Farm/Garden/Lawn

* Fertilizer
	+ NPK fertilizer contains Nitrogen, Phosphorus and potassium (Kalium in Latin)
		- Nitrogen, normally as NH3, or NH4+ like in NH4NO3, is used to form amino acids to build proteins; alternative is to plant legumes, whose roots harbor rhizobium bacteria which use nitrogenase to convert N2, H+, H2O, and ATP into NH3, H2, ADP, and phosphate
		- Phosphorus from phosphates in bone, fish, and bird guano (droppings) used by plants to make ADP, ATP, and nucleotides (for DNA and RNA)
		- Potassium (K) is needed to prevent water loss and transport particles across membranes (ie. H+ transport by mitochondria to make ATP)
	+ Micronutrient plant minerals: cofactors in plant enzymes
		- Ca from CaO (lime) or CaCO3 (limestone) or CaSO4 (gypsum); like K is needed to transport particles across membranes; gypsum helps soil retain water if it contains salt (NaCl), which tends to desiccate (dehydrate) it
		- Mg needed to make chlorophyll for photosynthesis, obtained from magnesite and dolomite deposits
		- S (sulfur) needed for making amino acid cysteine contained in some proteins; obtained mostly from removing sulfur from natural gas and petroleum
* Pesticides and insect management
	+ DDT
		- First broad-spectrum pesticide discovered; first appeared to be a miracle chemical
		- Now is mostly banned because it is fat-soluble (liver toxin) and super stable (doesn’t break down in environment)
		- It bioaccumulates like mercury in fish
		- Interferes with Ca metabolism in birds; soft bones and fragile eggshells
		- Still allowed in malaria-ridden areas because of its effectiveness in killing mosquitos
	+ Currently pesticides are mostly phosphorous esters and carbamates
		- Phosphorus esters are anticholinesterases (milder than sarin but still toxic to humans) but they are biodegradable because bacteria don’t have nerves, and can safely consume them; breakdown products (phosphates) are good fertilizer
		- Carbamates are amides
			* Not as effective as phosphate esters but not as toxic to humans
			* Are very toxic to bees which are necessary for pollination of plants, however
* Organic pesticides
	+ Some extracted from plants which have evolved to protect themselves from insects
		- Example: pyrethrin extracted from chrysanthemum
			* Analogs of this found in Raid insecticides
			* Work on insects like anticholinesterases work in mammals
* Many of these are toxic to fish
	+ Another organic pesticide is diatomaceous earth (DE)
		- This is fossil remains of bodies of ancient microscopic shellfish
		- Acts like broken glass against insect skin
		- Food grade DE was originally from fresh-water shellfish; is edible by humans
* GMO insect control
	+ Some food crops genetically modified to produce pesticides
	+ Some insects genetically modified to be sterile; these mate with ordinary insects and produce no offspring
* Sex pheromones attract insects to poison
* Juvenile hormones keep insects from maturing so they will not be able to produce offspring
* Herbicides
	+ Defoliants like agent orange are toxic broad-spectrum plant killers; make plants lose leaves
		- Wipe out trees, plants, food crops, and sometimes people
		- Dioxin impurity in agent orange used as defoliant during Vietnam War proved to be carcinogenic and teratogenic
		- Paraquat defoliant sprayed on marijuana plants in past is very toxic to humans; damages liver, kidneys, and lungs
	+ Weed killers
		- Kill weeds but not trees or other plants
		- The most common weed killer is glyphosate found in Roundup
			* Glyphosate interferes with a plant’s ability to make 3 aromatic amino acids
			* Humans don’t make these amino acids (must get them in diet)
			* Because humans don’t make aromatic amino acids Monsanto claimed Roundup should be safe for humans to use
			* In spite of Monsanto’s claim glyphosate is a mild neurotoxin; crosses the blood-brain barrier and gets into brain
			* Glyphosate very water-soluble; rinse off fruits and vegetables before eating them
			* Some GMO crops are designed to be genetically resistant to glyphosate; these can be sprayed with Roundup without harming them
		- Organic weed killers exist
			* Clove oil, vinegar, fatty acids, and orange oil are examples
			* These are not as effective as glyphosate
		- Other commercial non-organic weed killers also exist which work differently than glyphosate
* Other issues
	+ Sustainability
		- Overuse of land to grow a single crop eventually exhausts the soil of the nutrients consumed by that crop; crop rotation helps minimize this
		- Overirrigation (excessive water usage) leaches minerals from soil, depletes the water table, and promotes algae growth in receiving bodies of water
			* Algae growth prevents oxygen from entering water
			* Deoxygenated water causes fish kills
			* Dead fish are consumed by very smelly anaerobic bacteria
		- Monoculture associated with GMO’s makes any pathogen which kills one plant kill of an entire crop of genetically-identical plants
			* Diversity is healthiest in plants, animals, and humans
			* The Irish potato famine in 1845 killed one million Irish people (from hunger) because potatoes in Ireland at the time were essentially a monoculture which was killed off by a potato blight fungus
	+ World hunger
		- Famines are routine in Africa and poor regions of the world
		- Poor people tend to have more children than more affluent people, and this exacerbates food shortages
		- World population is growing; this and climate change may cause food and water shortages
		- Agriculture is now the biggest overuser of water; this may lead to water scarcity, lack of water to grow crops, and food shortages
	+ Livestock
		- Consume far more resources than crops
		- Factory farms have feedlots than pack animals so close together that they can’t move (abusive)
		- Close-packed animals must eat where they defecate (unhealthy)
		- Close packing of animals facilitates animal disease epidemics
		- Monocultured (GMO) animals especially susceptible to epidemics
		- Overuse of antibiotics in factory-farmed animals leads to antibiotic-resistant bacteria (harmful to humans and resistant to antibiotics)
		- Antibiotic resistance usually not caused by evolution (too slow) but rather by plasmid exchange among bacteria
		- GMO technology requires growing bacteria with plasmids which contain antibiotic-resistant genes
		- Free-range farming is one solution to overcrowding in factory farms
		- Free-range farming makes animals more susceptible to predators
		- Free-range farming requires more scarce land than factory farming
		- Free-range farming is more resource intensive and less efficient than factory farming
		- Free-range food animals are more expensive than factory-farmed animals
	+ GMO’s
		- Claimed to produce more crops and animals per acre and make food more plentiful and cheaper than non-GMO species, but this claim is only partially true
			* In undeveloped countries use of GMO’s improved yields by up to 200%
				+ Upgrading to use GMO’s required upgrading other farming techniques already in use in developed countries, which improved yields independent of GMO use
				+ GMO availability enabled corporate entities to buy up land in undeveloped countries and outcompete local farmers
			* In developed countries yields improved by less than 20%
				+ Modern farming techniques required to use GMO’s which maximize yields already in use
				+ GMO’s which are used by corporate farms to control pests tend to also control pests in neighboring farms which don’t use GMO’s
		- Benefits
			* GMO’s do tend to reduce insect pest problems
			* In some undeveloped countries molds grow on crops which produce deadly mycotoxins; GMO’s seem to be able to solve this problem
			* Some, but not all, GMO’s use less resources and are cheaper to produce
			* Some crops can be designed to grow in places where climate doesn’t ordinarily allow them to be grown (ie. oranges in cold climates)
			* GMO foods can be designed to have higher nutritional value than wild foods
		- Problems
			* Although GMO foods seem to be safe for most people to consume, people with unusual medical conditions might be allergic to some of them
			* Insects and weeds are slowly developing resistance to GMO insecticides and herbicides
			* GMO’s tend to minimize genetic diversity in crops; monocultures are less robust than wild diverse crops (ie. Irish potato famine)
			* Unexpected toxicity can happen because plant biochemistry is very complicated (more so than animal biochemistry in many ways); most plants produce mutagens which are not mutagenic enough to be carcinogenic but unintended epigenetic modification of a plant genome might cause a plant to overproduce mutagens to the point where they become carcinogenic, for example
			* Allergenicity problems can occur if genes from something like peanuts or shellfish are incorporated into foods which are not ordinarily harmful to people who have deadly allergic responses to these other foods
			* Worsening of existing cancers; example: IGF (Insulin-like Growth Factor) in milk produced by transgenic cows can increase the growth rate of most common cancers
			* GMO’s can hasten the development of antibiotic-resistant bacteria because genetic editing is done using bacterial plasmids, and these plasmids have antibiotic resistance so that bacteria which do not have the plasmids containing the desired DNA modifications can be killed off with antibiotics which will not remove the bacteria containing plasmids containing the desired edited DNA; bacteria which escape into the environment exchange plasmids with wild bacteria and can thereby make these antibiotic-resistant and accordingly more dangerous to humans
		- Recommendations
			* Allow GMO’s to be sold and consumed but require that they be labelled
			* Carefully test organic foods for the presence of transgenes and make sure that they cannot be sold as “GMO free”
			* Continually test GMO foods for safety in every conceivable way
			* GMO foods should be cheaper than organic foods or the tech is pointless
				+ Let people decide for themselves whether the risks are worth the cost saving
				+ Nothing in life is completely risk-free; experience will eventually allow us to sort out the risks vs. benefits of various GMO foods