Course Outline
Oceanography

Please Note: The course outline includes all of the modules and all of the topics that will be covered in each module. Oceanography does not have Virginia Standards of Learning (SOL) so Biology (BIO), Chemistry (CH), Earth Science (ES), and Physics (PH) SOL are listed.

Module/Topic	Name	Number	2003 SOL	2010 SOL
Developmental Module	The purpose of this module is to review skills that students need in order to be successful in other areas of the course.			
Module 1	**What is Oceanography?**	**1**		
Topic 1	The Formation of the Oceans	1.1	N/A	N/A
Topic 2	Branches of Oceanography	1.2	N/A	N/A
Topic 3	Tools of Oceanography and Current Technologies	1.3	N/A	N/A
Topic 4	Careers and Universities	1.4	N/A	N/A
Module 2	**The History of Oceanography**	**2**		
Topic 1	The Phoencians, The Egyptians, and The Greeks	2.1	N/A	N/A
Topic 2	Early Christian Oceanography	2.2	N/A	N/A
Topic 3	The Portuguese and The Voyages of Columbus	2.3	N/A	N/A
Topic 4	Notable Voyages	2.4	N/A	N/A
Topic 5	Diving and Submersibles	2.5	N/A	N/A
Topic 6	Today's Voyages	2.6	N/A	N/A
Module 3	**Geology**	**3**		
Topic 1	Earth's Structure	3.1	**ES 8 b, c** The student will investigate and understand geologic processes including plate tectonics. b) Processes (folding, faulting, volcanism, metamorphism, weathering, erosion, deposition, and sedimentation and their	**ES 7 a, b** The student will investigate and understand geologic processes including plate tectonics. Key concepts include a) geologic processes and their resulting features; and b) tectonic processes

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			resulting features c) Tectonic Processes (subduction, rifting, and seafloor spreading with continental collision).	
Topic 2	Pangaea and Continental Drift	3.2	**ES 8 b, c** The student will investigate and understand geologic processes including plate tectonics. b) Processes (folding, faulting, volcanism, metamorphism, weathering, erosion, deposition, and sedimentation and their resulting features c) Tectonic Processes (subduction, rifting, and seafloor spreading with continental collision).	**ES 7 a, b** The student will investigate and understand geologic processes including plate tectonics. Key concepts include a) geologic processes and their resulting features; and b) tectonic processes
Topic 3	Seafloor Spreading	3.3	**ES 8 b, c** The student will investigate and understand geologic processes including plate tectonics. b) Processes (folding, faulting, volcanism, metamorphism, weathering, erosion, deposition, and sedimentation and their resulting features c) Tectonic Processes (subduction, rifting, and seafloor spreading with continental collision).	**ES 7 a, b** The student will investigate and understand geologic processes including plate tectonics. Key concepts include a) geologic processes and their resulting features; and b) tectonic processes
Topic 4	Plate Tectonics	3.4	**ES 8 b, c** The student will investigate and understand geologic processes including plate tectonics.	**ES 7 a, b** The student will investigate and understand geologic processes including plate tectonics. Key concepts include

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			b) Processes (folding, faulting, volcanism, metamorphism, weathering, erosion, deposition, and sedimentation and their resulting features c) Tectonic Processes (subduction, rifting, and seafloor spreading with continental collision).	a) geologic processes and their resulting features; and b) tectonic processes
Module 4	**Bathymetry**	**4**		
Topic 1	Continental Margins	4.1	**ES 11 d** The students will investigate and understand that the oceans are complex, interactive, physical, chemical, and biological systems and are subject to long- and short-term variations. Key concepts include d) Features of the seafloor	**ES 10 d** The student will investigate and understand that oceans are complex, interactive physical, chemical, and biological systems and are subject to long- and short-term variations. Key concepts include d) features of the sea floor as reflections of tectonic processes
Topic 2	Mid-Ocean Ridges and Hydrothermal Vents	4.2	**ES 11 d** The students will investigate and understand that the oceans are complex, interactive, physical, chemical, and biological systems and are subject to long- and short-term variations. Key concepts include d) Features of the seafloor	**ES 10 d** The student will investigate and understand that oceans are complex, interactive physical, chemical, and biological systems and are subject to long- and short-term variations. Key concepts include d) features of the sea floor as reflections of tectonic processes
Topic 3	Abyssal Plains	4.3	**ES 11 d** The students will investigate and understand that the oceans are complex, interactive, physical, chemical, and biological systems and are subject to long- and short-term variations. Key	**ES 10 d** The student will investigate and understand that oceans are complex, interactive physical, chemical, and biological systems and are subject to long- and short-term variations. Key concepts include d) features of the sea floor as

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Module/Topic	Name	Number	2003 SOL	2010 SOL
			concepts include d) Features of the seafloor	reflections of tectonic processes
Topic 4	Seamounts and Guyots	4.4	**ES 11 d** The students will investigate and understand that the oceans are complex, interactive, physical, chemical, and biological systems and are subject to long- and short-term variations. Key concepts include d) Features of the seafloor	**ES 10 d** The student will investigate and understand that oceans are complex, interactive physical, chemical, and biological systems and are subject to long- and short-term variations. Key concepts include d) features of the sea floor as reflections of tectonic processes
Topic 5	Trenches	4.5	**ES 11 d** The students will investigate and understand that the oceans are complex, interactive, physical, chemical, and biological systems and are subject to long- and short-term variations. Key concepts include d) Features of the seafloor	**ES 10 d** The student will investigate and understand that oceans are complex, interactive physical, chemical, and biological systems and are subject to long- and short-term variations. Key concepts include d) features of the sea floor as reflections of tectonic processes
Module 5	**Sedimentation**	**5**		
Topic 1	Classification of Marine Sediment	5.1	**ES 8 b** The student will investigate and understand geologic processes including plate tectonics. b) Processes (sedimentation)	**ES 7 a** The student will investigate and understand geologic processes including plate tectonics. Key concepts include a) geologic processes and their resulting feature
Topic 2	Origin and Location of Sediment	5.2	**ES 8 b** The student will investigate and understand geologic processes including plate tectonics. b) Processes (sedimentation)	**ES 7 a** The student will investigate and understand geologic processes including plate tectonics. Key concepts include a) geologic processes and their resulting feature

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Module/Topic	Name	Number	2003 SOL	2010 SOL
Topic 3	Deep-sea Sedimentation	5.3	**ES 8 b** The student will investigate and understand geologic processes including plate tectonics. b) Processes (sedimentation)	**ES 7 a** The student will investigate and understand geologic processes including plate tectonics. Key concepts include a) geologic processes and their resulting feature
Topic 4	Ocean Floor Resources	5.4	N/A	N/A
Module 6	**Ocean Water Chemistry**	**6**		
Topic 1	The Water Molecule	6.1	**CH 2 h** The student will investigate and understand that the placement of elements on the periodic table is a function of their atomic structure. The periodic table is a tool used for the investigations of h) Chemical and Physical Properties	**CH 2 h** The student will investigate and understand that the placement of elements on the periodic table is a function of their atomic structure. The periodic table is a tool used for the investigations of h) chemical and physical properties
Topic 2	Salinity	6.2	**ES 11 a** The students will investigate and understand that the oceans are complex, interactive, physical, chemical, and biological systems and are subject to long- and short-term variations. Key concepts include a) Physical and chemical changes	**ES 10 a** The student will investigate and understand that oceans are complex, interactive physical, chemical, and biological systems and are subject to long- and short-term variations. Key concepts include a) physical and chemical changes related to tides, waves, currents, sea level and ice cap variations, upwelling, and salinity variations
Topic 3	Structure of the Oceans	6.3	**PH 7 a** The student will investigate and understand the properties of fluids (density and pressure). a) Variation of pressure with depth. **CH 5 a**	N/A **CH 5 a**

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Module/Topic	Name	Number	2003 SOL	2010 SOL
			The student will investigate and understand that the phases of matter are explained by kinetic theory and forces of attraction between particles. Key concepts include a) Pressure, temperature, and volume	The student will investigate and understand that the phases of matter are explained by kinetic theory and forces of attraction between particles. Key concepts include a) pressure, temperature, and volume
Topic 4	Gases	6.4	**BIO 3 a, d** The student will investigate and understand the chemical and biochemical principles essential for life. Key concepts include a) water chemistry and its impact on life processes d) the capture, storage, transformation, and flow of energy through the processes of photosynthesis and respiration	**BIO 2 a, d** The student will investigate and understand the chemical and biochemical principles essential for life. Key concepts include a) water chemistry and its impact on life processes d) the capture, storage, transformation, and flow of energy through the processes of photosynthesis and respiration
Topic 5	Global Water Cycles	6.5	**BIO 3 a** The student will investigate and understand the chemical and biochemical principles essential for life. Key concepts include a) water chemistry and its impact on life processes	**BIO 2 a** The student will investigate and understand the chemical and biochemical principles essential for life. Key concepts include a) water chemistry and its impact on life processes
Topic 6	Other Properties of Water	6.6	**BIO 3 a** The student will investigate and understand the chemical and biochemical principles essential for life. Key concepts include a) water chemistry and its impact on life processes	**BIO 2 a** The student will investigate and understand the chemical and biochemical principles essential for life. Key concepts include a) water chemistry and its impact on life processes
Module 7	**Ocean Motion**	**7**		

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Module/Topic	Name	Number	2003 SOL	2010 SOL
Topic 1	Surface Ocean Currents	7.1	**ES 11 a** The students will investigate and understand that the oceans are complex, interactive, physical, chemical, and biological systems and are subject to long- and short-term variations. Key concepts include a) Physical and chemical changes	**ES 10 a** The student will investigate and understand that oceans are complex, interactive physical, chemical, and biological systems and are subject to long- and short-term variations. Key concepts include a) physical and chemical changes related to tides, waves, currents, sea level and ice cap variations, upwelling, and salinity variations
Topic 2	Deep Ocean Circulation	7.2	**ES 11 a** The students will investigate and understand that the oceans are complex, interactive, physical, chemical, and biological systems and are subject to long- and short-term variations. Key concepts include a) Physical and chemical changes	**ES 10 a** The student will investigate and understand that oceans are complex, interactive physical, chemical, and biological systems and are subject to long- and short-term variations. Key concepts include a) physical and chemical changes related to tides, waves, currents, sea level and ice cap variations, upwelling, and salinity variations
Topic 3	Anatomy of a wave	7.3	**PH 9 a, b** The student will investigate and understand how to use models of transverse and longitudinal waves to interpret wave phenomena. Key concepts include a) Wave characteristics b) Fundamental Wave Processes **ES 11 a** The students will investigate and understand that the oceans are complex, interactive, physical, chemical, and biological systems and are	**PH 8 a, b** The student will investigate and understand wave phenomena. Key concepts include a) wave characteristics; b) fundamental wave processes **ES 10 a** The student will investigate and understand that oceans are complex, interactive physical, chemical, and biological systems and are subject to long- and short-term variations. Key concepts include a) physical and chemical changes related to tides, waves, currents, sea level and ice cap

Module/Topic	Name	Number	2003 SOL	2010 SOL
			subject to long- and short-term variations. Key concepts include a) Physical and chemical changes	variations, upwelling, and salinity variations
Topic 4	Types of Breakers	7.4	**ES 11 a** The students will investigate and understand that the oceans are complex, interactive, physical, chemical, and biological systems and are subject to long- and short-term variations. Key concepts include a) Physical and chemical changes	**ES 10 a** The student will investigate and understand that oceans are complex, interactive physical, chemical, and biological systems and are subject to long- and short-term variations. Key concepts include a) physical and chemical changes related to tides, waves, currents, sea level and ice cap variations, upwelling, and salinity variations
Topic 5	Tsunami and Seismic Sea Waves	7.5	**ES 8 C** The student will investigate and understand geologic processes including plate tectonics. c) Tectonic Processes **ES 11 a** The students will investigate and understand that the oceans are complex, interactive, physical, chemical, and biological systems and are subject to long- and short-term variations. Key concepts include a) Physical and chemical changes	**ES 7 b** The student will investigate and understand geologic processes including plate tectonics. Key concepts include b) tectonic processes **ES 10 a** The student will investigate and understand that oceans are complex, interactive physical, chemical, and biological systems and are subject to long- and short-term variations. Key concepts include a) physical and chemical changes related to tides, waves, currents, sea level and ice cap variations, upwelling, and salinity variations
Topic 6	Tidal Characteristics	7.6	**ES 4 b** The student will investigate and understand the characteristics of the Earth and solar system. Key	**ES 3 b** The student will investigate and understand the characteristics of Earth and the solar system. Key concepts include

Module/Topic	Name	Number	2003 SOL	2010 SOL
			concepts include b) The Sun-Earth-Moon relationships **ES 11 a** The students will investigate and understand that the oceans are complex, interactive, physical, chemical, and biological systems and are subject to long- and short-term variations. Key concepts include a) Physical and chemical changes	b) sun-Earth-moon relationships; (seasons, tides, and eclipses) **ES 10 a** The student will investigate and understand that oceans are complex, interactive physical, chemical, and biological systems and are subject to long- and short-term variations. Key concepts include a) physical and chemical changes related to tides, waves, currents, sea level and ice cap variations, upwelling, and salinity variations
Topic 7	Causes of Tides	7.7	**ES 4 b** The student will investigate and understand the characteristics of the Earth and solar system. Key concepts include b) The Sun-Earth-Moon relationships **ES 11 a** The students will investigate and understand that the oceans are complex, interactive, physical, chemical, and biological systems and are subject to long- and short-term variations. Key concepts include a) Physical and chemical changes	**ES 3 b** The student will investigate and understand the characteristics of Earth and the solar system. Key concepts include b) sun-Earth-moon relationships; (seasons, tides, and eclipses) **ES 10 a** The student will investigate and understand that oceans are complex, interactive physical, chemical, and biological systems and are subject to long- and short-term variations. Key concepts include a) physical and chemical changes related to tides, waves, currents, sea level and ice cap variations, upwelling, and salinity variations
Module 8	**Biological Oceanography**	**8**		
Topic 1	Origin of Life in the Oceans	8.1	**BIO 2 a** The student will investigate	**BIO 3 a** The student will investigate and

Module/Topic	Name	Number	2003 SOL	2010 SOL
			and understand the history of biological concepts. Evidence supporting the cell theory; a) Scientific explanations of the development of organisms through time (biological evolution) **BIO 8 e** The students will investigate and understand how populations change through time. Key concepts include e) scientific explanations for biological evolution	understand relationships between cell structure and function. Key concepts include a) evidence supporting the cell theory **BIO 7 e** The student will investigate and understand how populations change through time. Key concepts include e) scientific evidence and explanations for biological evolution
Topic 2	Marine Organism Classification	8.2	**BIO 7 a, b, c, d, e** The student will investigate and understand bases for modern classification systems a) structural similarities among organisms; b)fossil record interpretation; c) comparison of developmental stages in different organisms; d) examination of biochemical similarities and differences among organisms; and e) systems of classification that are adaptable to new scientific discoveries. **BIO 5 a** The student will investigate and understand life functions of archaebacteria, monerans (eubacteria), protists, fungi, plants, and animals including humans.	**BIO 6 a, b, c, d, e** The student will investigate and understand bases for modern classification systems. Key concepts include a) structural similarities among organisms; b) fossil record interpretation; c) comparison of developmental stages in different organisms; d) examination of biochemical similarities and differences among organisms; and e) systems of classification that are adaptable to new scientific discoveries. **BIO 4 c** The student will investigate and understand life functions of Archaea, Bacteria and Eukarya. Key concepts include

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Module/Topic	Name	Number	2003 SOL	2010 SOL
			Key concepts include a) how their structures and functions vary between and within the kingdoms	c) how the structures and functions vary among and within the Eukarya kingdoms of protists, fungi, plants, and animals, including humans
Topic 3	Marine Organism Adaptations	8.3	**BIO 7 a, b, c, d, e** The student will investigate and understand bases for modern classification systems a) structural similarities among organisms; b)fossil record interpretation; c) comparison of developmental stages in different organisms; d) examination of biochemical similarities and differences among organisms; and e) systems of classification that are adaptable to new scientific discoveries. **BIO 2 a** The student will investigate and understand the history of biological concepts. Evidence supporting the cell theory; a) Scientific explanations of the development of organisms through time (biological evolution) **BIO 5 c, d** The student will investigate and understand life functions of archaebacteria, monerans (eubacteria), protists, fungi, plants, and animals including humans. Key concepts include	**BIO 6 a, b, c, d, e** The student will investigate and understand bases for modern classification systems. Key concepts include a) structural similarities among organisms; b) fossil record interpretation; c) comparison of developmental stages in different organisms; d) examination of biochemical similarities and differences among organisms; and e) systems of classification that are adaptable to new scientific discoveries. **BIO 3 a** The student will investigate and understand relationships between cell structure and function. Key concepts include b) evidence supporting the cell theory **BIO 4 b** The student will investigate and understand life functions of Archaea, Bacteria and Eukarya. Key concepts include c) maintenance of homeostasis

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Module/Topic	Name	Number	2003 SOL	2010 SOL
			c) analyses of their responses to the environment; d) maintenance of homeostasis; **BIO 8 e** The student will investigate and understand how populations change through time. Key concepts include e) scientific explanations for biological evolution.	**BIO 7 e** The student will investigate and understand how populations change through time. Key concepts include e) scientific evidence and explanations for biological evolution
Module 9	**Marine Ecology**	**9**		
Topic 1	Productivity in the Oceans	9.1	**BIO 9 a, b, c, d** The student will investigate and understand dynamic equilibria within populations, communities, and ecosystems. Key concepts include a) interactions within and among populations including carrying capacities, limiting factors, and growth curves; b) nutrient cycling with energy flow through ecosystems; c)succession patterns in ecosystems; d) the effects of natural events and human activities on ecosystems **BIO 3 d** The student will investigate and Understand the chemical and biochemical principles essential for life Key concepts include d)the capture, storage transformation and flow of energy through the	**BIO 8 a, b, c, d** The student will investigate and understand dynamic equilibria within populations, communities, and ecosystems. Key concepts include a) interactions within and among populations including carrying capacities, limiting factors, and growth curves; b) nutrient cycling with energy flow through ecosystems; c) succession patterns in ecosystems; d) the effects of natural events and human activities on ecosystems **BIO 2 d** The student will investigate and understand the chemical and biochemical principles essential for life. Key concepts include d)the capture, storage, transformation, and flow of energy through the processes of photosynthesis and respiration,

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Module/Topic	Name	Number	2003 SOL	2010 SOL
			processes of photosynthesis and respiration.	
Topic 2	Oceanic Feeding Relationships And The Transfer Of Energy	9.2	**BIO 9 a** The student will investigate and understand dynamic equilibria within populations, communities, and ecosystems. Key concepts include a) interactions within and among population including carrying capacities, limiting factors, and growth curves;	**BIO 8 a** The student will investigate and understand dynamic equilibria within populations, communities, and ecosystems. Key concepts include a) interactions within and among populations including carrying capacities, limiting factors, and growth curves;
Topic 3	Relationships in the Oceans	9.3	**BIO 8 b** The student will investigate and understand how populations change through time. Key concepts include b) how genetic variation, reproductive strategies, and environmental pressures impact the survival of populations	**BIO 7 b** The student will investigate and understand how populations change through time. Key concepts include b) how genetic variation, reproductive strategies, and environmental pressures impact the survival of populations
Topic 4	Marine Communities	9.4	**BIO 9 c** The student will investigate and understand dynamic equilibria within populations, communities, and ecosystems. Key concepts include c)succession patterns in ecosystems;	**BIO 8 c** The student will investigate and understand dynamic equilibria within populations, communities, and ecosystems. Key concepts include c)succession patterns in ecosystems;
Module 10	**Environmental Oceanography**	**10**		
Topic 1	Marine Pollution	10.1	**BIO 9 d** The student will investigate and understand dynamic equilibria within populations, communities, and ecosystems. Key concepts include	**BIO 8 d** The student will investigate and understand dynamic equilibria within populations, communities, and ecosystems. Key concepts include d) the effects of natural events

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Module/Topic	Name	Number	2003 SOL	2010 SOL
			d) the effects of natural events and human activities on ecosystems	and human activities on ecosystems
Topic 2	Oceanic Effects of Global Climate Change	10.2	**BIO 9 d** The student will investigate and understand dynamic equilibria within populations, communities, and ecosystems. Key concepts include d) the effects of natural events and human activities on ecosystems	**BIO 8 d** The student will investigate and understand dynamic equilibria within populations, communities, and ecosystems. Key concepts include d) the effects of natural events and human activities on ecosystems
Topic 3	Overfishing	10.3	**BIO 9 d** The student will investigate and understand dynamic equilibria within populations, communities, and ecosystems. Key concepts include d) the effects of natural events and human activities on ecosystems	**BIO 8 d** The student will investigate and understand dynamic equilibria within populations, communities, and ecosystems. Key concepts include d) the effects of natural events and human activities on ecosystems
Topic 4	Marine Protected Areas	10.4	**BIO 9 d** The student will investigate and understand dynamic equilibria within populations, communities, and ecosystems. Key concepts include d) the effects of natural events and human activities on ecosystems	**BIO 8 d** The student will investigate and understand dynamic equilibria within populations, communities, and ecosystems. Key concepts include d) the effects of natural events and human activities on ecosystems
Topic 5	Helping the Ocean	10.5	**BIO 9 d** The student will investigate and understand dynamic equilibria within populations, communities, and ecosystems. Key concepts include d) the effects of natural events and human	**BIO 8 d** The student will investigate and understand dynamic equilibria within populations, communities, and ecosystems. Key concepts include d) the effects of natural events and human activities on ecosystems

Module/Topic	Name	Number	2003 SOL	2010 SOL
			activities on ecosystems	