)

- Understand the relationship between the structures and functions of cells and their organelles
- Analyze the cell as a living system
- Analyze the interdependence of living organisms within their environments
- Understand the impact of human activities on the environment (one generation affects the next)
- Explain how traits are determined by the structure and function of DNA
- Understand how the environment, and/or the interaction of alleles, influences the expression of genetic traits
- Understand the application of DNA technology
- Explain the theory of evolution by natural selection as a mechanism for how species change over time
- Analyze how classification systems are developed based upon speciation
- Understand how biological molecules are essential to the survival of living organisms
- Analyze the relationships between the biochemical processes and energy use in the cell