



Growing Minds In Science

Debra Kearney
Melissa Bigge



Magnet Scramble

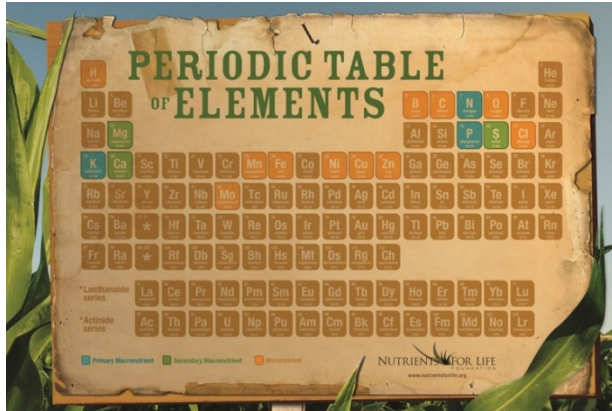
- 3 minutes!
- Create two sentences using the words on the magnet to create sentences about soil science or food production.
- Then get in pairs and share!



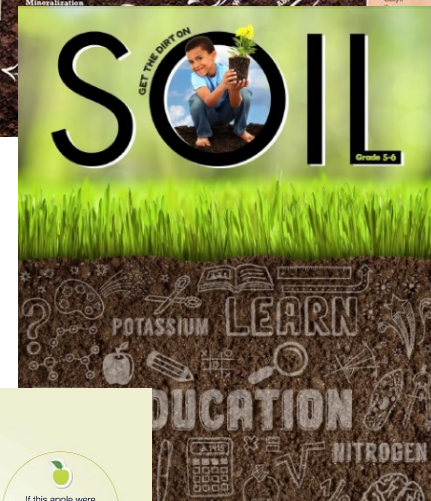
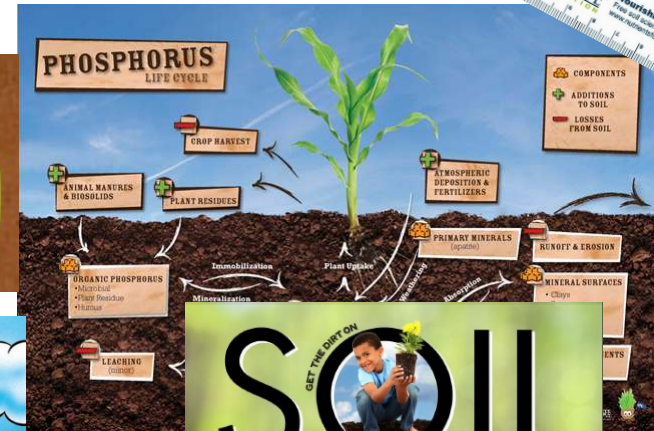
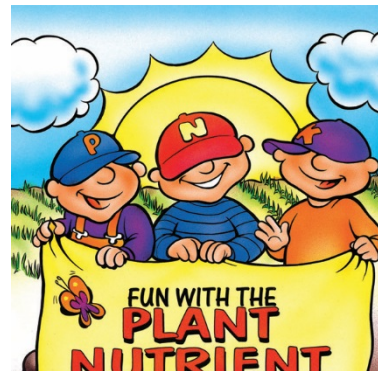
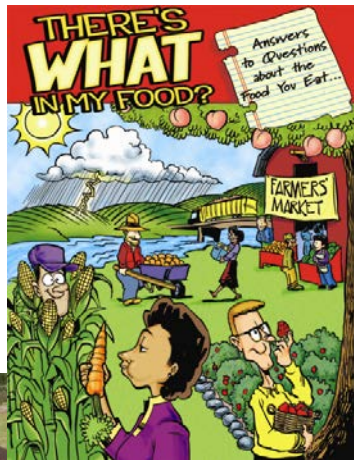


- Who are we?
 - A Foundation with a goal to provide science-based information to help educate people about the benefits of fertilizer.
- With whom do we partner?
 - International Plant Nutrition Institute
 - Smithsonian Institution
 - The Fertilizer Institute
 - Discovery Education

Educational Resources & Materials



organisms	human	plants	elements	diet	plant	agriculture
nutrients	help	what	the	land	properties	increases
need	food	you	require	healthy	improve	world
growing	in	vegetables	desired	soil	they	nourishment
product	used	yield	the	best	production	food
is	nitrogen				crops	product
biology	a	cycle			to	plants
through					the	soil
soybeans	air				release	building
use	micro	provide	century	farmers	ingredients	organic
contain	in	phosphorus	potassium	macro	essential	fertilizer
right	more	we	planet	growing	air	population
demand	primary	air	time	season	can	be
remove	place	rate	water	from	soil	red



From the Ground Up: The Science of Soil

- Six interactive lesson plans
- Six educational videos highlighting soil science
- Teacher Toolkit
- Five family activities (both English and Spanish)
- Four career connection profiles
- Exploring Plant Nutrients Interactive Tool
- Not All Soils Are Created Equal Interactive Tool

www.thescienceofsoil.com

FROM THE GROUND UP
THE SCIENCE OF SOIL

NUTRIENT FOR LIFE
EDUCATION

Discovery
EDUCATION

SEARCH

SHARE [f](#) [t](#)

[Home](#) [Teacher Resources](#) [Family Resources](#) [Career Connection](#)

Interactive LESSON PLANS
Looking for ways to make science relevant for your students? Plant the seeds of curiosity with six interactive lesson plans, engaging videos, and more on the science of soil.

[Get Started](#)

From the Ground Up: The Science of Soil Highlighting...

WATCH TEACHERS TURN CLASSROOMS INTO LABS
See how educators are turning their classrooms into a virtual lab by integrating new interactive life-science lesson plans into their middle school curriculum.

INTERACTIVE LESSON PLANS
Turn your classroom into a virtual lab with interactive lesson plans designed to engage varied learners, enhance digital literacy, and increase overall retention of core concepts by bringing science to life.

[Choose Lesson Plan](#)

[GET STARTED](#)

FAMILY ACTIVITIES [In English & Español](#)

NEW! **Our Food Supply**
Learn how your family's food gets from farm to fork. The food-supply chain has many necessary steps to provide food for

CAREER CONNECTION
SPOTLIGHT ON AGRONOMY

SIGN UP FOR UPDATES

NOT ALL SOILS ARE CREATED EQUAL
Soils are the foundations on which we build everything in our lives, but not all soils are created equal! Learn more about the different soil across the US.

NOT ALL SOILS ARE CREATED EQUAL
COMING SOON!

EXPLORING PLANT NUTRIENTS
Plants, like people, require nutrients to grow. See if you can find the right mix of water, air, and nutrients to nurse this plant back to health!

[Download Handout \[PDF\]](#) [START](#)



Lesson 1

Engage

In Search of Essential Nutrients



PERIODIC TABLE OF ELEMENTS

PERIODIC TABLE																		2 He helium 4.0026			
OF ELEMENTS																					
1 H hydrogen 1.0079																	2 He helium 4.0026				
3 Li lithium 6.941	4 Be beryllium 9.0122															5 B boron 10.811	6 C carbon 12.011	7 N nitrogen 14.007	8 O oxygen 15.999	9 F fluorine 18.998	10 Ne neon 20.180
11 Na sodium 22.990	12 Mg magnesium 24.305															13 Al aluminum 26.982	14 Si silicon 28.086	15 P phosphorus 30.974	16 S sulfur 32.065	17 Cl chlorine 35.453	18 Ar argon 39.948
19 K potassium 39.098	20 Ca calcium 40.078	21 Sc scandium 44.956	22 Ti titanium 47.867	23 V vanadium 50.942	24 Cr chromium 51.996	25 Mn manganese 54.938	26 Fe iron 55.845	27 Co cobalt 58.933	28 Ni nickel 58.693	29 Cu copper 63.546	30 Zn zinc 65.38	31 Ga gallium 69.723	32 Ge germanium 72.61	33 As arsenic 74.922	34 Se selenium 78.96	35 Br bromine 79.904	36 Kr krypton 83.80				
37 Rb rubidium 85.468	38 Sr strontium 87.62	39 Y yttrium 88.906	40 Zr zirconium 91.224	41 Nb niobium 92.906	42 Mo molybdenum 95.94	43 Tc technetium [98]	44 Ru ruthenium 101.07	45 Rh rhodium 102.91	46 Pd palladium 106.42	47 Ag silver 107.87	48 Cd cadmium 112.41	49 In indium 114.82	50 Sn tin 118.71	51 Sb antimony 121.76	52 Te tellurium 127.60	53 I iodine 126.90	54 Xe xenon 131.29				
55 Cs cesium 132.91	56 Ba barium 137.33	57-71 *	72 Hf hafnium 178.49	73 Ta tantalum 180.95	74 W tungsten 183.84	75 Re rhenium 186.21	76 Os osmium 190.23	77 Ir iridium 192.22	78 Pt platinum 195.08	79 Au gold 196.97	80 Hg mercury 200.59	81 Tl thallium 204.38	82 Pb lead 207.2	83 Bi bismuth 208.98	84 Po polonium [209]	85 At astatine [210]	86 Rn radon [222]				
87 Fr francium [223]	88 Ra radium [226]	89-103 *	104 Rf rutherfordium [261]	105 Db dubnium [262]	106 Sg seaborgium [266]	107 Bh bohrium [264]	108 Hs hassium [269]	109 Mt meitnerium [268]	110 Ds darmstadtium [271]	111 Rg roentgenium [272]	112 Ch copernicium [277]										
* Lanthanaide series			57 La lanthanum 138.91	58 Ce cerium 140.12	59 Pr praseodymium 140.91	60 Nd neodymium 144.24	61 Pm promethium [145]	62 Sm samarium 150.36	63 Eu europium 151.96	64 Gd gadolinium 157.25	65 Tb terbium 158.93	66 Dy dysprosium 162.50	67 Ho holmium 164.93	68 Er erbium 167.26	69 Tm thulium 168.93	70 Yb ytterbium 173.04	71 Lu lutetium 174.97				
* Actinide series			89 Ac actinium [227]	90 Th thorium 232.04	91 Pa protactinium 231.04	92 U uranium 238.03	93 Np neptunium [237]	94 Pu plutonium [244]	95 Am americium [243]	96 Cm curium [247]	97 Bk berkelium [247]	98 Cf californium [251]	99 Es einsteinium [252]	100 Fm fermium [257]	101 Md mendelevium [258]	102 No nobelium [259]	103 Lr lawrencium [262]				

Primary Macronutrient

Secondary Macronutrient

Micronutrient

NUTRIENTS FOR LIFE
FOUNDATION

www.nutrientsforlife.org

PERIODIC TABLE OF ELEMENTS

PERIODIC TABLE																		2			
OF ELEMENTS																		He			
1																	2				
H																	He				
hydrogen																	helium				
1.008																	4.002				
3	4															5	6	7	8	9	10
Li	Be															B	C	N	O	F	Ne
lithium	beryllium															boron	carbon	nitrogen	oxygen	fluorine	neon
6.941	9.012															10.811	12.011	14.007	15.999	18.998	20.180
11	12															13	14	15	16	17	18
Na	Mg															Al	Si	P	S	Cl	Ar
sodium	magnesium															aluminum	silicon	phosphorus	sulfur	chlorine	argon
22.990	24.305															26.982	28.086	30.974	32.06	35.45	39.948
19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36				
K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	Ge	As	Se	Br	Kr				
potassium	calcium	scandium	titanium	vanadium	chromium	manganese	iron	cobalt	nickel	copper	zinc	gallium	germanium	arsenic	selenium	bromine	krypton				
39.098	40.078	44.956	47.867	50.942	51.996	54.938	55.845	58.933	58.693	63.546	65.38	69.723	72.61	74.922	78.96	79.904	83.80				
37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54				
Rb	Sr	Y	Zr	Nb	Mo	Tc	Ru	Rh	Pd	Ag	Cd	In	Sn	Sb	Te	I	Xe				
rubidium	strontium	yttrium	zirconium	niobium	molybdenum	technetium	ruthenium	rhodium	palladium	silver	cadmium	indium	tin	antimony	tellurium	iodine	xenon				
85.468	87.62	88.906	91.224	92.906	95.94	[98]	101.07	102.91	106.42	107.87	112.41	114.82	118.71	121.76	127.6	126.90	131.29				
55	56	57-71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86				
Cs	Ba	*	Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg	Tl	Pb	Bi	Po	At	Rn				
cesium	barium		hafnium	tantalum	tungsten	rhenium	osmium	iridium	platinum	gold	mercury	thallium	lead	bismuth	polonium	astatine	radon				
132.91	137.33		178.49	180.95	183.84	186.21	190.23	192.22	195.08	196.97	200.59	204.38	207.2	208.98	[209]	[210]	[222]				
87	88	89-103	104	105	106	107	108	109	110	111	112										
Fr	Ra	*	Rf	Db	Sg	Bh	Hs	Mt	Ds	Rg	Ch										
francium	radium		rutherfordium	dubnium	seaborgium	bohrium	hassium	meitnerium	darmstadtium	roentgenium	copernicium										
[223]	[226]		[261]	[262]	[266]	[264]	[265]	[268]	[271]	[272]	[277]										
* Lanthanaide series			57	58	59	60	61	62	63	64	65	66	67	68	69	70	71				
			La	Ce	Pr	Nd	Pm	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu				
			lanthanum	cerium	praseodymium	neodymium	promethium	samarium	europium	gadolinium	terbium	dysprosium	holmium	erbium	thulium	ytterbium	lutetium				
			138.91	140.12	140.91	144.24	[145]	150.36	151.96	157.25	158.93	162.50	164.93	167.26	168.93	173.04	174.97				
* Actinide series			89	90	91	92	93	94	95	96	97	98	99	100	101	102	103				
			Ac	Th	Pa	U	Np	Pu	Am	Cm	Bk	Cf	Es	Fm	Md	No	Lr				
			actinium	thorium	protactinium	uranium	neptunium	plutonium	americium	curium	berkelium	californium	einsteinium	fermium	mendelevium	nobelium	lawrencium				
			[227]	232.04	231.04	238.03	[237]	[244]	[243]	[247]	[247]	[251]	[252]	[257]	[258]	[259]	[262]				

* Lanthanide series

* Actinide series

■ Primary Macronutrient
 ■ Secondary Macronutrient
 ■ Micronutrient

NUTRIENTS FOR LIFE
FOUNDATION

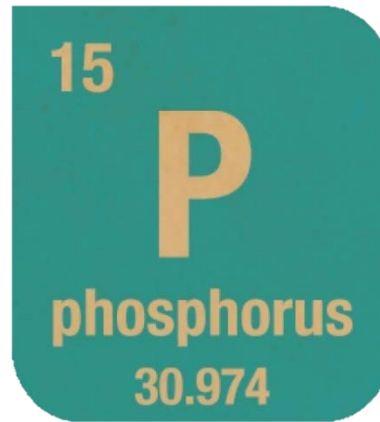
www.nutrientsforlife.org

What are the basic nutrients?

Nitrogen



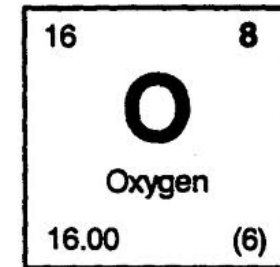
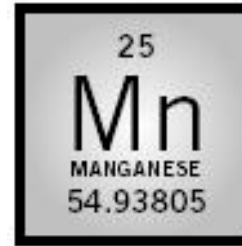
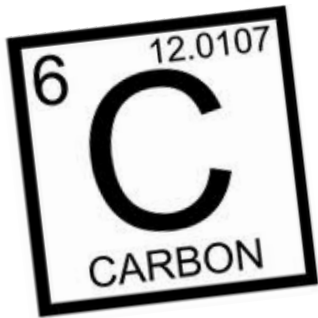
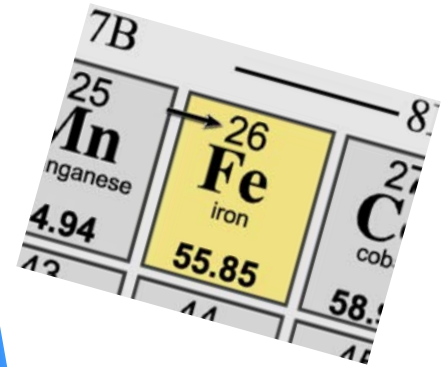
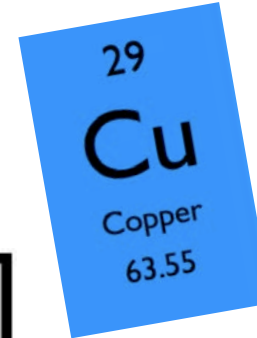
Phosphorus



Potassium

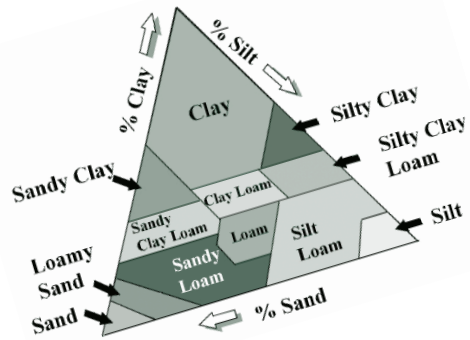


Essential Nutrients



Lesson 2

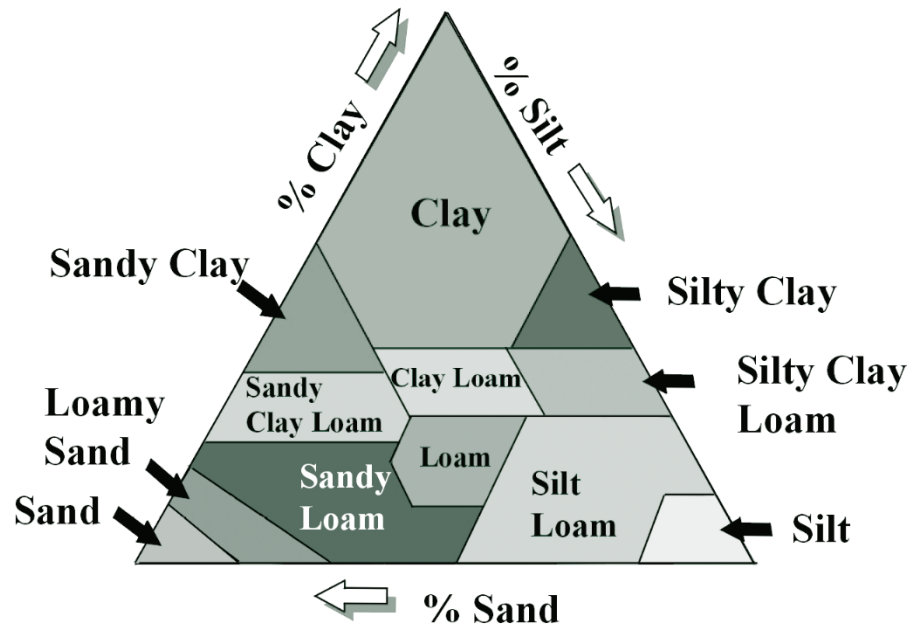
Explore



Properties of Soil

- Observe the soil in the bottles
- What do you notice?
- What is different?







Lesson 3

Explain

Plant – Soil Interactions



Students investigate the mechanism by which roots obtain nutrients from the soil.

Students describe what they can see and then explore how the plants use each part of the roots.

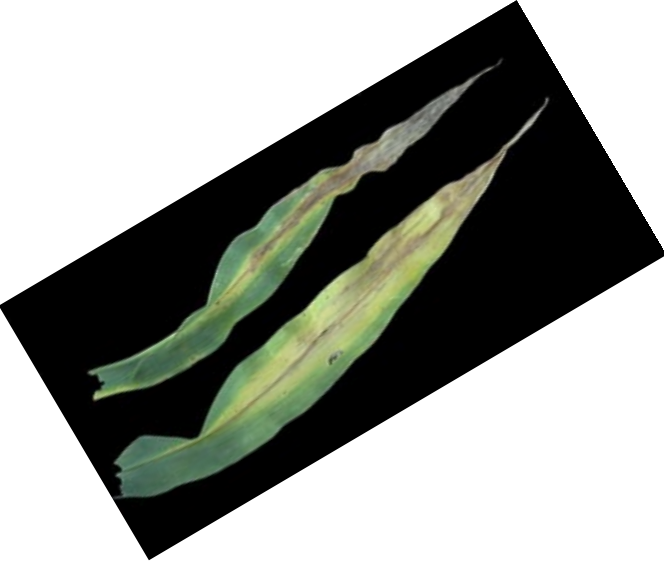


- **LESSON 3: PLANT SOIL INTERACTIONS**

Actual plant roots are examined and analyzed in lesson three. The diffusion process used by roots to absorb nutrients, and the transport of water through the xylem are demonstrated in visual lab activities.

Students also learn about soil horizons and the formation of soil. Then, students investigate the Great Dust Bowl.





Lesson 4

Elaborate

Plant Nutrient Deficiencies



Corn Case Study 2

Primary Information

The farmer reports that the plants are stunted. Her corn grows in sandy soil. Some weeds are present in the fields. She provided the following photograph, which shows some yellowing of leaves.



Corn Case Study 2

Secondary Information

The farmer sent this additional photograph of a leaf from an affected plant. She also reports that some of her plants have stems that aren't strong enough to support the ears of corn.



Nutrient Deficiencies of Corn

Potassium Deficiency

Plants that lack potassium show stunted growth and mature later than normal plants. Potassium deficiency results in yellowing and drying of the leaf edges, especially on older leaves. The death of cells in the leaves may be visible as a dark discoloration. The stems of potassium-deficient plants are weak and often break below the ears.

Potassium deficiencies happen most often in soils that are sandy, wet, or compacted (dense) or when potassium has been removed through repeated cropping and natural levels are low. Restoring potassium to the soil will help the plants better absorb water and prevent wilting and dry leaves.



The older leaves of potassium-deficient corn plants yellow and die around the edges (a), while areas of cell death on leaves may appear as dark spots (b).

- **LESSON 4: PLANT NUTRIENT DEFICIENCIES**

Students discuss the need to restore nutrient balance in the soil to maintain healthy plants in lesson four. In the main activity, students assume the roles of plant doctors and diagnose nutrient deficiencies in crop plants. Teachers have the option of conducting this activity through an interactive Internet program, or through reference manuals in the classroom.

High School Edition: Students also use EDTA to observe the physical manifestation of a plant calcium deficiency.





Lesson 5

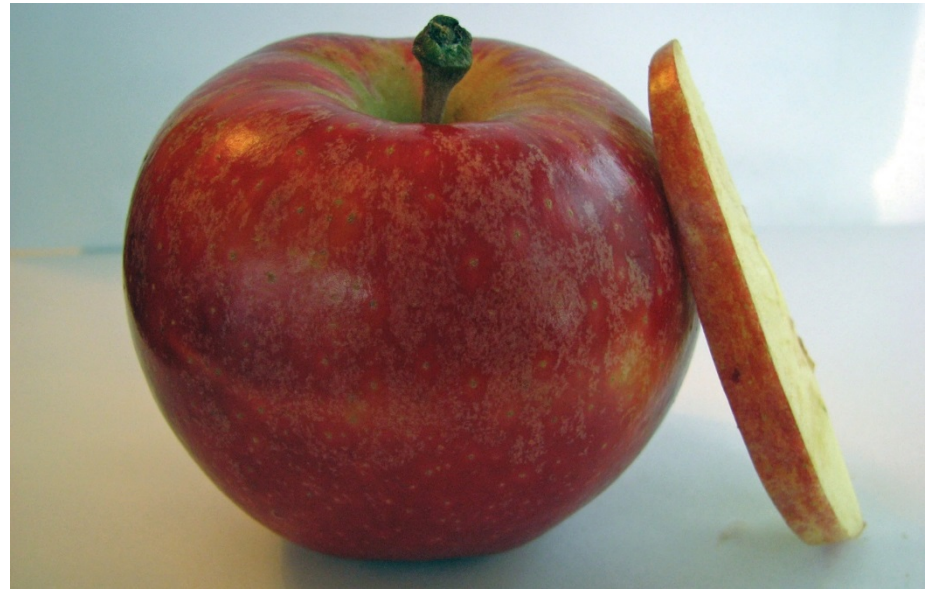
Explain-Elaborate

Fertilizers And The Environment



Discussion: If a billion acres of extra farmland are needed to feed the world's population, from where should it come? What are you willing to sacrifice?

The Apple Activity



- **LESSON 5: FERTILIZERS AND THE ENVIRONMENT**

Lesson five bridges science to social issues. Students use estimates of population growth and land use to calculate how much additional farmland will be needed in the future to feed the growing world population. Students investigate the advantages and disadvantages of using organic and inorganic fertilizers, as well as the role of nutrient pollution and how to limit its negative affects.





Lesson 6

Evaluate

Nourishing the Planet

In the 21st Century

-As an Expert make 3 recommendations



- **LESSON 6: NOURISHING THE PLANET IN THE 21ST CENTURY**

In this concluding lesson, students discuss what challenges must be met in order to feed the world's population in 2050.

Students then analyze a list of 10 recommendations about farming and select the three that they feel are most important based on what they have learned about soil, plant growth and plant nutrients through a class discussion and debate.



Pre-test and Post-test Assessment

- For high school and middle school lessons, pre- and post-test are available for download at

<http://www.nutrientsforlife.org/teachers/curriculum/lessons/1>



dkearney@nutrientsforlife.org

MBigge@nutrientsforlife.org

