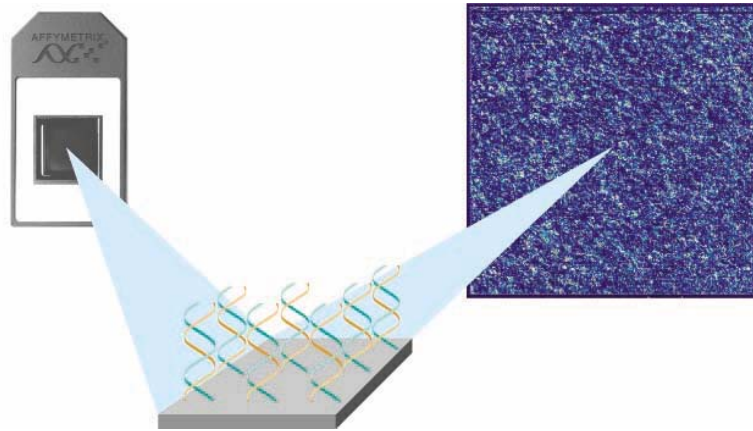


Gene Chip® Microarrays



Grades 9-12 Standards Connection - National and California

The use of this curriculum module can be done by teachers of many different class levels. The primary target level is to advanced High School biology classes (such as Advanced Placement or Honors Biology or Biotechnology), but the module can easily be used in a college or junior college setting or adapted for use at a basic high school Biology class. It is not limited to one area and is designed to be flexible enough to encourage teachers of many levels to use in their classroom.

This curriculum can help teachers meet the *National Science Education Standards (NSES)* for the Science Content Standards for grades 9 -12 as well as any state level science standards. Obviously, the advanced nature of this technology goes above and beyond the basic national standards for Life Science in the area of the molecular basis of heredity and most state standards in the areas of cell biology and genetics. However, the activities do present an opportunity to reinforce the basic concepts in areas such as DNA structure and function, basic Mendelian Genetics, and cell biology. The students are required to apply what they have learned about these topics while learning about GeneChip microarrays. And by seeing the application of these basic concepts in such an advanced and exciting technology like GeneChip microarrays, students will be motivated and this strengthen their understanding in these conceptual standards.

Just as important, many of the activities in this module provide opportunities for teachers to meet many of the “science inquiry” standards. The lessons have sections that challenge the students to apply their scientific understanding, to analyze and interpret data to solve problems, to use models to illustrate scientific concepts, and to

communicate their understanding and explanations in various ways. Also, the fifth activity provides a way for teachers to meet standards of the “place of science in society” and the “ethical nature of scientific discoveries” that most science standards include.

Furthermore, the lessons have a strong focus on active learning by stressing the use of student collaboration. Students have the opportunity to work in small groups for discussions, analyzing information, and putting together presentations. However, it must be explained that the module is designed to challenge the students to use higher-order thinking skills while balancing both the group work with individual learning time. Both learning modes are important and both can be addressed in this curriculum module.

Below is a list of the NSE Standards and the Science Standards of the State Board of Education of California that the activities in this module apply to. Only the California standards are included to act as a guide, but you could easily find connections to your own state standards. Along with each standard listed is the activity that connects to it. Use these charts when developing your lesson plans for this module. These standard connections are made using the activities exactly as presented in the module. Of course, if you were to change the activities in anyway, the connections may no longer apply.

National Science Education Standards – Science Content Standards: 9-12

Science as Inquiry

Content Standard A: As a result of activities in grades 9-12, all students should develop abilities necessary to do science inquiry and develop understandings about scientific inquiry.	Connection to <i>GeneChip Microarrays</i>
<ul style="list-style-type: none"> • identify questions and concepts that guide scientific investigations 	Activity 4
<ul style="list-style-type: none"> • design and conduct scientific investigations 	Activity 4 & 5
<ul style="list-style-type: none"> • formulate and revise scientific explanations and models using logic and evidence 	Activity 2,3, & 4
<ul style="list-style-type: none"> • communicate and defend a scientific argument 	Activity 1,3,4 & 5

Life Science

Content Standard C: As a result of their activities in grades 9-12, all students should develop understanding of		Connection to <i>GeneChip Microarrays</i>
The cell		
<ul style="list-style-type: none"> • cells store and use information to guide their functions • the genetic information stored in DNA is used to direct synthesis of the thousands of proteins each cell requires 	Activity 2, 4	
The Molecular Basis Of Heredity		
<ul style="list-style-type: none"> • in all organisms, the instructions for specifying the characteristics of the organism are carried in the DNA, a large polymer formed of subunits of four kinds (A, G, C, and T) • the chemical and structural properties of DNA explain how the genetic information that underlies heredity is encoded in genes (as a string of molecular “letters”) 	Activity 2,3, & 4	
<ul style="list-style-type: none"> • the fact that the human body is formed from cells that contain two copies of each chromosome – and therefore two copies of each gene – explains many features of human heredity 	Activity 2	
<ul style="list-style-type: none"> • changes in DNA (mutations) occur spontaneously at low rates • some of these changes make no difference to the organisms, whereas others can change cells and organisms 	Activity 2, 4	

Science and Technology

Content Standard E: As a result of their activities in grades 9-12, all students should develop understanding of abilities of technological design and understanding about science and technology	Connection to GeneChip Microarrays
<ul style="list-style-type: none"> communicate the problem, process, and solution 	Activity 4 & 5
<ul style="list-style-type: none"> science often advances with the introduction of new technologies new technologies often extend the current levels of scientific understanding and introduce new areas of research 	Activity 1, 2, & 5
<ul style="list-style-type: none"> technological solutions may create new problems sometimes scientific advances challenge people’s beliefs and practical explanation concerning various aspects of the world 	Activity 5

Science in Personal and Social Perspectives

Content Standard F: As a result of their activities in grades 9-12, all students should develop understanding of science and technology in local, national, and global challenges	Connection to GeneChip Microarrays
<ul style="list-style-type: none"> science and technology are social enterprises, but alone they can only indicate what can happen – the latter involves human decisions about the use of knowledge 	Activity 5
<ul style="list-style-type: none"> understanding basic concepts and principles of science and technology should precede active debate about economics, policies, politics, and ethics of various science and technology related challenges 	Activity 5
<ul style="list-style-type: none"> individual and society must decide on proposals involving new research and the introduction of new technologies into society decisions involve assessment of alternatives, risks, costs, and benefits and consideration of who benefits and who suffers, who pays and who gains, and what the risks are and who bears them 	Activity 5

California's State Board of Education Standards– Science: Grades 9-12

Biology / Life Science

<p>1. Cell Biology – The fundamental life processes of plants and animals depend on a variety of chemical reactions that occur in specialized areas of the organism’s cells. As a basis for understanding this concept:</p>	<p>Connection to <i>GeneChip Microarrays</i></p>
<ul style="list-style-type: none"> students know the central dogma of molecular biology outlines the flow of information from transcription of ribonucleic acid (RNA) in the nucleus to translation of proteins on ribosomes in the cytoplasm 	<p>Activity 2</p>
<ul style="list-style-type: none"> students know most macromolecules (. . . nucleic acids . . .) in cells and organisms are synthesized from a small collection of simple precursors 	<p>Activity 2 & 3</p>
<p>4. Genetics – Genes are a set of instructions encoded in the DNA sequence of each organism that specify the sequence of amino acids in proteins characteristic of that organism. As a basis for understanding this concept:</p>	<p>Connection to <i>GeneChip Microarrays</i></p>
<ul style="list-style-type: none"> students know the general pathway by which ribosomes synthesize proteins, using tRNAs to translate genetic information in mRNA 	<p>Activity 2</p>
<ul style="list-style-type: none"> students know how mutations in the DNA sequence of a gene may or may not affect the expression of the gene 	<p>Activity 2 & 4</p>
<ul style="list-style-type: none"> students know specialization of cells in multi-cellular organisms is usually due to different patterns of gene expression rather than to differences in genes themselves 	<p>Activity 2 & 4</p>
<p>5. Genetics – The genetic composition of cells can be altered by incorporation of exogenous DNA into cells. As a basis for understanding this concept:</p>	<p>Connection to <i>GeneChip Microarrays</i></p>
<ul style="list-style-type: none"> students know the general structures and functions of DNA, RNA , and proteins 	<p>Activity 2,3, & 4</p>
<ul style="list-style-type: none"> students know how to apply base-pairing rules . . . during transcription of information from DNA to mRNA 	<p>Activity 2</p>

<ul style="list-style-type: none"> students know how genetic engineering (biotechnology) is used to produce novel biomedical and agricultural products 	Activity 1,2, & 5
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Investigation and Experimentation

<p>1. Scientific Progress is made by asking meaningful questions and conducting careful investigations. As a basis for understanding this concept . . . students will:</p>	<p>Connection to <i>GeneChip Microarrays</i></p>
<ul style="list-style-type: none"> formulate explanation by using logic and evidence 	Activities 1-5
<ul style="list-style-type: none"> recognize the cumulative nature of scientific evidence 	Activity 4
<ul style="list-style-type: none"> analyze situations and solve problems that require combining and applying concepts from more than one area of science 	Activity 4