Unit 3: Human Populations & Agriculture
UNIT PLAN

AP Environmental Science
Unit 3
Suggested Duration: 15-16 Days

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UNIT NARRATIVE

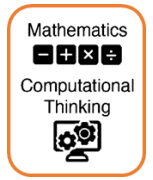
This unit is a combination of topics from College Board CED Unit 3 and CED Unit 5. Included in this unit are all the topics from the second half of CED Unit 3 (Populations) because they describe and explain changes in human populations and all topics from CED Unit 5 (Land & Water Use) that pertain to food production to feed the increasing human population (Agriculture, CAFOs, Pesticides, Aquaculture, etc.). These topics are combined into a single unit to help students more easily recognize and describe the multitude of connections between the growing human population and modern, mechanized, monoculture, agricultural and food production practices. This unit will be the first time students will properly focus on the environmental impacts of human civilization on the abiotic and biotic systems of planet Earth and agriculture practices are a fitting topic for this task as agriculture is the single biggest anthropogenic effect of human civilization on the environment.

The unit begins with sic days of exploring the human population demographics, trends and dynamics. Students will be immediately introduced to Age Structure Diagrams, commonly called Population Pyramids, (Day 01) and discover how they can be used to predict the future change in a population size by describing pattering Population Pyramids for several countries. Students will then explore the connections between increasing human populations, consumption and environmental impacts through the Material World presentation (Day 02) and the Don't Panic video (Days 03-04). Now that students have explored the basic concepts of describing human demographics they will be introduced to the Demographic Transition model (Day 05) use and make connections between it and Population Pyramids, Demographics, and Fertility Rate as a way to tie the concepts in this section together. This section concludes with practice with calculations about human populations including working with percent change and The Rule of 70 (Day 06).

The remainder of this unit focuses on describing the primary ways food is produced and their environmental impacts. This section begins with an introduction to modern agriculture by describing some its key characteristics including monocultures and irrigation practices (day 07), pesticide use and more sustainable options, then with a reading about agriculture and by watching the documentary Fresh (Day 08-09) to identify key concepts, vocabulary and takeaways. Next students will work in partners to explore the environmental and human health effects Concentrated Animal Feed Organizations (CAFOs) (Day 10) and overfishing (Day 11). Students will then work in partners to explore a case study to compare common pesticides practices with Integrated Pest Management (IPM) (Day 12-13). The final day of new content in this unit will focus on sustainable agriculture practices with a calculating the environmental impacts of Eating on a Lower Trophic Level and describing Regenerative Agriculture practices by watching online videos and discussing with partners.

Focus on Disciplinary Literacy

In science, disciplinary literacy is synonymous with the science and engineering practices. The SEPs are the context through which all science concepts should be taught. In the lessons, you will find the Science and Engineering practices icons when the SEPs are being explicitly used by students.



UNPACKED CONTENT STANDARDS

Below are the standards **taught** and **assessed** in this unit.

Topic		Learning Objective		Essential Knowledge	
3.6	**Age Structure Diagrams**	**EIN-1.A**	**Explain age structure diagrams.**	EIN-1.A.1	Population growth rates can be interpreted from age structure diagrams by the shape of the structure.
				EIN-1.A.2	A rapidly growing population will, as a rule, have a higher proportion of younger people compared to stable or declining populations.
3.7	**Total Fertility Rate**	**EIN-1.B**	**Explain factors that affect total fertility rate in human populations.**	EIN-1.B.1	Total fertility rate (TFR) is affected by the age at which females have their first child, educational opportunities for females, access to family planning, and government acts and policies.
				EIN-1.B.2	If fertility rate is at replacement levels a population is considered relatively stable.
				EIN-1.B.3	Factors associated with infant mortality rates include whether mothers have access to good healthcare and nutrition. Changes in these factors can lead to changes in infant mortality rates over time
3.8	**Human Population Dynamics**	**EIN-1.C**	**Explain how human populations experience growth and decline.**	EIN-1.C.1	Birth rates, infant mortality rates, and overall death rates, access to family planning, access to good nutrition, access to education, and postponement of marriage all affect whether a human population is growing or declining
				EIN-1.C.2	Factors limiting global human population include the Earth's carrying capacity and the basic factors that limit human population growth as set forth by Malthusian theory
				EIN-1.C.3	Population growth can be affected by both density-independent factors, such as major storms, fires, heat waves, or droughts, and density-dependent factors, such as access to clean water and air, food availability, disease transmission, or territory size.
				EIN-1.C.4	The rule of 70 states that dividing the number 70 by the percentage population growth rate approximates the population's doubling time.
3.9	**Demographic Transition**	**EIN-1.D**	**Define the demographic transition.**	EIN-1.D.1	The demographic transition refers to the transition from high to lower birth and death rates in a country or region as development occurs and that country moves from a preindustrial to an industrialized economic system. This transition is typically demonstrated through a four-stage demographic transition model (DTM).
				EIN-1.D.2	Characteristics of developing countries include higher infant mortality rates and more children in the workforce than developed countries.
5.3	**Green Revolution**	**EIN-2.C**	**Describe changes in agricultural practices.**	EIN-2.C.1	The Green Revolution started a shift to new agricultural strategies and practices in order to increase food production, with both positive and negative results. Some of these strategies and methods are mechanization, genetically modified organisms (GMOs), fertilization, irrigation, and the use of pesticides.

				EIN-2.C.2	Mechanization of farming can increase profits and efficiency for farms. It can also increase reliance on fossil fuels.
5.4	**Impact of Agricultural Practices**	**EIN-2.D**	**Describe agricultural practices that cause environmental damage.**	LOR-2.D.1	Agricultural practices that cause environmental damage include tiling, slash-and-burn farming, and the use of fertilizers.
5.5	**Irrigation Methods**	**EIN-2.E**	**Describe the different methods of irrigation.**	EIN-2.E.1	The largest human use of freshwater is for irrigation (70%).
				EIN-2.E.2	Types of irrigation include drip irrigation, flood irrigation, furrow irrigation, and spray irrigation.
		EIN-2.F	**Describe the benefits and drawbacks of different methods of irrigation.**	EIN-2.F.1	Waterlogging occurs when too much water is left to sit in the soil, which raises the water table of ground water and inhibits plants' ability to absorb oxygen through their roots.
				EIN-2.F.2	Furrow irrigation involves cutting furrows between crop rows and filling them with water. This system is inexpensive, but about 1/3 of the water is lost to evaporation and runoff.
				EIN-2.F.3	Flood irrigation involves flooding an agricultural field with water. This system sees about 20% of the water lost to evaporation and runoff. This can also lead to waterlogging of the soil.
				EIN-2.F.4	Spray irrigation involves pumping groundwater into spray nozzles across an agricultural field. This system is more efficient than flood and furrow irrigation, with only 1/4 or less of the water lost to evaporation or runoff. However, spray systems are more expensive than flood and furrow irrigation, and also requires energy to run.
				EIN-2.F.5	Drip irrigation uses perforated hoses to release small amounts of water to plant roots. This system is the most efficient, with only about 5% of water lost to evaporation and runoff. However, this system is expensive and so is not often used.
				EIN-2.F.6	Salinization occurs when the salts in groundwater remain in the soil after the water evaporates. Over time, salinization can make soil toxic to plants.
				EIN-2.F.7	Aquifers can be severely depleted if overused for agricultural irrigation, as has happened to the Ogallala Aquifer in the central United States.
5.6	**Pest Control Methods**	**EIN-2.G**	**Describe the benefits and drawbacks of different methods of pest control.**	EIN-2.G.1	One consequence of using common pest-control methods such as pesticides, herbicides, fungicides, rodenticides, and insecticides is that organisms can become resistant to them through artificial selection. Pest control decreases crop damage by pest and increases crop yields.
				EIN-2.G.2	Crops can be genetically engineered to increase their resistance to pests and diseases. However, using genetically engineered crops in planting or other ways can lead to loss of genetic diversity of that particular crop.

5.7	**Meat Production Methods**	**EIN-2.H**	**Identify different methods of meat production.**	EIN-2.H.1	Methods of meat production include concentrated animal feeding operations (CAFOs), also called feedlots, and free-range grazing.
		EIN-2.I	**Describe the benefits and drawbacks of different methods of meat production.**	EIN-2.I.1	Meat production is less efficient than agriculture; it takes approximately 20 times more land to produce the same amount of calories from meat as from plants.
				EIN-2.I.2	Concentrated animal feeding operation (CAFOs) are used as a way to quickly get livestock ready for slaughter. They tend to be crowded, and animals are fed grains or feed that are not as suitable as grass. Additionally, feedlots generate a large amount of organic waste, which can contaminate ground and surface water. The use of feedlots are less expensive than other methods, which can keep costs to consumers down.
				EIN-2.I.3	Free range grazing allows animals to graze on grass during their entire lifecycle. Meat from free range animals tends to be free from antibiotics and other chemicals used in feedlots. Organic waste from these animals acts as fertilizer. Free range grazing requires large areas of land and the meat produced is more expensive for consumers.
				EIN-2.I.4	Overgrazing occurs when too many animals feed on a particular area of land. Overgrazing causes loss of vegetation, which leads to soil erosion.
				EIN-2.I.5	Overgrazing can cause desertification. Desertification is the degradation of low precipitation regions toward being increasingly arid until they become deserts.
				EIN-2.I.6	Less consumption of meat could reduce CO2, methane, and N2O emissions; conserve water; reduce the use of antibiotics and growth hormones; and improve topsoil.
5.14	**Integrated Pest Management**	**STB-1.C**	**Describe integrated pest management.**	STB-1.C.1	Integrated pest management (IPM) is a combination of methods used to effectively control pest species while minimizing the disruption to the environment. These methods include biological, physical, and limited chemical methods such as biocontrol, intercropping, crop rotation, and natural predators of the pests.
		STB-1.D	**Describe the benefits and drawbacks of integrated pest management (IPM).**	STB-1.D.1	The use of integrated pest management (IPM) reduces the risk that pesticides pose to wildlife, water supplies, and human health.
				STB-1.D.2	Integrated pest management (IPM) minimizes disruptions to the environment and threats to human health but can be complex and expensive.
5.15	**Sustainable Agriculture**	**STB-1.E**	**Describe sustainable agricultural and food production practices.**	STB-1.E.1	The goal of soil conservation is to prevent soil erosion. Different methods of soil conservation include contour plowing, windbreaks, perennial crops, terracing, no-till agriculture, and strip cropping.
				STB-1.E.2	Strategies to improve soil fertility include crop rotation and the addition of green manure and limestone.
				STB-1.E.3	Rotational grazing is the regular rotation of livestock between different pastures in order to avoid overgrazing in a particular area.

5.16	**Aquaculture**	**STB-1.F**	**Describe the benefits and drawbacks of aquaculture**	STB-1.F.1	Aquaculture has expanded because it is highly efficient, requires only small areas of water, and requires little fuel.
				STB-1.F.2	Aquaculture can contaminate wastewater, and fish that escape may compete or breed with wild fish. The density of fish in aquaculture can lead to increases in disease incidences, which can be transmitted to wild fish.

KEY UNDERSTANDINGS AND QUESTIONS

Important big ideas and processes for the unit.

Key Understandings
❑ Population growth rates can be interpreted from age structure diagrams by the shape of the structure ❑ A rapidly growing population will as a rule have a higher proportion of younger people compared to stable or declining populations**.** ❑ TFR is affected by the age at which females have their first child, educational opportunities for females, access to family planning and government acts and policies**.** ❑ Factors associated with infant mortality rates include whether mothers have access to good health care and nutrition. Changes in these factors can lead to changes in infant mortality rates over time**.** ❑ Birth rates, infant mortality rates, and overall death rates, access to family planning, access to good nutrition, access to education, and postponement of marriage all affect whether a human population is growing or declining ❑ Factors limiting global human population include the Earth's carrying capacity and the basic factors that limit human population growth as set forth by Malthusian theory ❑ Population growth can be affected by both density-independent factors, such as major storms, fires, heat waves, or droughts, and density-dependent factors, such as access to clean water and air, food availability, disease transmission, or territory size. ❑ The demographic transition refers to the transition from high to lower birth and death rates in a country or region as development occurs and that country moves from a preindustrial to an industrial economic system. ❑ Characteristics of less developed countries include higher infant mortality rates and more children in the workforce than developed countries. ❑ The population pyramid for a country/region should "tell the same story" as the stage of demographic transition. ❑ Percent population change $= \frac{change\ in\ population}{starting\ population}\ X\ 100$ ❑ The rule of 70 states that dividing the number 70 by the percentage population growth rate approximates the population's doubling time. ❑ Crude birth and death rates are the rate per 1,000 people ❑ $\text{change in population} = (B - D) + \ (I - E)$ ❑ Population Density$= \frac{population}{land\ area}$ ❑ The Green Revolution started a shift to new agricultural strategies and practices to increase food production, with both positive and negative results. Some methods are mechanization, genetically modified organisms (GMO's), fertilization, irrigation and the use of pesticides. ❑ The largest human use of freshwater is for irrigation (70%). ❑ Types of irrigation include drip irrigation, flood irrigation, furrow irrigation, and spray irrigation. ❑ Waterlogging occurs when too much water is left to sit in the soil, which raises the water table of groundwater and inhibits plants' ability to absorb oxygen through their roots. ❑ Furrow irrigation involves cutting furrows between crop rows and filling them with water. This system is inexpensive, but about 1/3 of the water is lost to evaporation and runoff. ❑ Flood irrigation involves flooding an agricultural field with water. This system sees about 20% of the water lost to evaporation and runoff. This can also lead to waterlogging of the soil.

- ❑ Spray irrigation involves pumping groundwater into spray nozzles across an agricultural field. This system is more efficient than flood and furrow irrigation, with only 1/4 or less of the water lost to evaporation or runoff. However, spray systems are more expensive than flood and furrow irrigation, and also requires energy to run.
- ❑ Drip irrigation uses perforated hoses to release small amounts of water to plant roots. This system is the most efficient, with only about 5% of water lost to evaporation and runoff. However, this system is expensive and so is not often used.
- ❑ Salinization occurs when the salts in groundwater remain in the soil after the water evaporates. Over time, salinization can make soil toxic to plants.
- ❑ Aquifers can be severely depleted if overused for agricultural irrigation, as has happened to the Ogallala Aquifer in the central United States.
- ❑ Mechanization of farming can increase profits and efficiency for farms. It can also increase reliance on fossil fuels.
- ❑ Agricultural practices that cause environmental damage include tiling, slash-and-burn farming, and the use of fertilizers.
- ❑ One consequence of using common pest-control methods such as pesticides, herbicides, fungicides, rodenticides, and insecticides is that organisms can become resistant to them through artificial selection. Pest control decreases crop damage by pest and increases crop yields.
- ❑ Crops can be genetically engineered to increase their resistance to pests and diseases. However, using genetically engineered crops in planting or other ways can lead to loss of genetic diversity of that particular crop.
- ❑ Methods of meat production include concentrated animal feeding operations (CAFOs), also called feedlots, and free-range grazing.
- ❑ Concentrated animal feeding operation (CAFOs) are used as a way to quickly get livestock ready for slaughter. They tend to be crowded, and animals are fed grains or feed that are not as suitable as grass. Additionally, feedlots generate a large amount of organic waste, which can contaminate ground and surface water. The use of feedlots are less expensive than other methods, which can keep costs to consumers down.
- ❑ Free range grazing allows animals to graze on grass during their entire lifecycle. Meat from free range animals tends to be free from antibiotics and other chemicals used in feedlots. Organic waste from these animals acts as fertilizer. Free range grazing requires large areas of land and the meat produced is more expensive for consumers.
- ❑ Overgrazing occurs when too many animals feed on a particular area of land. Overgrazing causes loss of vegetation, which leads to soil erosion.
- ❑ Overgrazing can cause desertification. Desertification is the degradation of low precipitation regions toward being increasingly arid until they become deserts.
- ❑ Less consumption of meat could reduce CO2, methane, and N2O emissions; conserve water; reduce the use of antibiotics and growth hormones; and improve topsoil.
- ❑ Crops can be genetically engineered to increase their resistance to pests and diseases. However, using genetically engineered crops in planting or other ways can lead to loss of genetic diversity of that particular crop.
- ❑ Overfishing has led to the extreme scarcity of some fish species, which can lessen biodiversity in aquatic systems and harm people who depend on fishing for food and commerce.
- ❑ Aquaculture has expanded because it is highly efficient, requires only small areas of water, and requires little fuel.
- ❑ Aquaculture can contaminate wastewater, and fish that escape may compete or breed with wild fish. The density of fish in aquaculture can lead to increases in disease incidences, which can be transmitted to wild fish.
- ❑ One consequence of using common pest control methods such as pesticides, Herbicides, fungicides, rodenticides and insecticides is that organisms can become resistant to them through artificial selection.
- ❑ Crops can be genetically engineered to increase their resistance to pests and diseases.

- ❑ Integrated pest management (IPM) is a combination of methods used to effectively control pest species while minimizing the disruption to the environment. These methods include biological, physical, and limited chemical methods such as biocontrol, intercropping, crop rotation, and natural predators of the pests.
- ❑ The use of integrated pest management (IPM) reduces the risk that pesticides pose to wildlife, water supplies, and human health.
- ❑ Integrated pest management (IPM) minimizes disruptions to the environment and threats to human health but can be complex and expensive.
- ❑ Eating at a lower trophic level would decrease the impact of agriculture on the environment by significantly decreasing the amount of land needed to produce enough food for people.
- ❑ The goal of soil conservation is to prevent soil erosion. Different methods of soil conservation include contour plowing, windbreaks, perennial crops, terracing, no-till agriculture and strip cropping.
- ❑ Strategies to improve soil fertility include crop rotation and addition of green manures and limestone.
- ❑ Integrated pest management (IPM) minimizes disruptions to the environment and threats to human health but can be complex and expensive.
- ❑ Agriculture can be regenerative in that it can improve soil and water quality, increase biodiversity, etc.
- ❑

Key Questions

- How are changes in human populations modeled and analyzed quantitatively?
- How do human populations change as they transition from agriculture to industrial based and beyond?
- What is the Green Revolution and what were its environmental impacts?
- What are the different types of agriculture irrigation, and which are the most sustainable?
- How is the widespread use of chemical pesticides causing environmental problems?
- What is pesticide resistance?
- What are the advantages and disadvantages of Integrated Pest Management (IPM) as an alternative to chemical pesticides?
- How is animal protein commonly produced in modern, industrialized agriculture and what are the environmental impacts?
- How are antibiotic resistant bacteria created?
- What are the causes and consequences of overfishing?
- What are the advantages and disadvantages of producing seafood through aquaculture? How can aquaculture be done more sustainably?
- What are sustainable agriculture techniques and what are the advantages and disadvantages of implementing them?

ROADMAP

AT A Glance: Unit #:				
Day	**Date**	**Lesson**	**Lesson Title**	**Lesson & Pacing Notes**
1		01	Population Pyramids	
2		02	Material World	
3		03	Don't Panic – Day 1	
4		04	Don't Panic – Day 2	
5		05	Demographic Transition	
6		06	Population Math Practice	
7		07	Intro: Agriculture & the Environment	
8		08	Fresh Documentary – Day 1	
9		09	Fresh Documentary – Day 2	
10		10	CAFOs & GMOs	
11		11	Overfishing & Aquaculture	
12		12	Pesticides	
13		13	Integrated Pest Management	
14			Sustainable Agriculture	
15		Unit Exam	**TX_SCI_APEnvironmentalScience_F25_UE3**	
16		Success Day	*Time Permitting* - Success Day Lesson Plan to review the UE FRQ and MC gaps.	

Lesson	Objective(s) and Standard(s)	Instructional Notes	Resources
Day 1 **Power of the Pyramids**	**STANDARD(s)** **Topic 3.6: Explain Age Structure Diagrams** **EIN-1.A** **Explain** age structure diagrams. **SWBAT:** **Make and justify** claims about key characteristics of a population qualitatively by analyzing age structure diagrams. **DISCIPLINARY LITERACY FOCUS:**  	**KEY UNDERSTANDINGS CHECKLIST:** ❑ Population growth rates can be interpreted from age structure diagrams by the shape of the structure ❑ A rapidly growing population will as a rule have a higher proportion of younger people compared to stable or declining populations. **LESSON CONTEXT FOR LESSON MASTERY:** Students will analyze the primary type of graph used to describe the population of regions or countries, sometimes called population pyramids because of their common pyramid-like shape. Students will recognize patterns in population growth, understand how economic and social factors influence demographics, and connect population trends to environmental sustainability and resource use. **LOOK-FORS 🔍 (What to observe students doing or producing)** • Students can explain why birth and death rates change across DTM stages. • Can correctly interpret population pyramids and link them to DTM stages. • Can make predictions about future population growth and challenges for countries in different DTM stages. • Can connect socioeconomic factors (education, healthcare, industrialization, women's empowerment) to demographic changes. **COMMON MISCONCEPTIONS 🚩 (Historical/widespread misunderstandings)** • Students confuse population size with population growth rate • Population pyramids only show **a**ge, not realizing they also reflect social and economic patterns. • Students think that Stage 5 (population decline) means the population will "disappear" instead of stabilizing at a lower level. • Fertility rate only depends on biology, not on cultural, economic, and political factors. **MAKING CONNECTIONS** • Students should be able to connect population pyramid shape with the stages of demographic transition during/after that lesson	Slides 2-5 of Do Now PPT **TEACHER CONTENT BACKGROUND RESOURCES** • Khan Academy – Population (Age) Pyramids • Smedes – Age Structure Diagrams

Lesson	Objective(s) and Standard(s)	Instructional Notes	Resources
Day 02 **Material World**	**STANDARD(s)** **Topic 3.7: Total Fertility Rate** **EIN-1.B - Explain** factors that affect total fertility rate in human populations. **SWBAT:** **Explain** the factors that affect the total fertility rate of a country or region. **DISCIPLINARY LITERACY FOCUS:**  	**KEY UNDERSTANDINGS CHECKLIST:** ❑ TFR is affected by the age at which females have their first child, educational opportunities for females, access to family planning and government acts and policies**.** ❑ Factors associated with infant mortality rates include whether mothers have access to good health care and nutrition. Changes in these factors can lead to changes in infant mortality rates over time**.** **LESSON CONTEXT FOR LESSON MASTERY:** Students will use PPT and different websites to explore the differences in consumption between Less Developed Countries and Developed Countries PPT is pictures of family food expenditures for 1 week (this project is over 10 years old but even though pictures are dated the comparisons between countries are valid) PPT – last two slides are extra math practice that parallels population math using Tootsie Pops instead of people Female access to education, jobs and family planning services is the number one factor to stabilize human populations **LOOK-FORS 🔍 (What to observe students doing or producing)** • Students list and explain multiple factors that influence fertility rate, not just one. • Students connect TFR to population **structure** (age pyramids, workforce size) • Students analyze how education of women, **access to** contraception, and healthcare improvements reduce TFR. • Students compare high-TFR regions (e.g., Sub-Saharan Africa) with low-TFR regions (e.g., Europe/Japan) with diagrams and math problems. **COMMON MISCONCEPTIONS 🚩 (Historical/widespread misunderstandings)** • Thinking that fertility rate only depends on biological ability to have children, not social/economic factors. • Confusing fertility rate with birth rate (fertility rate = average number of children per woman; birth rate = births per 1,000 people).	**TEACHER CONTENT BACKGROUND RESOURCES** • Smedes -Total Fertility Rate • Affluence is killing the Planet •

Lesson	Objective(s) and Standard(s)	Instructional Notes	Resources
		MAKING CONNECTIONS Human population growth is a driving factor in nearly every type of anthropogenic environmental degradation so it can be connected to everything already introduced in this course and everything yet to be covered.	
Day 03 **Don't Panic – day 1**	**Standard(s)** **Topic 3.8: Human Population Dynamics** **EIN-1.C - Explain** how human populations experience growth and decline. **SWBAT:** **Explain** the key factors that affect human population growth. **DISCIPLINARY LITERACY FOCUS:**	**KEY UNDERSTANDINGS CHECKLIST:** ❑ Birth rates, infant mortality rates, and overall death rates, access to family planning, access to good nutrition, access to education, and postponement of marriage all affect whether a human population is growing or declining ❑ Factors limiting global human population include the Earth's carrying capacity and the basic factors that limit human population growth as set forth by Malthusian theory ❑ Population growth can be affected by both density-independent factors, such as major storms, fires, heat waves, or droughts, and density-dependent factors, such as access to clean water and air, food availability, disease transmission, or territory size. **LESSON CONTEXT FOR LESSON MASTERY:** Students will watch a documentary and individually take notes and discuss CFU and discussion questions. Students will be introduced to the environmental	

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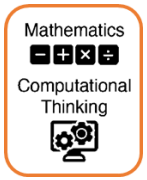
Day 04 **Don't Panic – day 2**	 	concerns with the exponentially growing human population and the carrying capacity of humans on Earth and the different factors that increase or decrease the rate of human population growth. **LOOK-FORS (What to observe students doing or producing)** • Students recording notes/observations about the video using the categories on the student document • Students discussing guiding questions by citing evidenced from the video **COMMON MISCONCEPTIONS (Historical/widespread misunderstandings)** • Thinking that the human population will grow indefinitely • Thinking that the human population can grow indefinitely **MAKING CONNECTIONS** Human population growth is a driving factor in nearly every type of anthropogenic environmental degradation so it can be connected to everything already introduced in this course and everything yet to be covered	**TEACHER CONTENT BACKGROUND RESOURCES** • Khan Academy – Population Dynamics
Day 05 **Demographic Transition**	**Standard(s)** **Topic 3.9: Demographic Transition** **EIN-1.D - Define** the demographic transition. **SWBAT:** **Describe and explain** each stage of the demographic transition model including examples of countries or regions that are in each stage. **DISCIPLINARY LITERACY FOCUS:**	**KEY UNDERSTANDINGS CHECKLIST:** ❑ The demographic transition refers to the transition from high to lower birth and death rates in a country or region as development occurs and that country moves from a preindustrial to an industrial economic system. ❑ Characteristics of less developed countries include higher infant mortality rates and more children in the workforce than developed countries. ❑ The population pyramid for a country/region should "tell the same story" as the stage of demographic transition. **LESSON CONTEXT FOR LESSON MASTERY:** Students will explore the Demographic Transition Model by creating their own graph of Crude Birth Rate (CBR) and Crude Death Rate (CDR) using Gap minder website • *NOTE – see teacher instructions video for using Gap minder*	**Materials:** • **Graph paper** • **Colored pencils** • **Computer access to gapminder.com** **TEACHER CONTENT BACKGROUND RESOURCES** • Our World in Data – Demographic Transition

Lesson	Objective(s) and Standard(s)	Instructional Notes	Resources
		• Students will watch AP Daily video covering the stages of demographic transition • Focus on making connections between different stages and descriptions of exemplar countries/regions – GDP, life expectancy, IMR, CBR, CDR, female education opportunities, specific countries examples *NOTE – Stage 5 of DTM not officially taught by College Board APES but it is an interesting discussion question:(Taught at AP Human Geography class)* • *Ask - What is happening during this stage (beyond Stage 4)? → Births have dropped even lower than low death rat* • *Ask - Why? → Mostly social factors like high cost of living, families with two working parents, high cost of raising children,* • *Where? → many countries are beginning to experience natural population decline, Japan, Germany, Portugal, Italy are some notable examples* **LOOK-FORS 🔍 (What to observe students doing or producing)** • Students can explain trends in birth and death rates for each DTM stage. • Students compare examples of real countries at different stages of DTM. • Students predict consequences of a country moving to the next stage (e.g., population momentum, aging workforce, and pressure on pensions). • Students connect development factors (education, healthcare, urbanization, economic shifts) to demographic changes. **COMMON MISCONCEPTIONS 🚩 (Historical/widespread misunderstandings)** Confusing birth rate with fertility rate (fertility = # of children per woman; birth rate = # per 1,000 people per year). Thinking about a country's stage = level of wealth only, ignoring other social factors (education, gender equality, healthcare access). **MAKING CONNECTIONS** • The Demographic Transition stage of a population can be determined using the Population Pyramid graph and vice versa. These two must match. • The Demographic Transition stage indicates the affluence level of a country.	• **Khan Academy – Demographic Transition Model** • **Khan Academy – Demographic Transition**

Lesson	Objective(s) and Standard(s)	Instructional Notes	Resources
Day 06 **Population Math Practice**	**Standard(s)** **Topic 3.8: Human Population Dynamics** **EIN-1.C - Explain** how human populations experience growth and decline. **Calculate** population changes by using percentages, crude rates, and the Rule of 70. **DISCIPLINARY LITERACY FOCUS:**  	**KEY UNDERSTANDINGS CHECKLIST:** ❑ Percent population change = $\frac{change\ in\ population}{starting\ population}$ $X\ 100$ ❑ The rule of 70 states that dividing the number 70 by the percentage population growth rate approximates the population's doubling time. ❑ Crude birth and death rates are the rate per 1,000 people ❑ change in population $= (B - D) + (I - E)$ ❑ Population Density= $\frac{population}{land\ area}$ **LESSON CONTEXT FOR LESSON MASTERY:** This unit is of the few APES unit that has a heavy focus on the mathematical routines that will be required on the AP Exam. Students must be able to work with percentages and in this unit will need to calculate percent change of populations. They will also get practice in this lesson with two population specific mathematical routines – calculating crude birth/death rates (which is the same as percentages but divided by 1000), and the Rule of 70 to approximate the doubling time of an exponentially growing population. There is no formula sheet for APES so students will need to memorize the simple formulas for crude rate and the Rule of 70. **LOOK-FORS 🔍 (What to observe students doing or producing)** • Students correctly apply the **Rule of 70** to calculate doubling time. • Students distinguish between crude birth rate (CBR), crude death rate (CDR), and rate of natural increase (RNI). • Students correctly calculate population growth rate using percentages. • **COMMON MISCONCEPTIONS 🚩 (Historical/widespread misunderstandings)** • Confusing population growth rate (%) with crude birth rate (per 1,000). • Forgetting **to convert percentages properly** • Believing the **Rule of 70 is exact**, when it's an approximation. • Plugging growth rate into the Rule of 70 as a decimal instead of as a percentage.	**Students should always have access to calculators for APES calculations!** **No formula sheet is given in APES!** **TEACHER CONTENT BACKGROUND RESOURCES** • Quizlet – Pop Math Flashcards

Lesson	Objective(s) and Standard(s)	Instructional Notes	Resources
Day 07 **Intro Agriculture & the Environment**	**Standard(s)** **Topic 5.3 – Green Revolution** **EIN-2.C - Describe** changes in agricultural practices. **Topic 5.5 – Irrigation Methods** **EIN-2.E - Describe** the different methods of irrigation. **EIN-2.F - Describe** the benefits and drawbacks of different methods of irrigation. **SWBAT:** **Describe** the changes to agriculture during the Green Revolution and the environmental impacts related to monocultures, irrigation and soil erosion. **DISCIPLINARY LITERACY FOCUS:** 	**KEY UNDERSTANDINGS CHECKLIST:** ❑ The Green Revolution started a shift to new agricultural strategies and practices to increase food production, with both positive and negative results. Some methods are mechanization, genetically modified organisms (GMO's), fertilization, irrigation and the use of pesticides. ❑ The largest human use of freshwater is for irrigation (70%). ❑ Types of irrigation include drip irrigation, flood irrigation, furrow irrigation, and spray irrigation. ❑ Waterlogging occurs when too much water is left to sit in the soil, which raises the water table of groundwater and inhibits plants' ability to absorb oxygen through their roots. ❑ Furrow irrigation involves cutting furrows between crop rows and filling them with water. This system is inexpensive, but about 1/3 of the water is lost to evaporation and runoff. ❑ Flood irrigation involves flooding an agricultural field with water. This system sees about 20% of the water lost to evaporation and runoff. This can also lead to waterlogging of the soil. ❑ Spray irrigation involves pumping groundwater into spray nozzles across an agricultural field. This system is more efficient than flood and furrow irrigation, with only 1/4 or less of the water lost to evaporation or runoff. However, spray systems are more expensive than flood and furrow irrigation, and also requires energy to run. ❑ Drip irrigation uses perforated hoses to release small amounts of water to plant roots. This system is the most efficient, with only about 5% of water lost to evaporation and runoff. However, this system is expensive and so is not often used. ❑ Salinization occurs when the salts in groundwater remain in the soil after the water evaporates. Over time, salinization can make soil toxic to plants. ❑ Aquifers can be severely depleted if overused for agricultural irrigation, as has happened to the Ogallala Aquifer in the central United States. ❑ Mechanization of farming can increase profits and efficiency for farms. It can also increase reliance on fossil fuels. **LESSON CONTEXT FOR LESSON MASTERY:**	**TEACHER CONTENT BACKGROUND RESOURCES** • **Smedes – Green Revolution** • **Khan Academy – Impacts of Agricultural Practices**

Lesson	Objective(s) and Standard(s)	Instructional Notes	Resources
		Students will explore how changes in agriculture practices supported the rapid growth in the human population over the past several hundred years. Students will also begin to explore the environmental impacts of these changes by watching short videos in a station rotation activity – focusing on Irrigation, Monocultures, and Erosion. **LOOK-FORS 🔍 (What to observe students doing or producing)** • Students making connections between the rapidly increasing human population and changes in agricultural practices • Students describing the key changes in agricultural practices during the Green Revolution • Students connecting Green Revolution agricultural practices with consequences (e.g., fertilizer runoff → eutrophication; over-irrigation → salinization). • Students proposing or discuss sustainable alternatives to reduce impacts. **COMMON MISCONCEPTIONS 🚩 (Historical/widespread misunderstandings)** • Students assume fertilizers and pesticides only help crops and have no long-term side effects. • Irrigation always increases crop yield without considering soil salinization or aquifer depletion. • Confusing monocropping with crop rotation. **MAKING CONNECTIONS** • Agriculture is the single largest anthropogenic environmental impact • Agriculture is a primary driver in habitat destruction, which is a primary driver in species loss/ loss of biodiversity. • The changes to agriculture that happened during the industrial and green revolution have consistently decreased the amount of human effort to produce food (muscle and time) but have increased the required amount of nearly every kind of material input (water, arable land, soil nutrients, fertilizer, pesticides/herbicides, fossil fuels, etc.)	

Lesson	Objective(s) and Standard(s)	Instructional Notes	Resources
Day 08 **Fresh Documentary Day 1**	**Standard(s)** **Topic 5.4 – Impact of Agricultural Practices** **EIN-2.D - Describe** agricultural practices that cause environmental damage. **Topic 5.6 – Pest Control Methods** **EIN-2.G - Describe** the benefits and drawbacks of different methods of pest control. **Topic 5.7 – Meat Production Methods** **EIN-2.H** - **Identify** different methods of meat production. **EIN-2.I - Describe** the benefits and drawbacks of different methods of meat production.	**KEY UNDERSTANDINGS CHECKLIST:** ❑ Agricultural practices that cause environmental damage include tiling, slash-and-burn farming, and the use of fertilizers. ❑ One consequence of using common pest-control methods such as pesticides, herbicides, fungicides, rodenticides, and insecticides is that organisms can become resistant to them through artificial selection. Pest control decreases crop damage by pest and increases crop yields. ❑ Crops can be genetically engineered to increase their resistance to pests and diseases. However, using genetically engineered crops in planting or other ways can lead to loss of genetic diversity of that particular crop. ❑ Methods of meat production include concentrated animal feeding operations (CAFOs), also called feedlots, and free-range grazing. ❑ Concentrated animal feeding operation (CAFOs) are used as a way to quickly get livestock ready for slaughter. They tend to be crowded, and animals are fed grains or feed that are not as suitable as grass. Additionally, feedlots generate a large amount of organic waste, which can contaminate ground and surface water. The use of feedlots are less expensive than other methods, which can keep costs to consumers down. ❑ Free range grazing allows animals to graze on grass during their entire lifecycle. Meat from free range animals tends to be free from antibiotics and other chemicals used in feedlots. Organic waste from these animals acts as fertilizer. Free range grazing requires large areas of land and the meat produced is more expensive for consumers. ❑ Overgrazing occurs when too many animals feed on a particular area of land. Overgrazing causes loss of vegetation, which leads to soil erosion. ❑ Overgrazing can cause desertification. Desertification is the degradation of low precipitation regions toward being increasingly arid until they become deserts.	**TEACHER CONTENT BACKGROUND RESOURCES** • **Khan Academy – Impacts of Agricultural Practices** • **Smedes – Meat Production Methods** • **Smedes – Pest Control Methods**

Lesson	Objective(s) and Standard(s)	Instructional Notes	Resources
Day 09 **Fresh Documentary Day 2**	**Explain** how modern agricultural practices cause environmental degradation and evaluate more sustainable alternatives. **DISCIPLINARY LITERACY FOCUS:**  	❑ Less consumption of meat could reduce CO2, methane, and N2O emissions; conserve water; reduce the use of antibiotics and growth hormones; and improve topsoil. **LESSON CONTEXT** The documentary Fresh is used to further explore impacts of modern agricultural practices (post Green Revolution) on the environment and human health because it helps make the topics more relatable to students and helps students make connections between APES topics related to agriculture and food production and beyond and introduces students to more sustainable practices as well. Several topics in this lesson will be explored in greater detail in future lessons. **LOOK-FORS (What to observe students doing or producing)** • Students describing/discussing the impacts of modern agricultural practices. • Students making connections between topics explored in the documentary. • Students comparing/contrasting more sustainable options with common modern agricultural practices. **COMMON MISCONCEPTIONS (Historical/widespread misunderstandings)** • Assuming that modern agricultural practices "must be relatively sustainable" because [humans have been using them for a long time/people would not use them if they were not]. • Assuming that animal protein products are typically produced in pasture/free range environments. • Not recognizing that bacteria resistance to antibiotics is an example of selective evolution. **MAKING CONNECTIONS** • Bacterial resistance to antibiotics is a case of accidental selective evolution, similar to what is used for almost all food species. Instead of choosing which individuals reproduce based on desired characteristics, the individuals that survive are the ones that are most able to tolerate antibiotics and after generations the species can become totally resistant to the effects of antibiotics.	

Lesson	Objective(s) and Standard(s)	Instructional Notes	Resources
Day 10 **CAFOs & GMOs**	**Standard(s)** **Topic 5.7 – Meat Production Methods** **EIN-2.H - Identify** different methods of meat production. **EIN-2.I - Describe** the benefits and drawbacks of different methods of meat production. **Topic 5.6 – Pest Control Methods** **EIN-2.G** Describe the benefits and drawbacks of different methods of pest control. **Identify** different methods of meat production Describe the benefits and drawbacks of different methods of meat production. **Describe** changes in agricultural practices. **Describe** the advantages and disadvantages of producing animal protein using Concentrated	**KEY UNDERSTANDINGS CHECKLIST:** ❑ Methods of meat production include concentrated animal feeding operations (CAFOs), also called feedlots, and free-range grazing. ❑ Meat production is less efficient than agriculture; it takes approximately 20 times more land to produce the same amount of calories from meat as from plants. ❑ Concentrated animal feeding operation (CAFOs) are used as a way to quickly get livestock ready for slaughter. They tend to be crowded, and animals are fed grains or feed that are not as suitable as grass. Additionally, feedlots generate a large amount of organic waste, which can contaminate ground and surface water. The use of feedlots are less expensive than other methods, which can keep costs to consumers down. ❑ Free range grazing allows animals to graze on grass during their entire lifecycle. Meat from free range animals tends to be free from antibiotics and other chemicals used in feedlots. Organic waste from these animals acts as fertilizer. Free range grazing requires large areas of land and the meat produced is more expensive for consumers. ❑ Overgrazing occurs when too many animals feed on a particular area of land. Overgrazing causes loss of vegetation, which leads to soil erosion. ❑ Overgrazing can cause desertification. Desertification is the degradation of low precipitation regions toward being increasingly arid until they become deserts. ❑ Less consumption of meat could reduce CO2, methane, and N2O emissions; conserve water; reduce the use of antibiotics and growth hormones; and improve topsoil. Crops can be genetically engineered to increase their resistance to pests and diseases. However, using genetically engineered crops in planting or other ways can lead to loss of genetic diversity of that particular crop. ❑ Crops can be genetically engineered to increase their resistance to pests and diseases. However, using genetically engineered crops in planting or other ways can lead to loss of genetic diversity of that particular crop. **LESSON CONTEXT FOR LESSON MASTERY:** Students will explore how agricultural practices have evolved with the rise of industrialized farming. They will analyze different methods of meat production	**TEACHER CONTENT BACKGROUND RESOURCES** • **Smedes – Meat Production Methods** • **Britannica.com - Feedlot** • **NRDC – Industrial Agriculture Pollution 101** – mostly about animal feedlots

Lesson	Objective(s) and Standard(s)	Instructional Notes	Resources
	Animal Feedlot Operations (CAFOs). **Describe** Genetically Modified Organisms (GMO) foods and the advantages and disadvantages of using them to produce food. **DISCIPLINARY LITERACY FOCUS:** 	(free-range, pasture-fed, aquaculture, CAFOs) and compare their environmental, social, and economic impacts. Students will also examine the role of genetically modified organisms (GMOs) in agriculture, outlining their benefits and drawbacks. **LOOK-FORS (What to observe students doing or producing)** • Students explain how modern agriculture differs from traditional practices (industrialization, heavy chemical use, mechanization, biotechnology). • Students identify advantages and disadvantages of GMOs with real-world examples (Bt corn, Golden Rice, Roundup Ready crops). • Students connect agricultural practices to environmental issues (climate change, deforestation, eutrophication, biodiversity loss). • **COMMON MISCONCEPTIONS (Historical/widespread misunderstandings)** • Thinking CAFOs are "bad" with no benefits — ignoring affordability, efficiency, and food security aspects. • Thinking GMOs are inherently unsafe for consumption — scientific consensus shows most are safe, though ecological/economic issues exist. • Assuming meat production impacts are only about animal welfare, not realizing the climate and resource consequences. • **MAKING CONNECTIONS** • Animal waste from feedlots can have a significant impacts to nutrient cycles because it is concentrated nitrogen and phosphorous.	
Day 11 **Overfishing and Aquaculture**	**Standard(s)** **Topic 5.8 - Impact of Overfishing** **EIN-2.J - Describe** causes of and problems related to overfishing. **Topic 5.16 - Aquaculture**	**KEY UNDERSTANDINGS CHECKLIST:** ❑ Overfishing has led to the extreme scarcity of some fish species, which can lessen biodiversity in aquatic systems and harm people who depend on fishing for food and commerce. ❑ Aquaculture has expanded because it is highly efficient, requires only small areas of water, and requires little fuel. ❑ Aquaculture can contaminate wastewater, and fish that escape may compete or breed with wild fish. The density of fish in aquaculture can lead to increases in disease incidences, which can be transmitted to wild fish.	**TEACHER CONTENT BACKGROUND RESOURCES** • Smedes - Overfishing • Smedes - Aquaculture • WWF – Overfishing website

Lesson	Objective(s) and Standard(s)	Instructional Notes	Resources
	STB-1.F - **Describe** the benefits and drawbacks of aquaculture **Describe** the causes and environmental impacts of overfishing. **Make a Claim** about one way that aquaculture could become more sustainable and support the claim with evidence and reasoning. **DISCIPLINARY LITERACY FOCUS:**  	**LESSON CONTEXT FOR LESSON MASTERY:** Students will investigate the causes and consequences of overfishing and evaluate aquaculture as both a solution and a challenge for sustainable seafood production. Students will analyze data about the declining fish stocks around the world and explore how human demand, technology, and poor regulation have led to declining fish stocks. Students will explore several methods of aquaculture (fish farming) and compare the environmental impacts of each against harvesting wild fish. **LOOK-FORS 🔍 (What to observe students doing or producing)** • Students can clearly identify multiple causes of overfishing. • Students connect overfishing to ecological consequences (collapse of cod fishery, trophic cascades in marine ecosystems). • Students explain both benefits and drawbacks of aquaculture with examples. • Students compare traditional fishing vs. aquaculture in terms of sustainability. **COMMON MISCONCEPTIONS 🚩 (Historical/widespread misunderstandings)** • Thinking overfishing only affects fish populations, not realizing it disrupts entire marine food webs. • Assuming aquaculture is always a sustainable solution, ignoring pollution, disease, and invasive species risks. • Confusing bycatch with targeted catch (bycatch = unintended species caught). **MAKING CONNECTIONS** • Aquaculture is very similar to terrestrial feedlots, including the environmental problems it can cause. • Consumption of many types of seafood has an even larger impact than terrestrial animals because they are secondary consumers rather than primary consumers (higher on the food chain)	• **Khan Academy - Aquaculture** • **NOAA – What is aquaculture?**

Lesson	Objective(s) and Standard(s)	Instructional Notes	Resources
Day 12 **Pesticides**	**Standard(s)** **Topic 5.6 - Pest Control Methods** **EIN-2.G - Describe** the benefits and drawbacks of different methods of pest control. **Describe** the environmental disadvantages of pesticide use. **DISCIPLINARY LITERACY FOCUS:** 	**KEY UNDERSTANDINGS CHECKLIST:** ❑ One consequence of using common pest control methods such as pesticides, Herbicides, fungicides, rodenticides and insecticides is that organisms can become resistant to them through artificial selection. ❑ Crops can be genetically engineered to increase their resistance to pests and diseases. **LESSON CONTEXT FOR LESSON MASTERY:** Students will explore the advantages & disadvantages of using "icides" to kill pest organisms by analyzing case study data and teacher led guided discussion around pesticide resistance (the pesticide treadmill). **LOOK-FORS 🔍 (What to observe students doing or producing)** • Students can name and describe multiple pest control methods, not just "pesticides." • Students connect pesticide to ecological consequences (e.g., DDT → biomagnification in food webs). • Students explain pest resistance because of overuse of chemical pesticides. **COMMON MISCONCEPTIONS 🚩 (Historical/widespread misunderstandings)** Students assume chemical pesticides are the only effective method of pest control. Thinking that using more pesticides always means higher crop yields (ignoring resistance **and ecological damage).** **MAKING CONNECTIONS** • One of the most infamous case studies for pesticide use is DDT that was originally used to kill mosquitos to protect people from malaria and ended up being banned due to its environmental harm • Some pesticides are very persistent, remain in the environment without breaking down into less or less harmful chemicals. • Mary pesticides (like DDT) bioaccumulate in the fatty tissues of organisms such that even relatively low concentrations in the environment (air,	**TEACHER CONTENT BACKGROUND RESOURCES** • Smedes – Pest Control Methods • SciShow – How Safe are Pesticides, really? • FuseSchool – Pest Control • Smedes - IPM • Khan Academy - IPM

Lesson	Objective(s) and Standard(s)	Instructional Notes	Resources
		water, soil) can cause significant health problems for organisms further up the food chain – ***Explored in detail in Unit 8*** • Pest resistance to pesticides is accidental selective evolution, just like antibiotic resistant bacterial pathogens as seen in the Fresh documentary.	
Day13 **Integrated Pest Management (IPM)**	**Standard(s)** **Topic 5.14: Integrated Pest Management** **STB-1.C** - Describe integrated pest management. **STB-1.D** - Describe the benefits and drawbacks of integrated pest management (IPM). **Explain** the advantages and disadvantages of IPM compared to widespread application of pesticides. **DISCIPLINARY LITERACY FOCUS:** 	**KEY UNDERSTANDINGS CHECKLIST:** ❑ Integrated pest management (IPM) is a combination of methods used to effectively control pest species while minimizing the disruption to the environment. These methods include biological, physical, and limited chemical methods such as biocontrol, intercropping, crop rotation, and natural predators of the pests. ❑ The use of integrated pest management (IPM) reduces the risk that pesticides pose to wildlife, water supplies, and human health. ❑ Integrated pest management (IPM) minimizes disruptions to the environment and threats to human health but can be complex and expensive. **LESSON CONTEXT FOR LESSON MASTERY:** After Lesson 13 students are ready to explore **Integrated Pest Management (IPM)** as a sustainable approach to controlling agricultural pests. They will analyze how IPM combines biological, cultural, mechanical, and chemical strategies to reduce pest damage while minimizing environmental harm. Students will complete Part 2 of Pest Management Case Study. **LOOK-FORS 🔍 (What to observe students doing or producing)** Students can clearly define IPM and identify at least **3–4 strategies** used in IPM. Students describe specific benefits of IPM, such as **reduced** chemical dependency and protection of beneficial species (pollinators, predators). **COMMON MISCONCEPTIONS 🚩 (Historical/widespread misunderstandings)** • Students assume IPM eliminates all pesticide use • Believing IPM only addresses insects — it can target weeds, fungi, and other pests as well.	

Lesson	Objective(s) and Standard(s)	Instructional Notes	Resources
		MAKING CONNECTIONS • IPM is applicable to other areas, beyond agriculture. where pests can cause human health or economic problems such as forestry and controlling the spread of diseases carried by mosquitoes • Successful IPM requires a good deal of knowledge about the seasonal cycles and life cycles of a pest organism and population, which is very similar to the study of threatened or endangered species • The relationship between IPM and pesticides use is very analogous to the relationship between modern agriculture (high intensity/high input) and ancient agriculture (low input) because each requires a lot less human effort and time but more material input.	
Day 14 **Sustainable Agriculture**	**Standard(s)** **Topic 5.12 – Introduction to Sustainability** **Explain the concept of sustainability.** **SWBAT:** **Describe** sustainable agricultural practices and **explain** how they decrease negative environmental impacts of agriculture/food production. **DISCIPLINARY LITERACY FOCUS:**  	**KEY UNDERSTANDINGS CHECKLIST:** ❑ Eating at a lower trophic level would decrease the impact of agriculture on the environment by significantly decreasing the amount of land needed to produce enough food for people. ❑ The goal of soil conservation is to prevent soil erosion. Different methods of soil conservation include contour plowing, windbreaks, perennial crops, terracing, no-till agriculture and strip cropping. ❑ Strategies to improve soil fertility include crop rotation and addition of green manures and limestone. ❑ Integrated pest management (IPM) minimizes disruptions to the environment and threats to human health but can be complex and expensive. ❑ Agriculture can be regenerative in that it can improve soil and water quality, increase biodiversity, etc. **LESSON CONTEXT FOR LESSON MASTERY:** Students will first explore the drastic effect that eating lower on the food chain would have on environmental impacts of agriculture. Then students will be introduced to the concept of regenerative agriculture as a step beyond sustainable agriculture. Then students will compare/contrast several practices from sustainable agriculture. This provides will help students to develop a well rounded perspective about how agricultural practices can be changed to decrease their negative impacts on the environment and environmental systems.	**TEACHER SCONTENT BACKGROUND RESOURCES** • Khan Academy – Sustainable Agriculture

Lesson	Objective(s) and Standard(s)	Instructional Notes	Resources
		LOOK-FORS 🔍 (What to observe students doing or producing) • Students can list and describe multiple sustainable practices. Students explain the environmental benefits of each practice. Students connect sustainable practices to reducing soil erosion, water pollution, and biodiversity loss **COMMON MISCONCEPTIONS 🚩 (Historical/widespread misunderstandings)** • Students think sustainable farming means no chemicals at all — some practices use targeted, minimal inputs. • Assume sustainable agriculture is only for small farms — sustainable methods can be scaled to large operations. • Confusing organic farming with sustainable agriculture — organic is one method, but sustainability includes broader practices (soil conservation, water management, IPM). **MAKING CONNECTIONS** • Sustainable agriculture seeks to produce food for humans while preserving natural resources, ecosystems services and biodiversity.	
Day 15 **Review/Flex Day**			
Day 16 Unit 3 Exam	Unit 3 Exam – Human Population & Agriculture TX_SCI_APEnvironmentalScience_F25_UE3		
Success Day	Time Permitting		

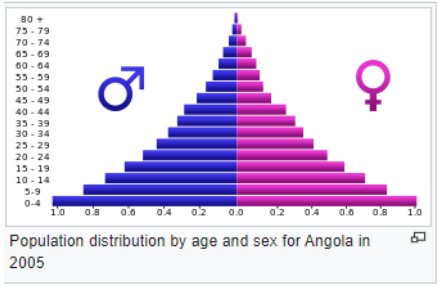
VERTICAL STANDARDS

This section details the **progression** of key student expectations/standards in the courses **before** and **after** this course. This will help you understand what **prior knowledge skills to build upon** and guide you in knowing what **skills you are preparing your students** for in the subsequent course.

BEFORE AP Environmental Science
Grade 6 •
Grade 7 •
Grade 8 •
Pre-AP Biology (Grade 8 or 9)
Pre-AP Chemistry (Grade 9 or 10) •
After AP Environmental Science
AP Biology (Grade 10, 11 or 12)
AP Chemistry

VOCABULARY GLOSSARY

Domain-specific words and definitions for this unit.

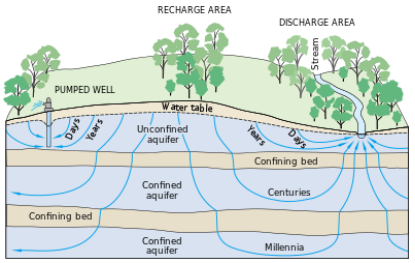
Key Content Vocabulary
Age Structure Diagrams (Population Pyramids) – *a graphical illustration of the distribution of a population (typically that of a country or region of the world) by age groups and sex; it typically forms the shape of a pyramid when the population is growing.* ***Reproductive Age –*** *Generally considered between ages 15-49, when healthy females are able to have babies. The exact age range may vary slightly from source to source.* ***Population Momentum*** *- Population momentum explains why a population will continue to grow even if the fertility rate declines. Population momentum occurs because it is not only the number of children per woman that determine population growth, but also the number of women in reproductive age. It is a consequence of the demographic transition.*  Population distribution by age and sex for Angola in 2005 ***Total Fertility Rate (TFR) – the*** *average number of children that would be born to a woman over her lifetime if:* • *She was to experience the exact current age-specific fertility rates (ASFRs) through her lifetime* • *She was to live from birth until the end of her reproductive life.* ***Replacement Fertility Rate (RFR) –*** *Replacement fertility is the total fertility rate at which women give birth to enough babies to sustain population levels. According to the UN Population Division, a total fertility rate (TFR) of about 2.1 children per woman in developed countries and 2.5 in less developed countries.* ***Infant Mortality Rate –*** *number of live births that pass away before their 1st birthday.* ***Crude Birth Rate*** *– the total number of live births per 1,000 population divided by the length of the period in years.* ***Crude Death Rate*** *- deaths per 1,000 individuals per year* ***Malthusian Theory –*** *the idea that population growth is potentially exponential while the growth of the food supply or other resources is linear, which eventually reduces living standards to the point of triggering a population die off.* ***Demographic Transition Model (DTM) –*** *a phenomenon and theory which refers to the historical shift from high birth rates and high infant death rates in societies with minimal technology, education (especially of women) and economic development, to low birth rates and low death rates in societies with advanced technology, education and economic development, as well as the stages between these two scenarios.* ***Developed or More Economically Developed Country (MEDC) –*** *country with high GDP typically characterized by an educated workforce, low IMR, long life expectance, lower TFR, and a large urban population.* ***Developing or Less Economically Developed Country (LEDC) –*** *country with low GDP typically characterized by low status of women, high IMR, shorter life expectancy, higher TFR, and a more rural or agrarian based economy.* ***Rule of 70 –*** *Formula to estimate the number of year it takes for exponential growth to double.* $$\textbf{Doubling Time} = \frac{\textbf{70}}{\textbf{growth rate (as \%)}}$$ ***Green Revolution*** *– the set of research technology transfer initiatives occurring between 1950 and the late 1960s, that increased agricultural production in parts of the world, beginning most markedly in the late 1960s. The initiatives resulted in the adoption of new technologies, including high-yielding varieties*

(HYVs) of cereals, especially dwarf wheat and rice. It was associated with chemical fertilizers, agrochemicals, and controlled water-supply (usually involving irrigation) and newer methods of cultivation, including mechanization.

Genetically Modified Organisms (GMO) *– any organism whose genetic material has been altered using genetic engineering techniques. The exact definition of a genetically modified organism and what constitutes genetic engineering varies, with the most common being an organism altered in a way that "does not occur naturally by mating and/or natural recombination".*

Irrigation – *the artificial process of applying controlled amounts of water to land to assist in the production of crops,[1] but also to grow landscape plants and lawns, where it may be known as watering*

Waterlogging *– the saturation of soil with water.[1] Soil may be regarded as waterlogged when it is nearly saturated with water much of the time such that its air phase is restricted and anaerobic conditions prevail.*



Soil Salinization *– the process of increasing the salt content is known as salinization*

Aquifers *– an underground layer of water-bearing permeable rock, rock fractures or unconsolidated materials (gravel, sand, or silt).*

Concentrated Animal Feeding Operation (CAFO) *– **a**s defined by the United States Department of Agriculture (USDA), is an intensive animal feeding operation (AFO) in which over 1,000 animal units are confined for over 45 days a year.*

Feedlot *- a type of animal feeding operation (AFO) which is used in intensive animal farming, notably beef cattle, but also swine, horses, sheep, turkeys, chickens or ducks, prior to slaughter.*

Free Range Grazing – *denotes a method of farming husbandry where the animals, for at least part of the day, can roam freely outdoors, rather than being confined in an enclosure for 24 hours each day.*

Overgrazing *– occurs when plants are exposed to intensive grazing for extended periods of time, or without sufficient recovery periods.*

Desertification *– a type of land degradation in drylands in which biological productivity is lost due to natural processes or induced by human activities whereby fertile areas become increasingly arid.*

Overfishing *– the removal of a species of fish from a body of water at a rate that the species cannot replenish, resulting in those species becoming underpopulated in that area.*

No-Till Agriculture *– Avoiding or refraining from tilling, or mixing up the soil and remnants of last years crops. Instead new crops are planted in the remnants of previous years. This prevents soil from being tilled, compacted, and left exposed.*

Strip Cropping *- a method of farming which involves cultivating a field partitioned into long, narrow strips which are alternated in a crop rotation system.*

Monoculture – *growth a single crop or animal that often results in the increased need for fertilizers, pesticides, or antibiotics.*

Contour plowing – *plowing or disturbing the land for planting in such a way that it follows the natural shape of the land instead of against it.*

Windbreaks/Agroforestry- *planting a row of bushes or trees on the periphery of a field to block winds and prevent soil erosion. May also be a habitat for natural predators to prevent pests.*

Perennial crops – *crops that are able to return year after year without replanting, plowing, or pesticides. They cover soil year round to prevent erosion.*

Terracing – *making a series of cuts or steps in a hill so that water used for crops "spills" over onto the next step, preventing soil erosion. Most often used with water heavy crops such as rice.*

Crop Rotation *- the practice of growing a series of different types of crops in the same area across a sequence of growing seasons.*

Bycatch –

Aquaculture *- also known as aquafarming, is the controlled cultivation ("farming") of aquatic organisms such as fish, crustaceans, mollusks, algae and other organisms of value such as aquatic plants (e.g. lotus).*

Pesticide - The Food and Agriculture Organization (FAO) has defined *pesticide* as:
any substance or mixture of substances intended for preventing, destroying, or controlling any pest, including vectors of human or animal disease, unwanted species of plants or animals, causing harm during or otherwise interfering with the production, processing, storage, transport, or marketing of food, agricultural commodities, wood and wood products or animal feedstuffs, or substances that may be administered to animals for the control of insects, arachnids, or other pests in or on their bodies.
Broad Spectrum (pesticide) – pesticide that targets groups of species or organisms that are harmful to plants (often unintentionally harm other species including pest predators)
Narrow spectrum (pesticide) – pesticide that targets only a specific species or family of pest
Persistence (pesticide) – describes the length of time that a pesticide remains in the environment without chemically breaking down. Often expressed in terms of half life.
Pesticide Resistance (Pesticide Treadmill) - describes the decreased susceptibility of a pest population to a pesticide that was previously effective at controlling the pest. Pest species evolve pesticide resistance via natural selection: the most resistant specimens survive and pass on their acquired heritable changes traits to their offspring.

Related Vocabulary

Stages of DTM: Stage 1 – Preindustrial Stage 2 – Early Industrial Stage 3 – Industrial Stage 4 – Post Industrial Stage 5 - ??	Child mortality rate Gross Domestic Product (GDP) Life Expectancy	Ogallala Aquifer Herbicide insecticide fungicide rodenticide pesticide drift bioaccumulation half life