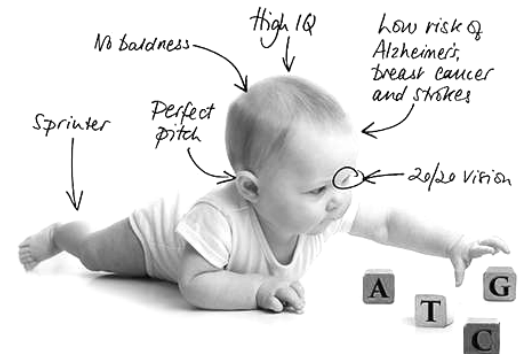
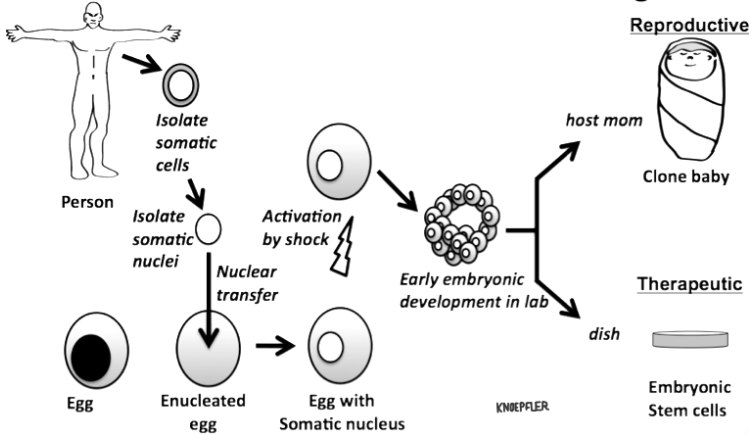


The two kinds of human cloning



From Sustainability to Biotechnology

A Cogitania Review of Applied Biochemistry Topics

Calories and Nutrition of Insects
Per 100 grams

Insect	Protein (g)	Fat (g)	Carbohydrate	Calcium (mg)	Iron (mg)	Calories
Giant Water Beetle	19.8	8.3	2.1	43.5	13.6	162.3
Red Ant	13.9	3.5	2.9	47.8	5.7	98.7
Silk Worm Pupae	9.6	5.6	2.3	41.7	1.8	98
Dung Beetle	17.2	4.3	0.2	30.9	7.7	108.3
Cricket	12.9	5.5	5.1	75.8	9.5	121.5
Grasshopper	20.6	6.1	3.9	35.2	5	152.9

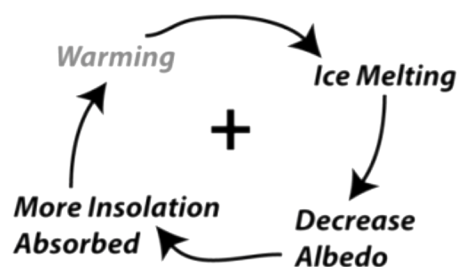
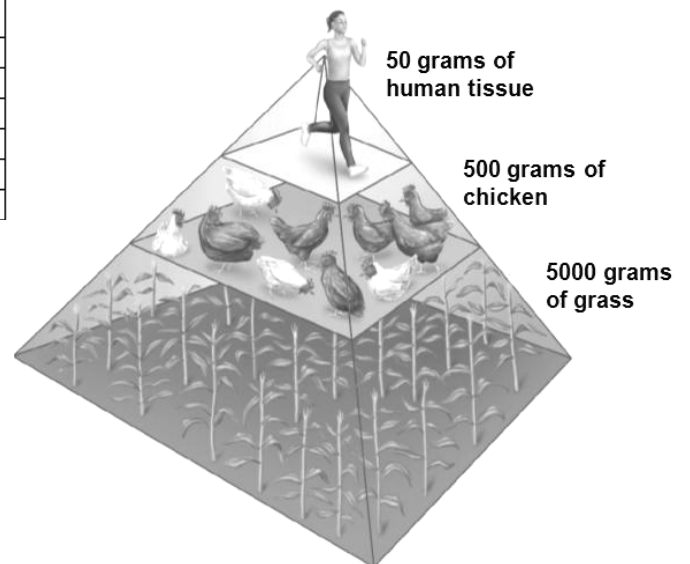


TABLE OF CONTENTS

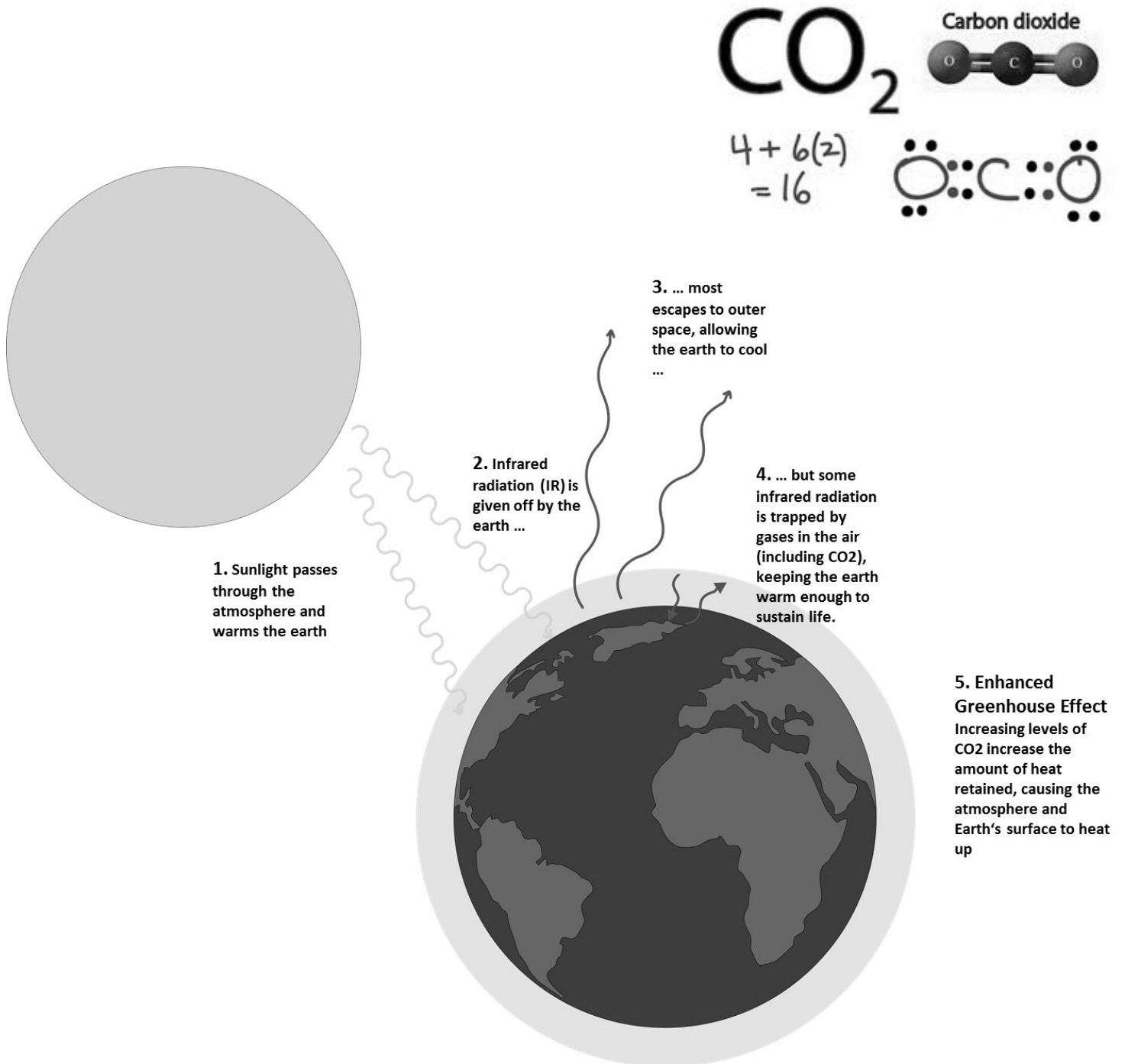
QUESTION	PAGE NUMBER
1 – How is global warming affecting the carbon cycle?	3
2 – How is widespread fertilizer use affecting the nitrogen cycle?	7
3 – How can we sustainably solve the problem of global malnourishment?	11
4 – How is atmospheric nitrogen used to make fertilizer?	15
5 – What are the ethical and political implications of emerging biotechnologies?	17
6 – How is a clone created and stimulated to develop into an organism?	20
7 – What makes a genetic disease a good candidate for gene therapy?	24
8 – How can viruses integrate genetic information into a host cell's genome?	27
9 – What might alien life look like, and where might we find it?	30

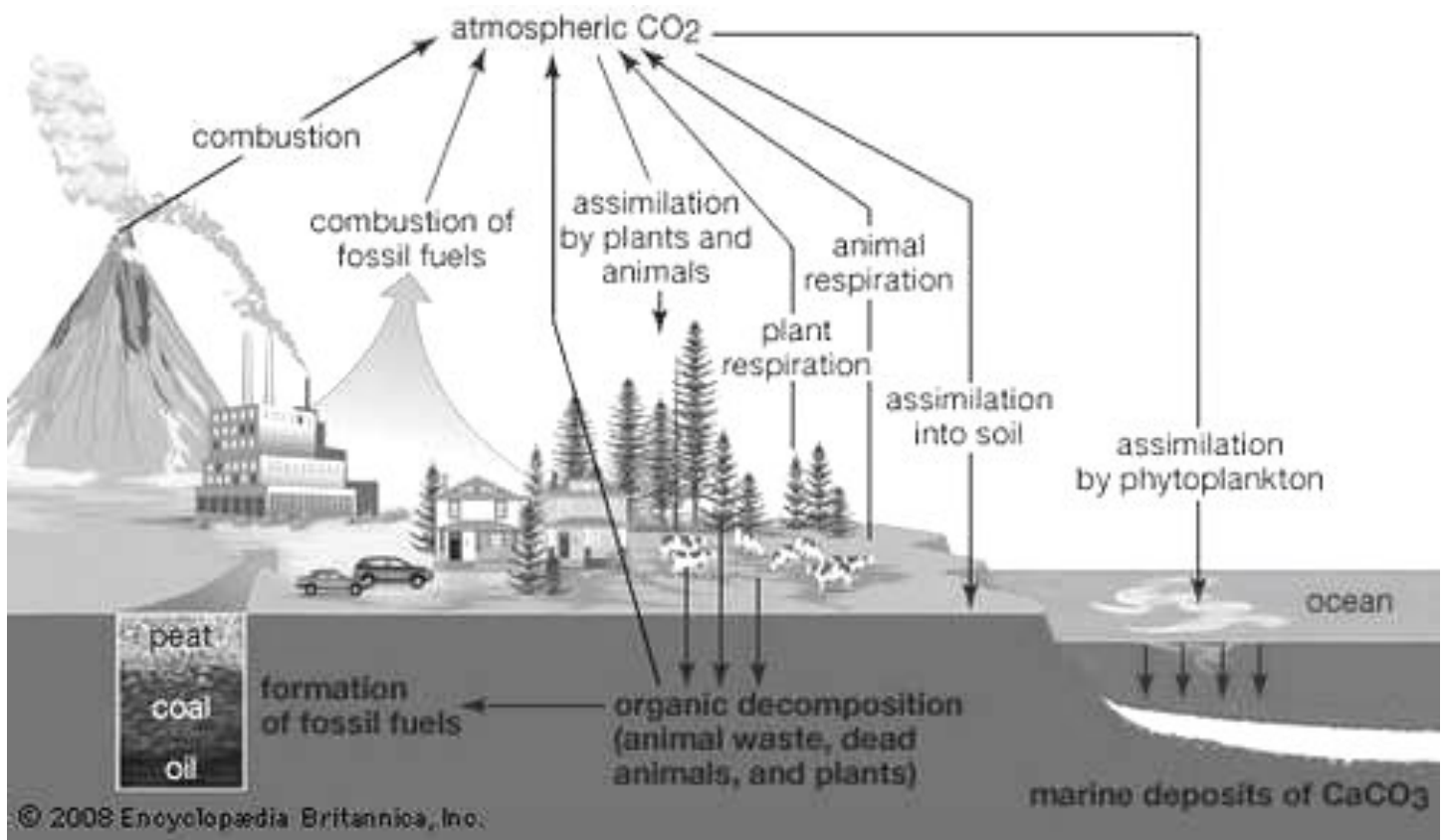
QUESTION 1: How is global warming affecting the carbon cycle?

VOCABULARY:

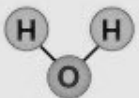
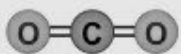
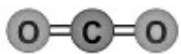
greenhouse effect insolation carbon dioxide infrared radiation double bond
decomposition calcium carbonate fossil fuels combustion carbonic acid ice cap. albedo
positive feedback deforestation soot permafrost tipping point "hothouse Earth"

DIAGRAMS:

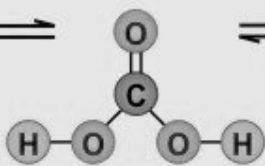




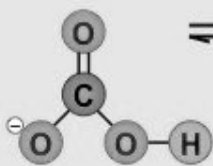
Atmospheric CO₂



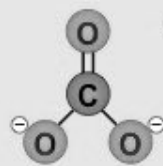
Aqueous CO₂
(in water)



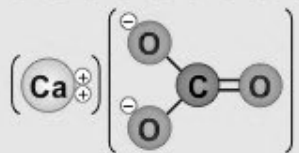
Carbonic Acid
(H₂CO₃)



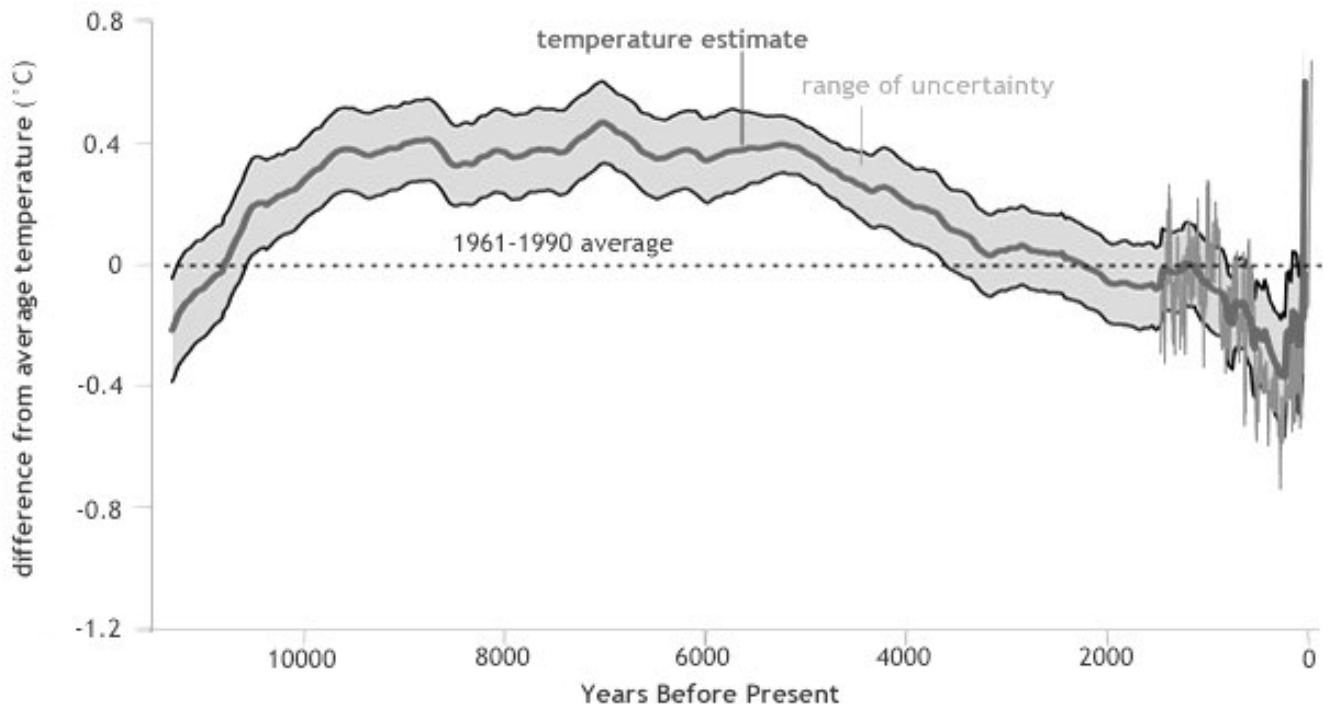
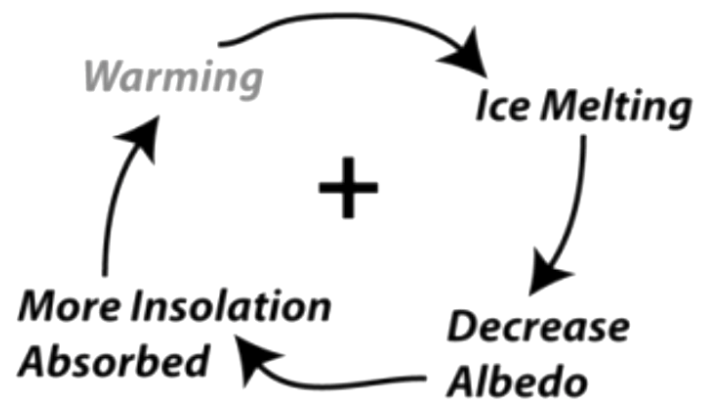
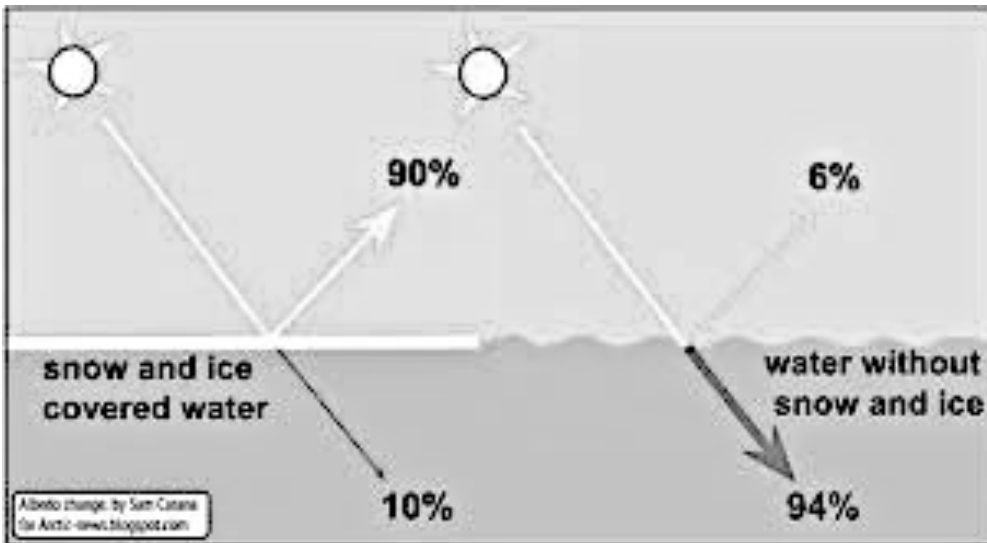
Bicarbonate
(HCO₃⁻)



Carbonate
(CO₃²⁻)



Calcium Carbonate
(CaCO₃)



GUIDING QUESTIONS:

- 1) Why does the presence of carbon dioxide in a planet's atmosphere have a warming effect?
- 2) How is carbon naturally cycled between Earth's atmosphere and materials beneath its surface?
- 3) Why might global warming be unstoppable if we don't quickly take action to reduce carbon emissions?

ADDITIONAL RESOURCES:

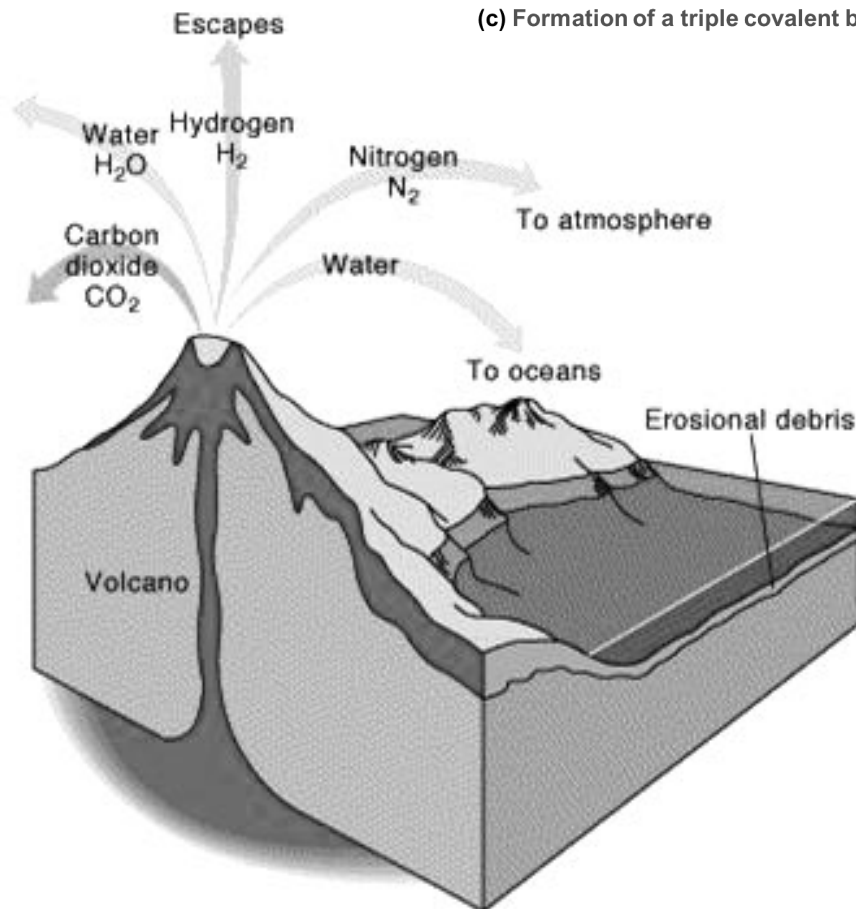
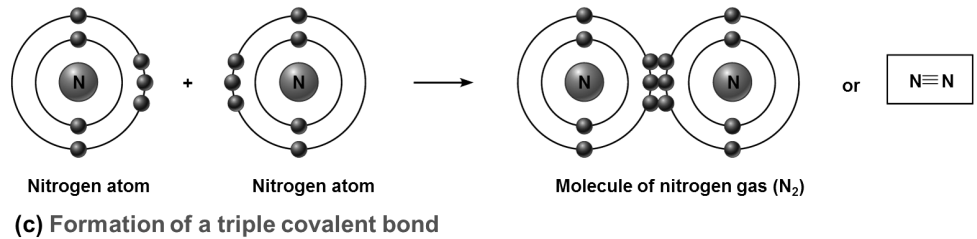
- "US and Saudi Arabia Blocking Regulation of Geoengineering, Sources Say" - Jonathan Watts, *TheGuardian.com*, 3/18/19
- "Great Strides for Carbon Capture Using Earth-Abundant Elements as Photocatalytic System" - *ScienceDaily.com*, 11/30/18
- "Coral Reef Experiment Shows: Acidification from Carbon Dioxide Slows Growth" - *ScienceDaily.com*, 3/14/18
- "Polar Vortex: How the Jet Stream and Climate Change Bring on Cold Snaps" - Bob Berwyn, *InsideClimateNews.org*, 2/2/2018
- "Transparent Solar Technology Represents 'Wave of the Future'" - *ScienceDaily.com*, 10/23/17

QUESTION 2: How is widespread fertilizer use affecting the nitrogen cycle?

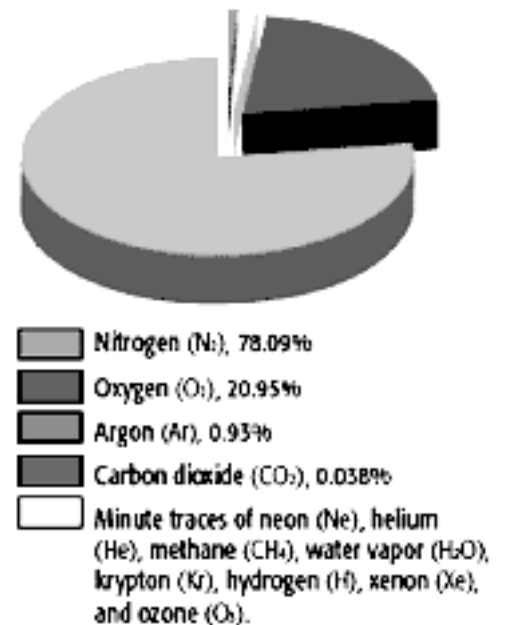
VOCABULARY:

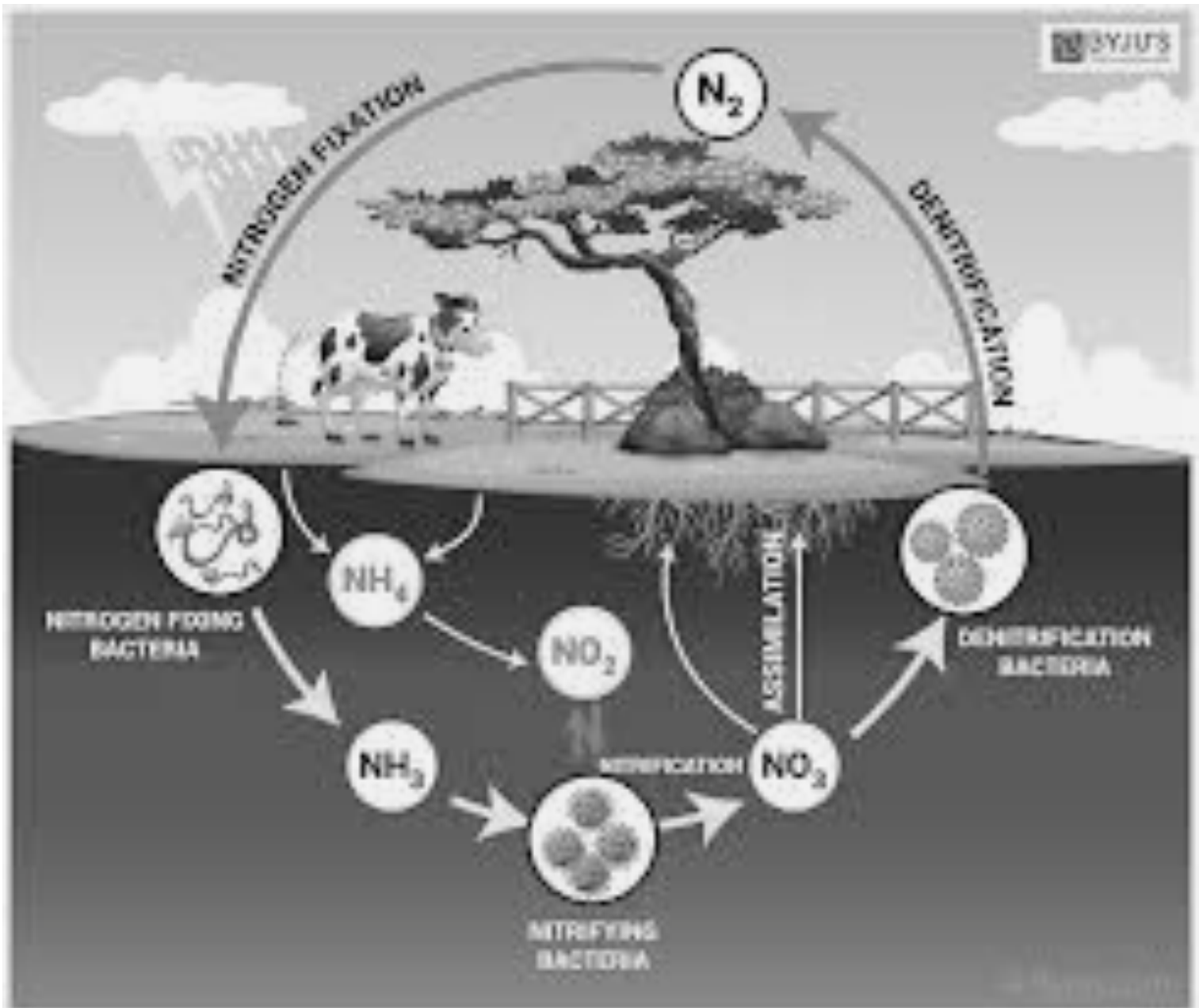
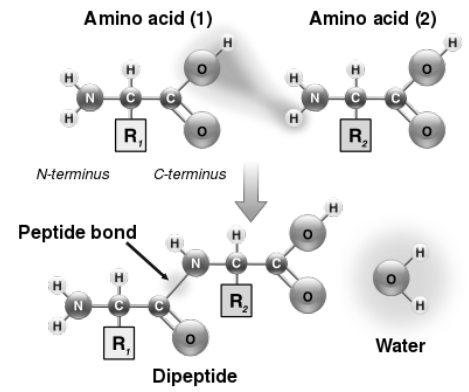
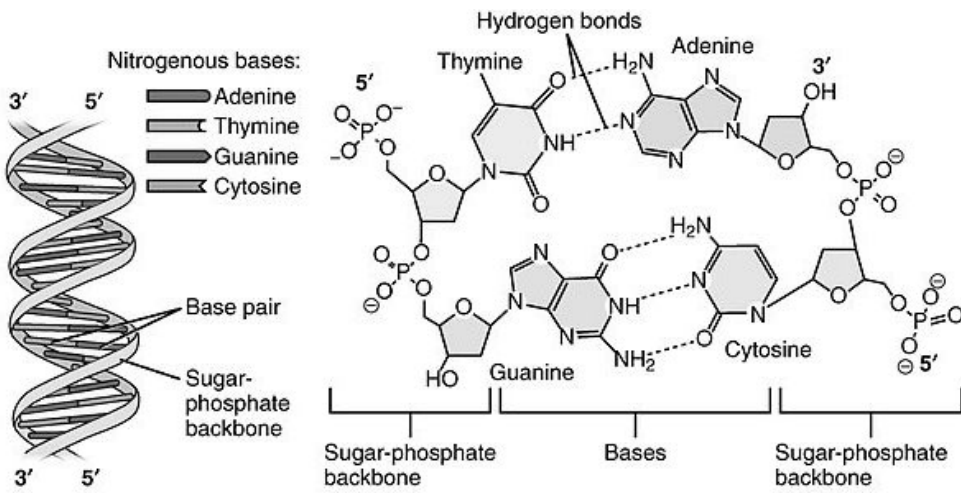
supernova outgassing atmospheric nitrogen triple bond nitrogenous base amino acid
 nitrogen fixation nitrogen-fixing bacteria nitrification nitrifying bacteria assimilation runoff
 denitrification algal bloom eutrophication oxygen depletion decomposition aerobic respiration

DIAGRAMS:



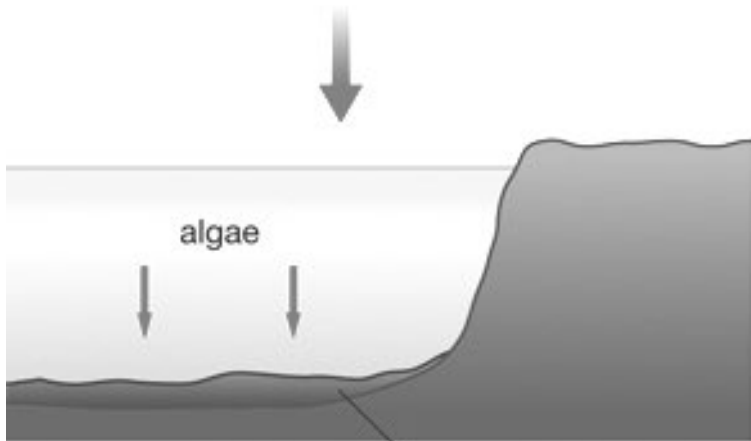
Atmospheric composition



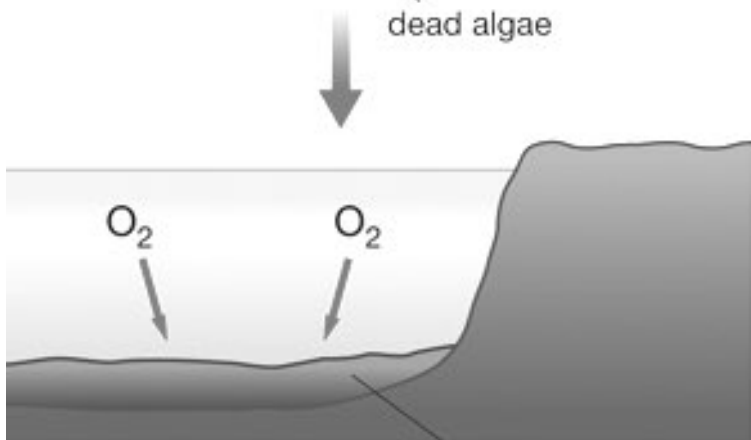




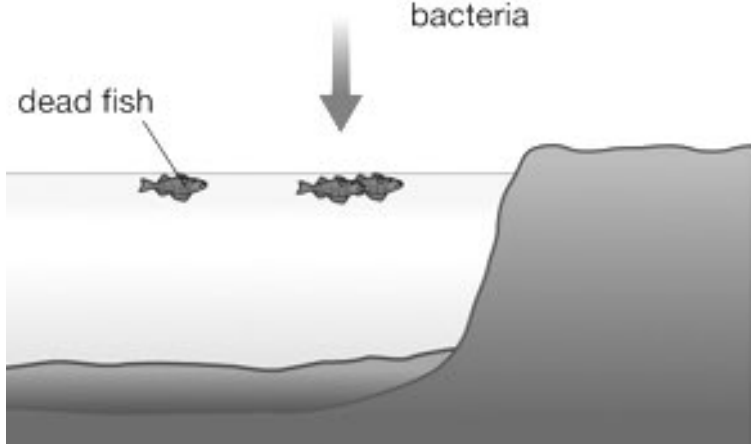
fertilisers from farm land or untreated sewage pollute the water



algae feed on the nutrients and grow rapidly. Many of the algae start to die and rot and fall to the bottom



bacteria on the river bed decomposes the algae, using up the oxygen in the water



animals cannot carry out respiration and start to die

GUIDING QUESTIONS:

- 1) Where did the nitrogen in Earth's atmosphere come from?
- 2) Why is nitrogen a gas except at very cold temperatures?
- 3) Why is access to nitrogen important to living things?
- 4) How do different bacteria enable plants and animals to access nitrogen?
- 5) How can the use of fertilizer to grow crops cause oxygen levels in nearby waterways to decrease?

ADDITIONAL RESOURCES:


- "Fertilizers, a Boon to Agriculture, Pose Growing Threat to U.S. Waterways" - Tatiana Schlossberg, *NYTimes.com*, 7/27/17
- "The Terrestrial Nitrogen Cycle" - *ScienceLearn.org.nz* (https://www.sciencelearn.org.nz/image_maps/14-the-terrestrial-nitrogen-cycle)

QUESTION 3: How can we sustainably solve the problem of global malnourishment?

VOCABULARY:

Thomas Malthus overpopulation carrying capacity erosion topsoil monoculture
 crop rotation biomass pyramid vertical farming drip irrigation artificial meat growth serum

DIAGRAMS:



"The power of population is so superior to the power of the Earth to produce subsistence for man, that premature death must in some shape or other visit the human race." —Thomas Malthus, 1798

"If the present growth trends in world population, industrialization, pollution, food production, and resource depletion continue unchanged, the limits to growth on this planet will be reached sometime within the next 100 years."
 —The Club of Rome think tank, 1972

Thomas Malthus

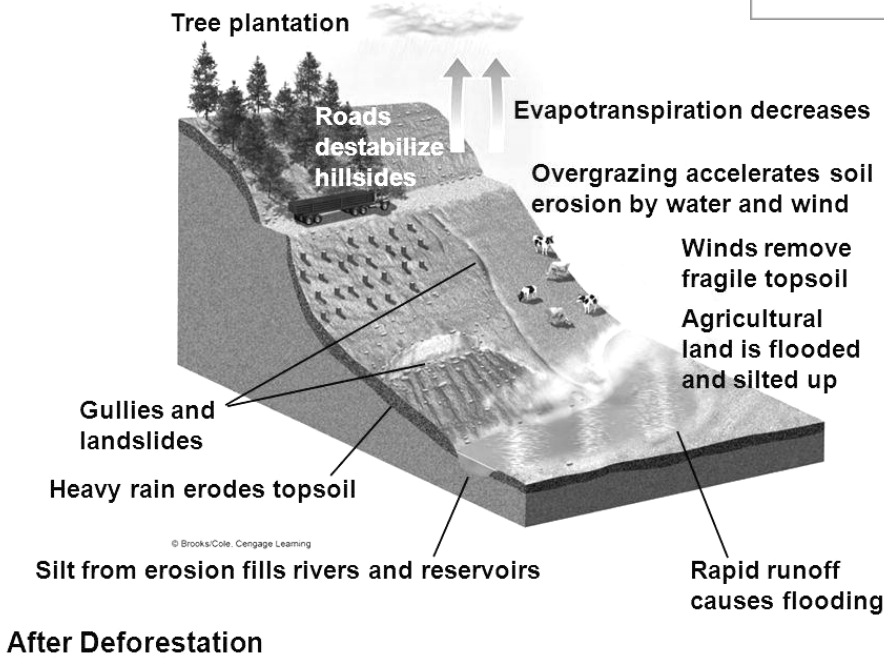
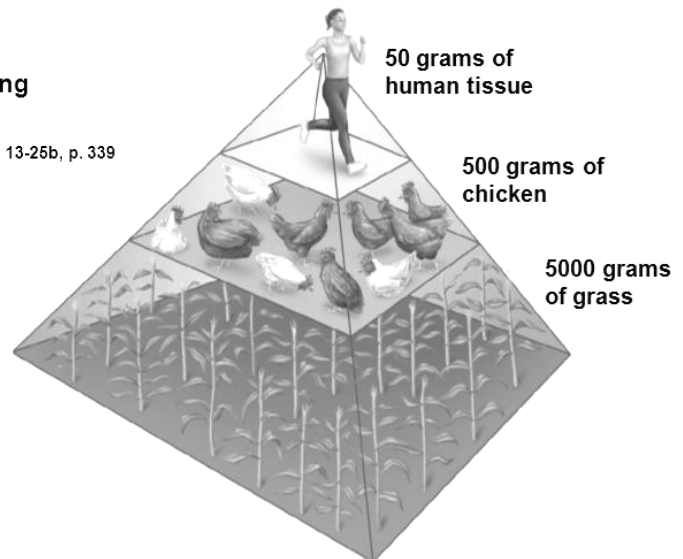


Fig. 13-25b, p. 339



Roughly **60 percent** of Utah's cropland is used to produce hay for livestock...



...and in Nevada, that figure is **90 percent.**



As much as **90 percent** of irrigated land in Montana is used to produce livestock feed.



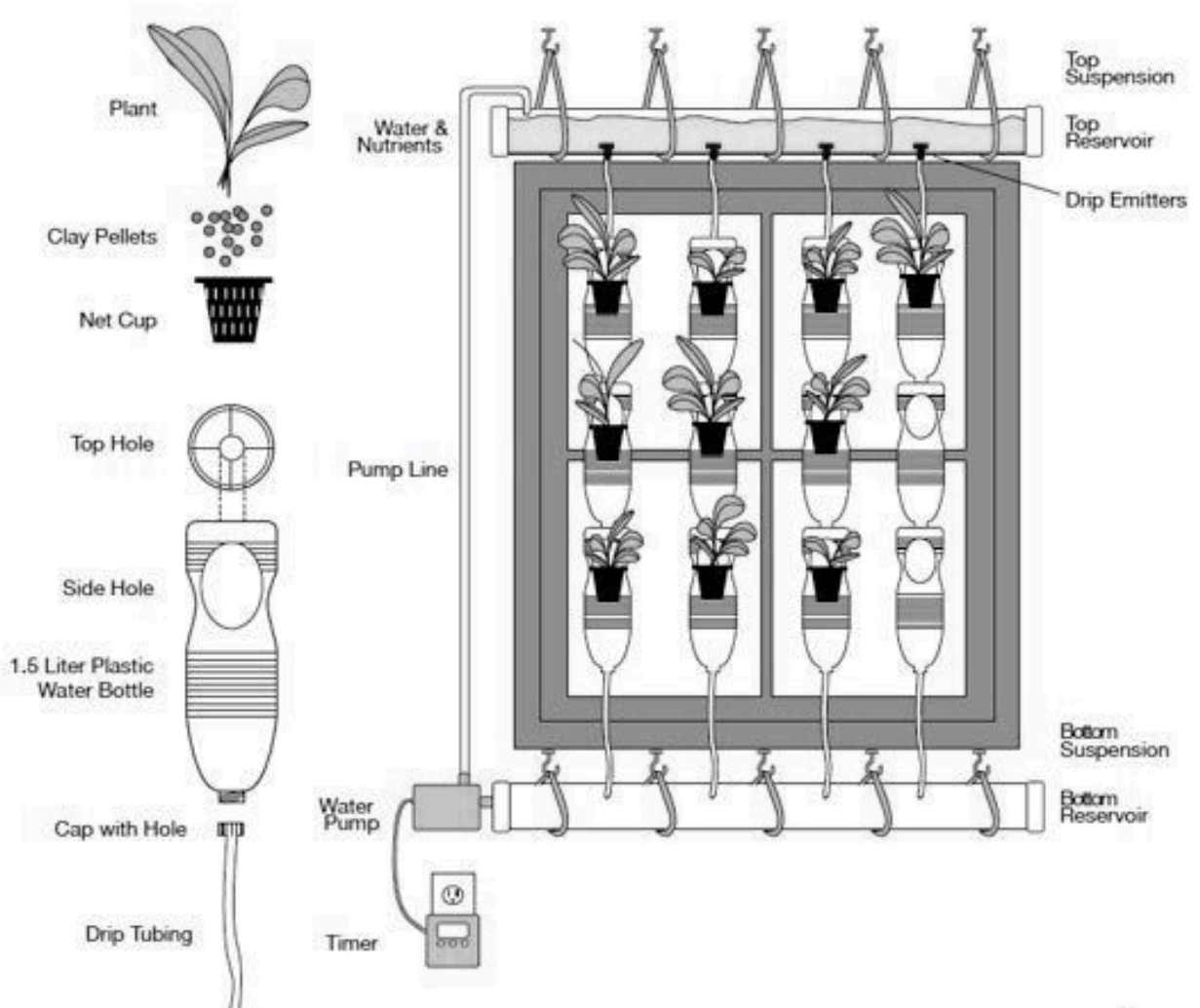
Livestock feed accounts for **half** of California's water usage.



Hay and alfalfa production in the West uses **ten times** more water than the region's cities and industries **combined.**



NEW REPUBLIC



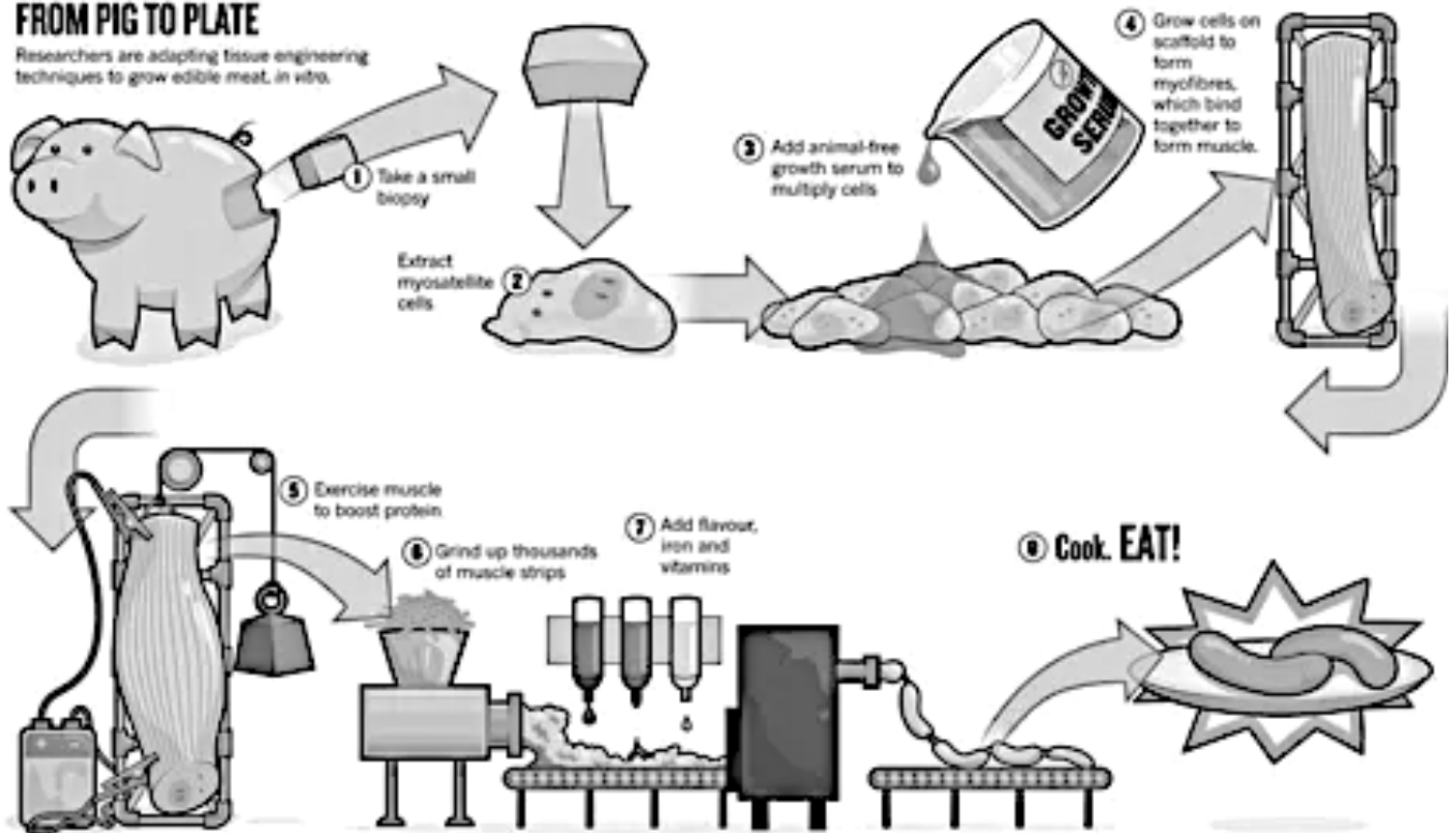
Calories and Nutrition of Insects

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Cricket	12.9	5.5	5.1	75.8	9.5	121.5
Grasshopper	20.6	6.1	3.9	35.2	5	152.9

FROM PIG TO PLATE

Researchers are adapting tissue engineering techniques to grow edible meat, in vitro.



GUIDING QUESTIONS:

- 1) How is the nature of food waste different in developing vs. developed countries?
- 2) Why is raising livestock for human consumption an inefficient use of resources?
- 3) What are the benefits and challenges of alternatives to raising livestock for human consumption?
- 4) What are the benefits and challenges of growing crops using vertical farms?

ADDITIONAL RESOURCES:

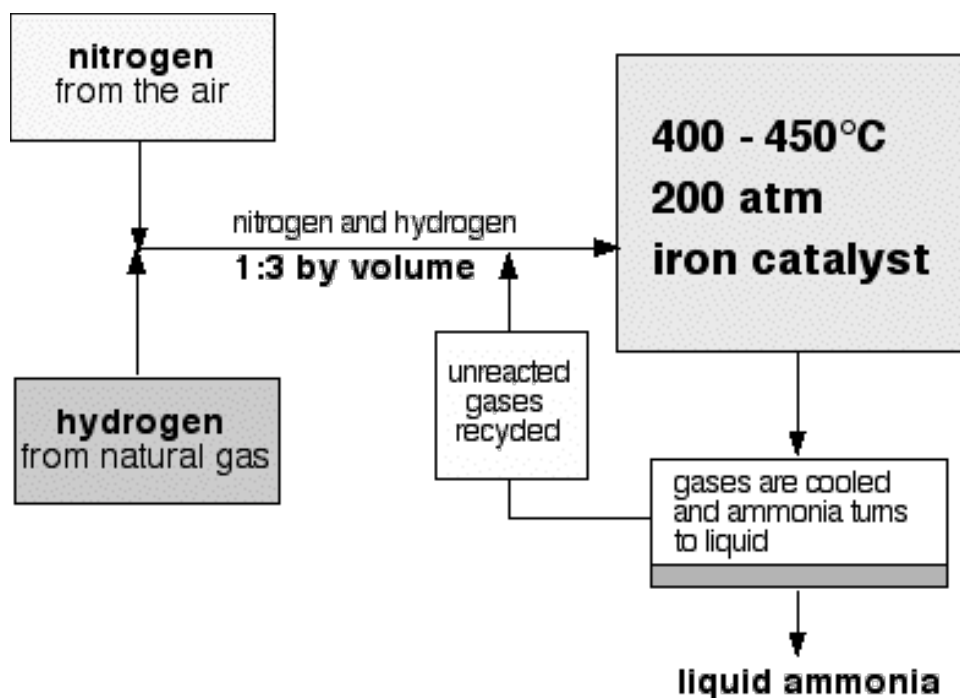
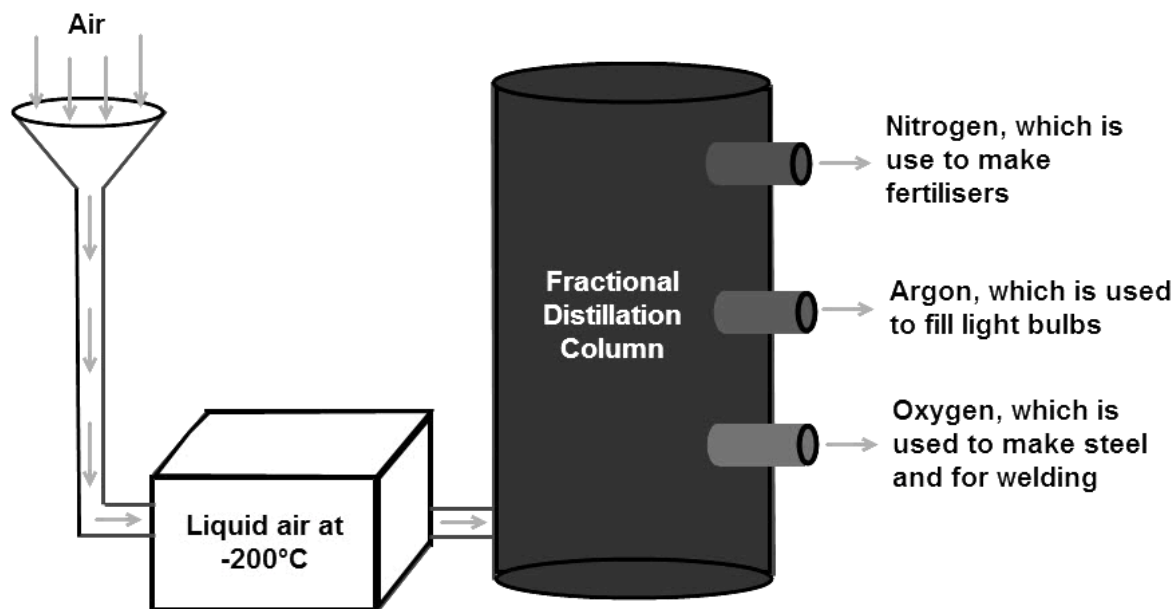
- “Watch: This Futuristic Vertical Farm Would Farm Fish, Bugs and Plants in the Middle of the City” - *BusinessInsider.co.za*, 3/25/19
- “What the Green New Deal Will Mean for Your Hamburger” - Jan Dutkiewicz, *TheGuardian.com*, 3/7/19

QUESTION 4: How is atmospheric nitrogen used to make fertilizer?

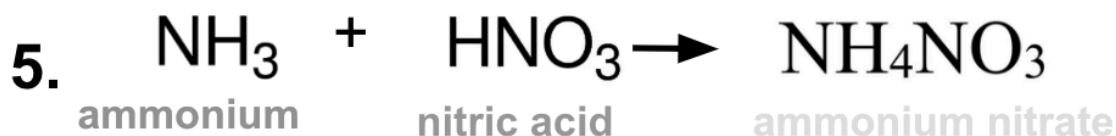
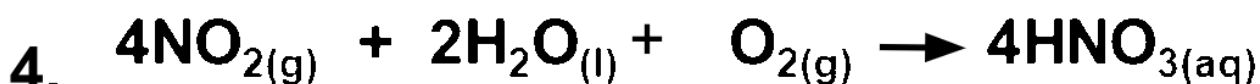
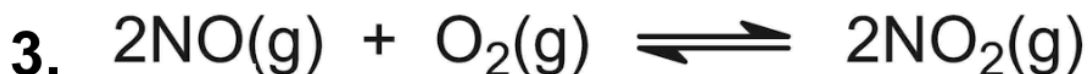
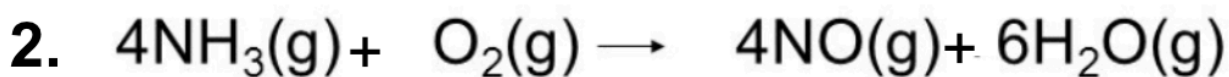
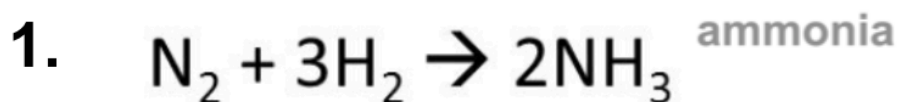
VOCABULARY:

fractional distillation pressure catalyst coefficient
ammonia nitrogen monoxide nitrous oxide nitric acid ammonium nitrate

DIAGRAMS:



How is ammonia converted to fertilizer?



GUIDING QUESTIONS:

- 1) How is nitrogen separated from other gases in the air?
- 2) How is nitrogen used to make ammonia?
- 3) What factors are important to consider when trying to control chemical reactions?
- 4) How can you determine whether a chemical equation is balanced or not?

ADDITIONAL RESOURCES:

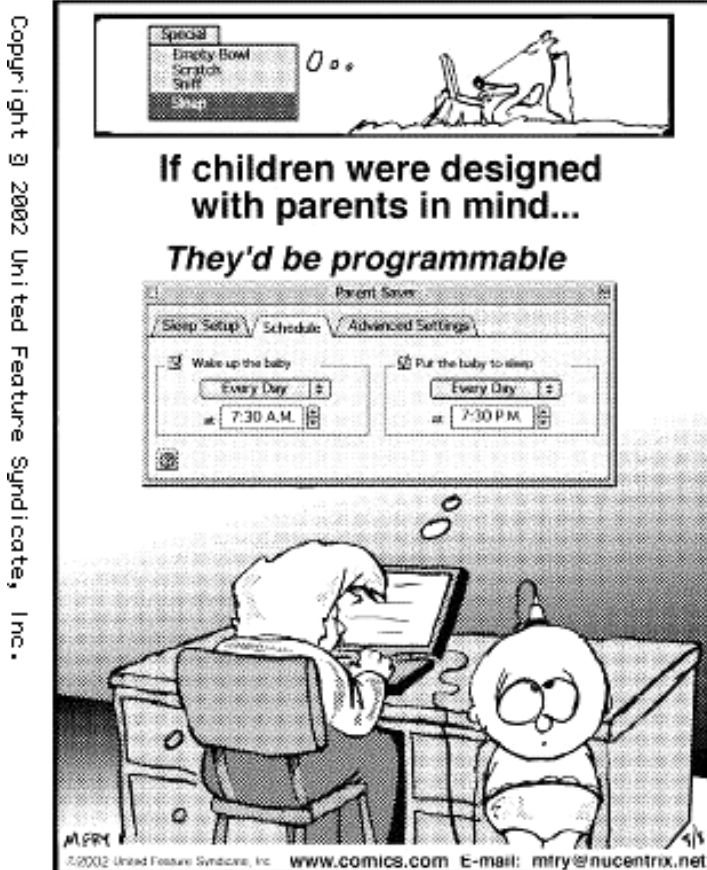
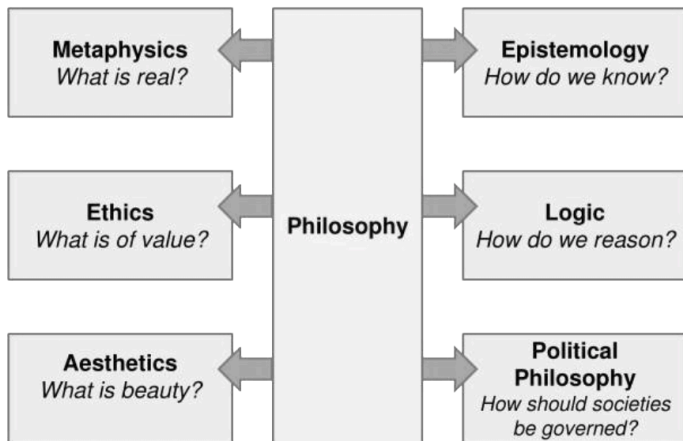
- "Bacteria Engineered to Create Fertilizer Out of Thin Air" - *ScienceDaily.com*, 7/18/18
- "Producing Fertilizer from Air Could be Five Times as Efficient" - *ScienceDaily.com*, 5/15/17

QUESTION 5: What are the ethical and political implications of emerging biotechnologies?

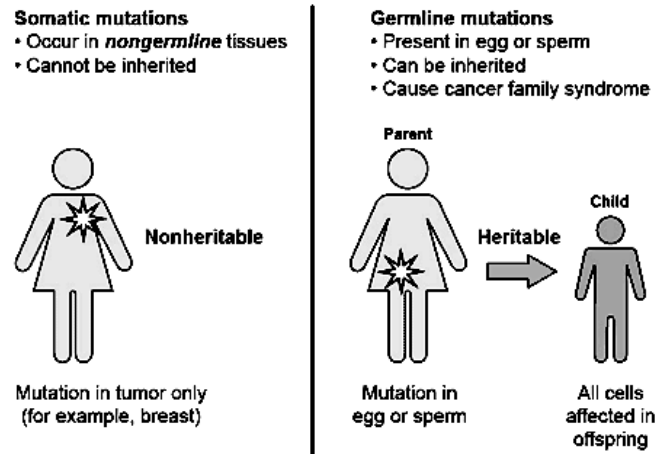
VOCABULARY:

bioethics germ-line genetic engineering “designer baby” genetic discrimination informed consent
 cloning surrogate mother socioeconomic inequality abortion viability embryo fetus
 consciousness terminal illness conflict of interest euthanasia physician-assisted suicide

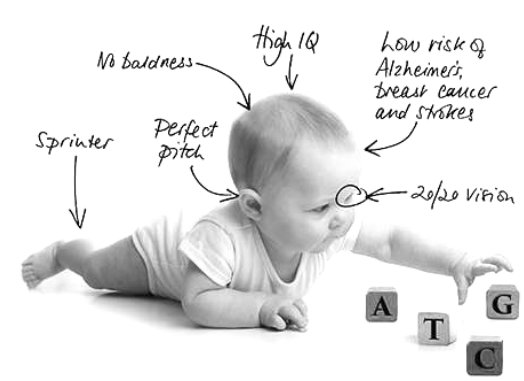
DIAGRAMS:



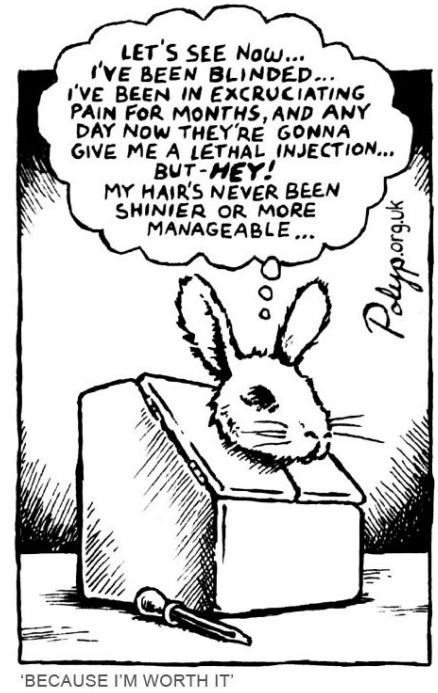
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Adapted from the National Cancer Institute and the American Society of Clinical Oncology



Age (weeks)					
1	2	3	4	5	6
← zygote to formation of embryonic disc →		embryo			
	primitive streak	Gastrulation occurs; notochord and beginning of neural tube form	Neural tube closes; heart beats; arm buds, tail, and gill grooves form	Incipient eye parts—retina (as optic cup) and lens (as lens pits)—form; leg buds form; brain enlarges	Webbed fingers and external ear form; pigment appears in retina; tail and gill grooves disappearing
Age (weeks)					
7	8	9	10	11	12
embryo		fetus			
Webbed toes form; bones begin to harden; back straightens; eyelids form	Upper limbs bend at elbows; genitalia begin to differentiate; fingers are distinct	Toes separate; eyelids develop; major parts of brain are present	Chin grows; nostrils separate; face appears human; genitals appear male or female	Well-defined neck appears; genitalia are complete; sucking reflex appears	
Age (months)					
4	5	6	7	8	9
fetus					
Blood cells form; all major organs form; head and body hair appear; movements are felt by mother		Fetus may be viable if born; eyelids open; lungs and lung circulation develop; may suck thumb; fat deposited under skin		Fetus usually viable if born; fat deposits increase; body hair is lost; head hair is well developed; most senses are well developed; fetus turns head down in uterus	



GUIDING QUESTIONS:

- 1) Is it ethical to clone animal or human cells, and if yes, under what circumstances?
- 2) How should access to genetic information be regulated?
- 3) How should our ability to genetically modify human embryos be regulated?
- 4) Is abortion ethical, and if yes, under what circumstances?
- 5) Is animal testing ethical, and if yes, under what circumstances?
- 6) Should terminally ill patients have the right to ask a doctor to help them kill themselves?

ADDITIONAL RESOURCES:

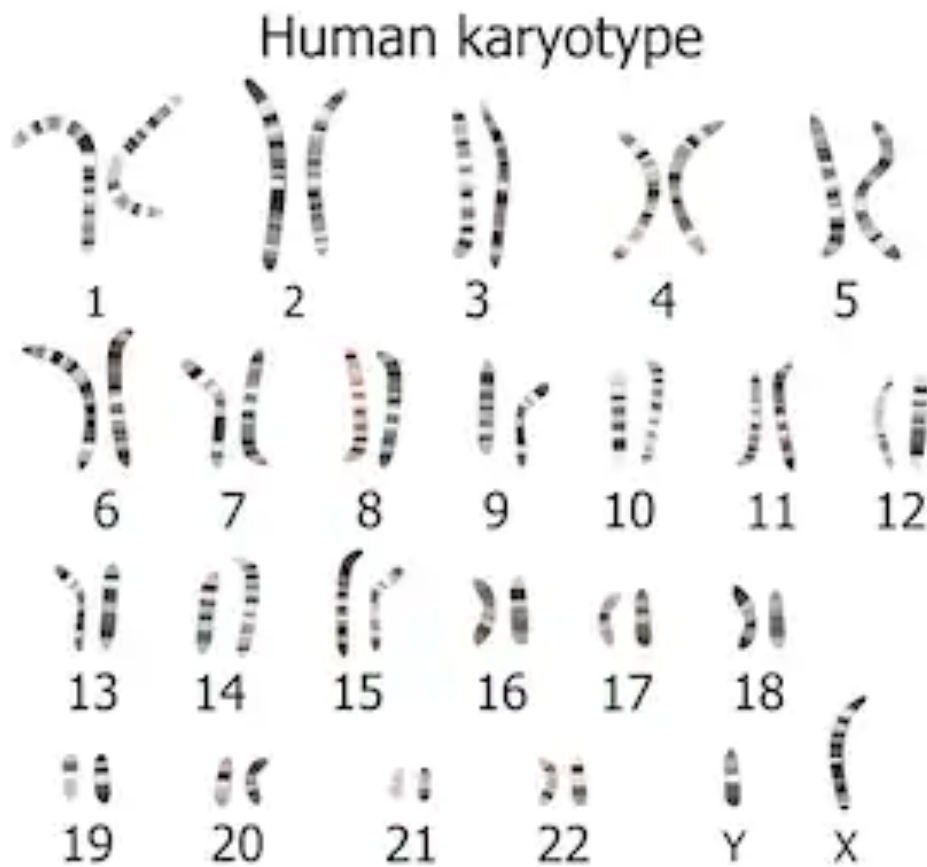
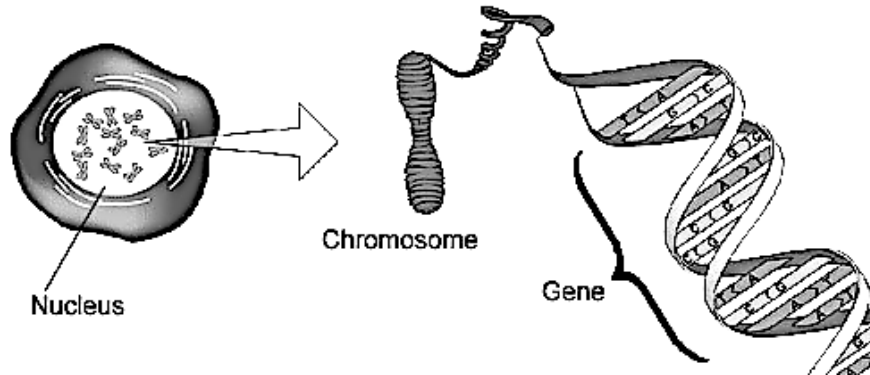
- “Death on Demand: Has Euthanasia Gone Too Far?” - Christopher de Bellaigue, *TheGuardian.com*, 1/18/19
- “Most People of European Ancestry Can Be Identified From a Relative’s DNA” - Sarah Zhang, *TheAtlantic.com*, 10/11/18
- “Barbra Streisand’s Dog Cloning is a Modern Tragedy. Pets are Meant to Die” - Stuart Heritage, *TheGuardian.com*, 3/2/18

QUESTION 6: How is a clone created and stimulated to develop into an organism?

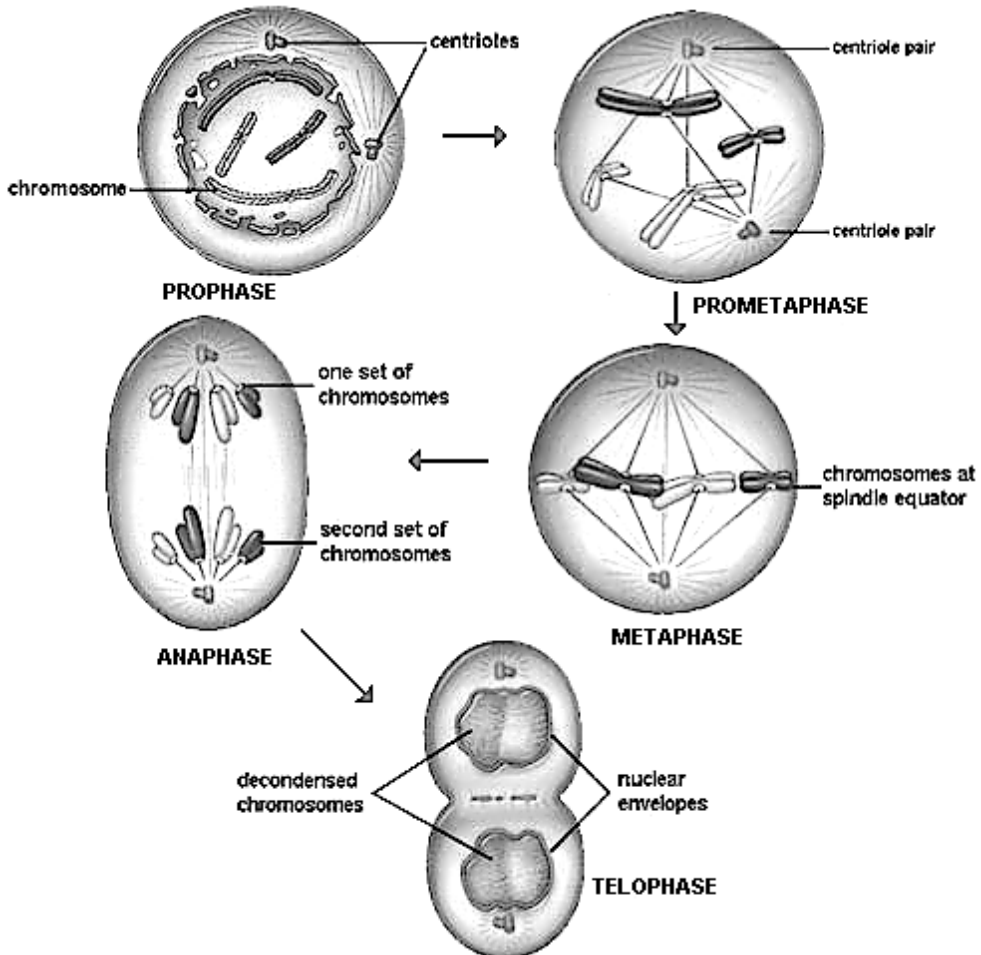
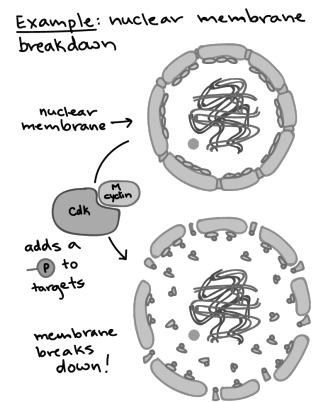
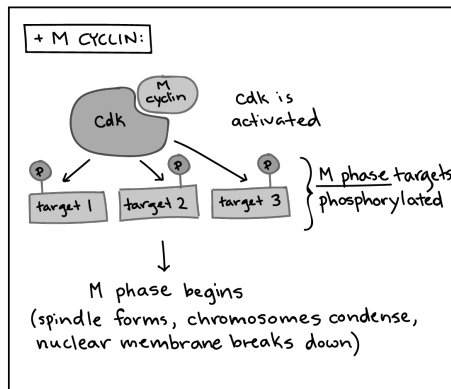
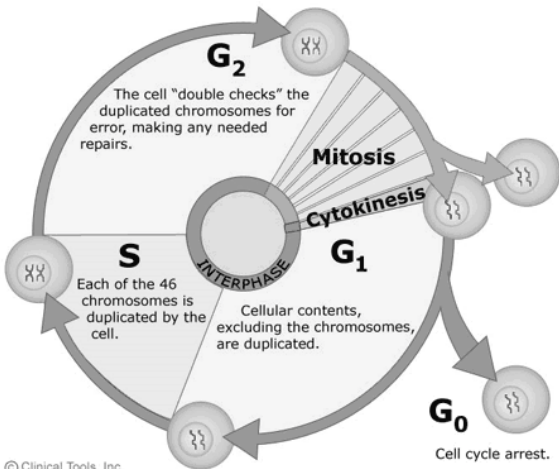
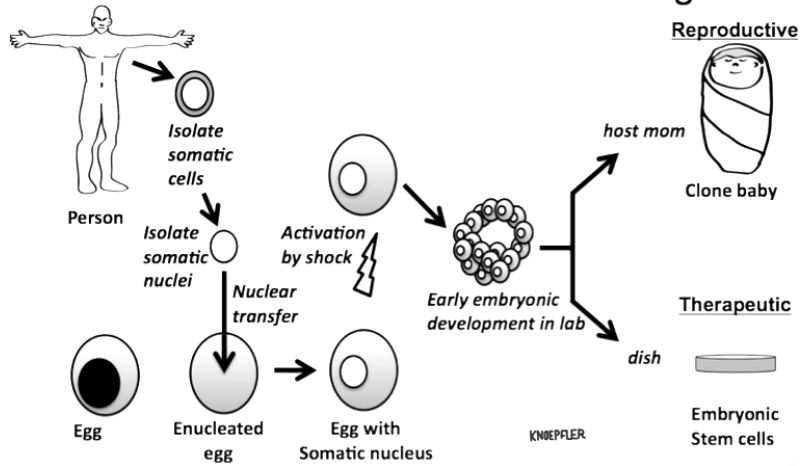
VOCABULARY:

gene chromosome karyotype enucleation somatic cell nuclear transfer mitosis cyclin
centriole spindle fiber prophase metaphase anaphase telophase cytokinesis
differentiation specialization gene expression transcription factor HOX genes

DIAGRAMS:



The two kinds of human cloning



Cell Differentiation

- Differentiation is when cells become specialized in structure and function
- It results from selective gene expression, the turning on and off of specific genes.

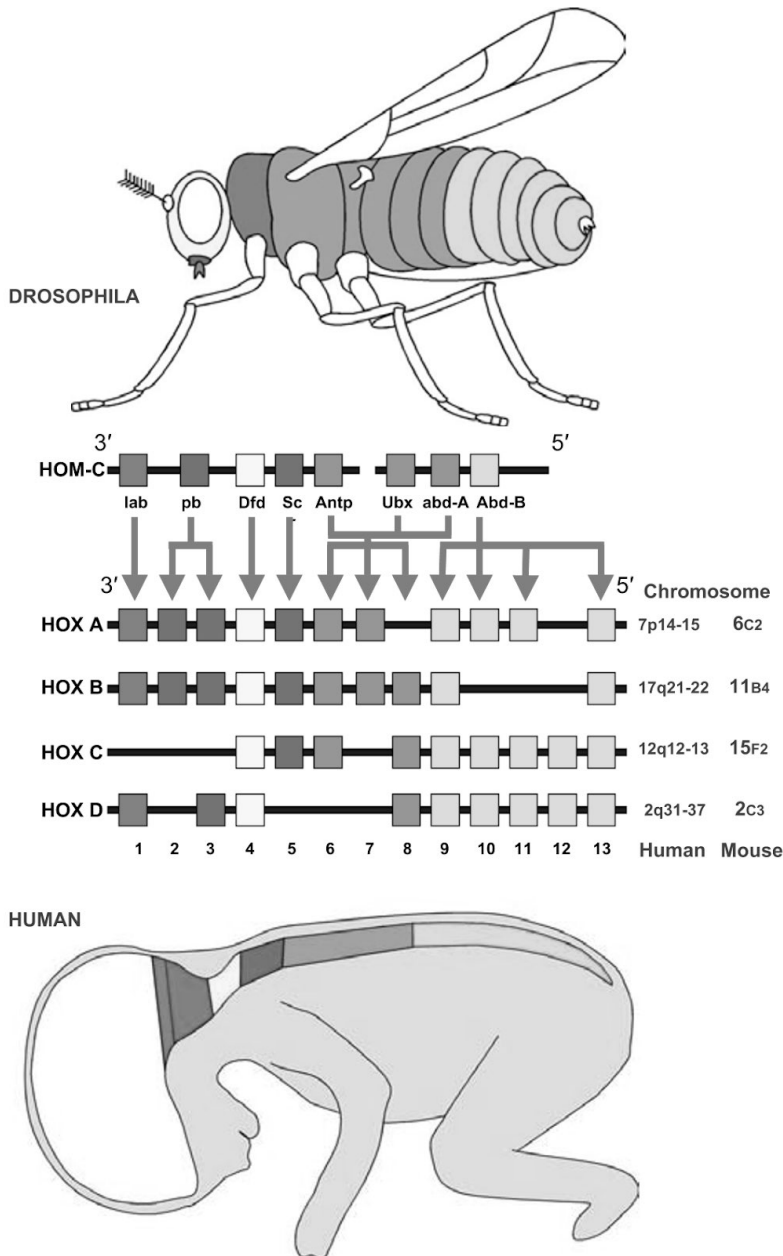
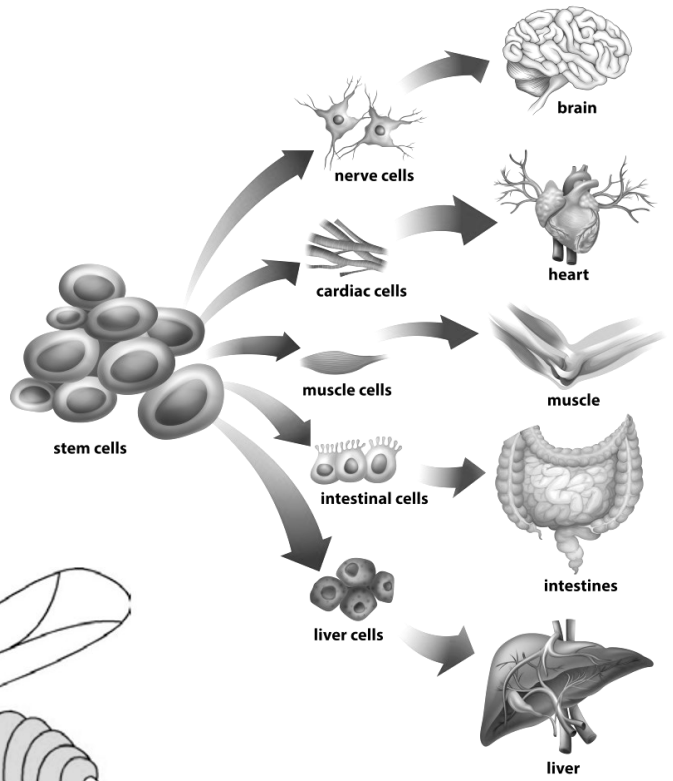
	Pancreas cell	Eye lens cell (in embryo)	Nerve cell
Glycolysis enzyme gene	Active	Inactive	Inactive
Transparent protein gene	Inactive	Active	Inactive
Insulin gene	Active	Inactive	Inactive
Hemoglobin gene	Inactive	Inactive	Inactive

Key

Active gene (represented by a dark grey bar)

Inactive gene (represented by a light grey bar)

Various Potential Application of Stem Cells



GUIDING QUESTIONS:

- 1) How is the first cell of a human clone created?
- 2) Why must a cell's chromosomes be duplicated before mitosis (cell division)?
- 3) How do cyclins control the process of mitosis?
- 4) How do the first cells of an organism differentiate to become many different types of cells?

ADDITIONAL RESOURCES:

- "Researchers Create First Stem Cells Using CRISPR Genome Activation" - *ScienceDaily.com*, 1/18/18
- "Cloning" - Genetic Science Learning Center (<https://learn.genetics.utah.edu/content/cloning/>)

QUESTION 7: What makes a genetic disease a good candidate for gene therapy?

VOCABULARY:

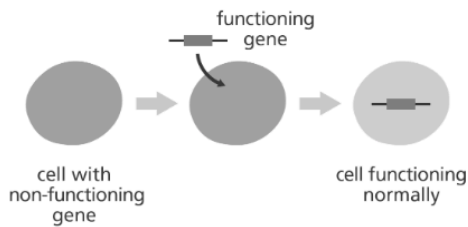
in vivo *ex vivo* mutation gene augmentation therapy gene inhibition therapy vector integration
protein cystic fibrosis sickle cell anemia hemoglobin Wilson's disease
Down syndrome trisomy nondisjunction

DIAGRAMS:

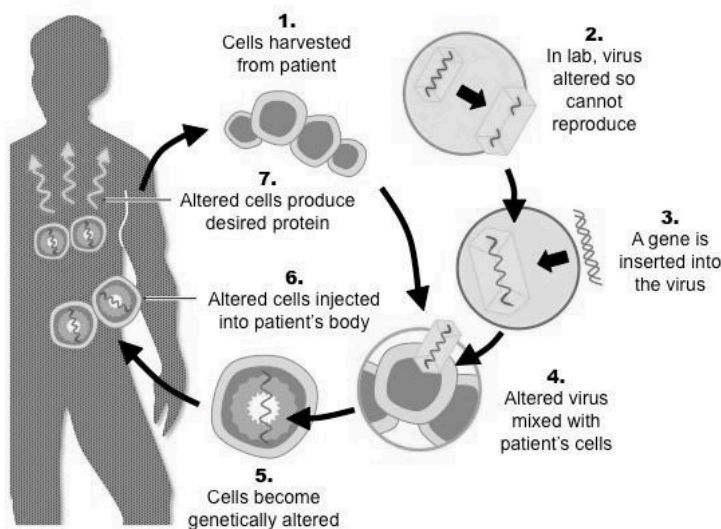
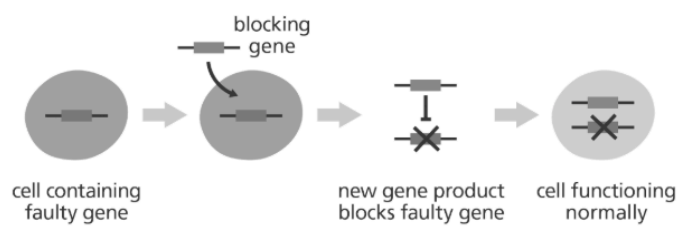
Is this genetic disease a good candidate for gene therapy?

- 1) Do we know which tissues and proteins are affected?
- 2) Are only 1-2 genes working incorrectly?
- 3) Would a correct gene copy fix the disease, or does a faulty gene also need to be blocked?
- 4) Can we deliver the gene to affected cells?

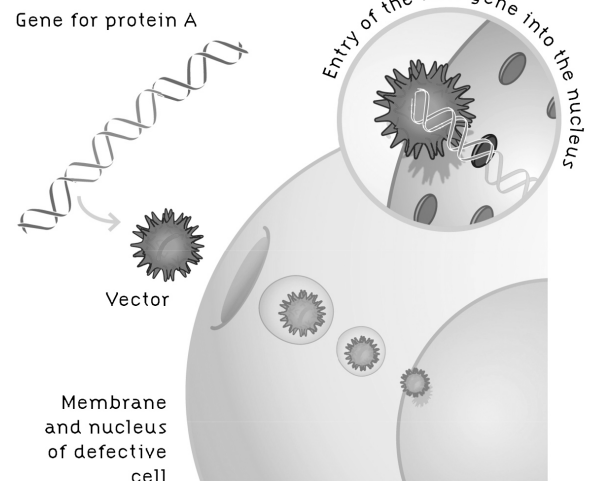
Gene augmentation therapy

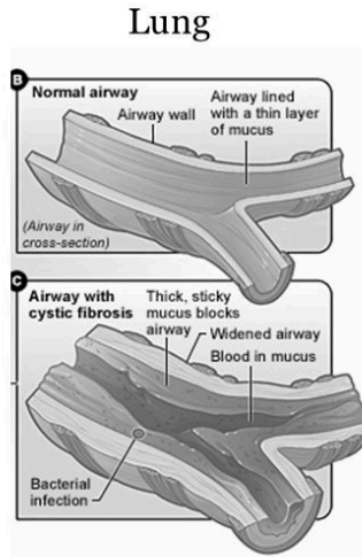
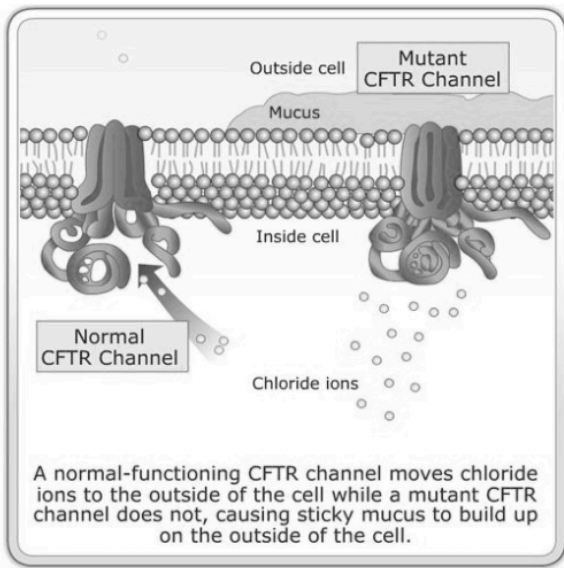


Gene inhibition therapy

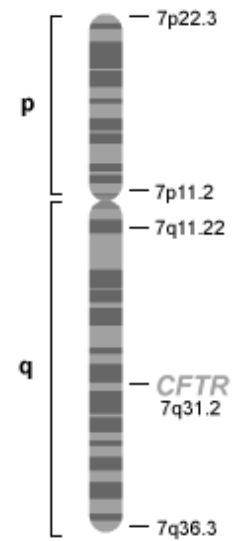


Action of vectors at the level of the cells of the injected organ

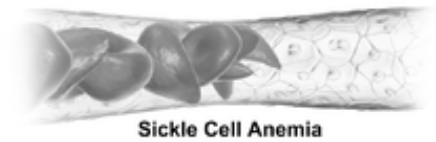
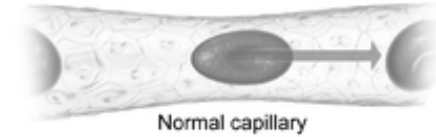
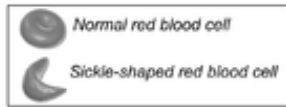




Chromosome 7

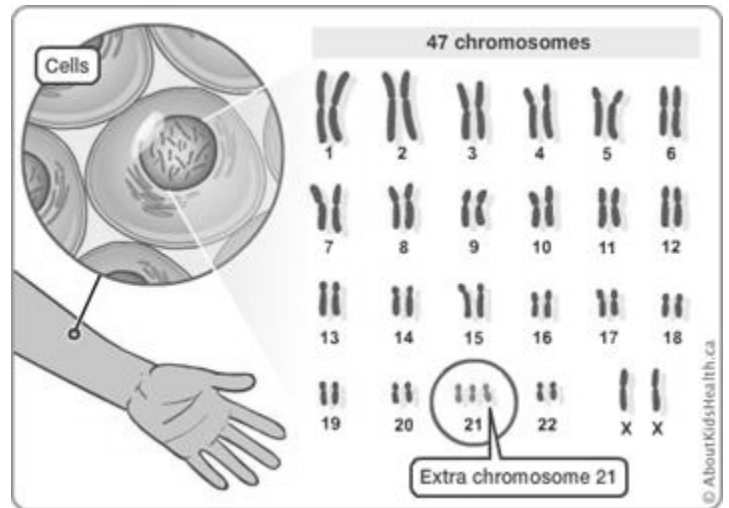
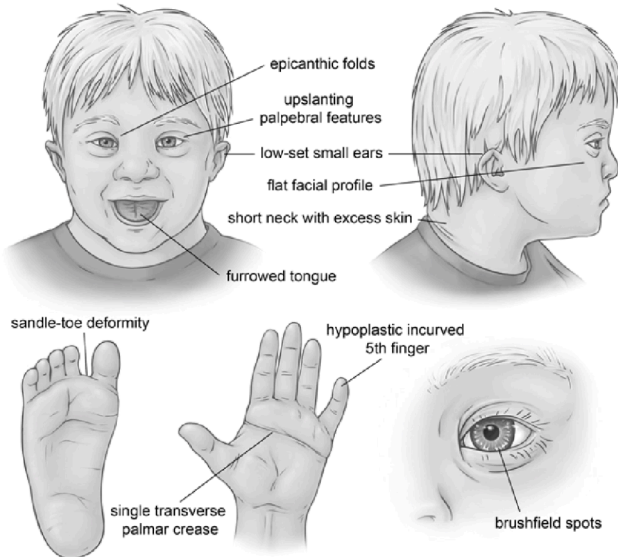


COURTESY OF NCBI



	Normal	Missense Mutation
Partial DNA Sequence of Beta Globin Gene:	CCT GAG GAG GGA CTC CTC	CCT GTG GAG GGA CAC CTC
Partial RNA Sequence:	CCU GAG GAG	CCU GUG GAG
Partial Amino Acid Sequence for Beta Globin:	Pro — Glu — Glu	Pro — Val — Glu
Hemoglobin Molecule:		
Red Blood Cell:		

Dysmorphic features of down syndrome



GUIDING QUESTIONS:

- 5) Why is gene augmentation therapy enough to treat cystic fibrosis but not sickle cell anemia?
- 6) Why isn't Down syndrome a good candidate for gene therapy?
- 7) What are the benefits and challenges of using viruses as vectors for gene therapy?

ADDITIONAL RESOURCES:

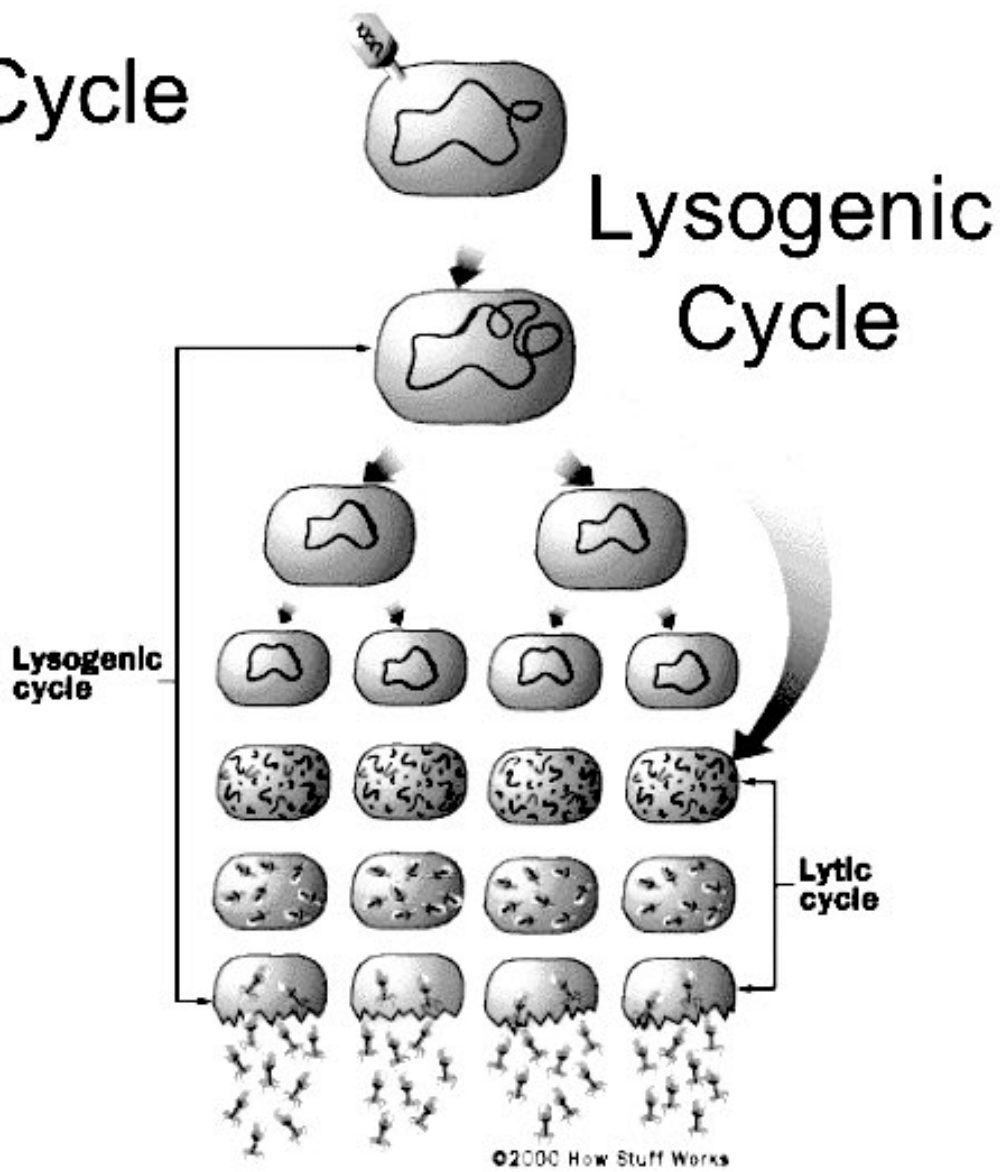
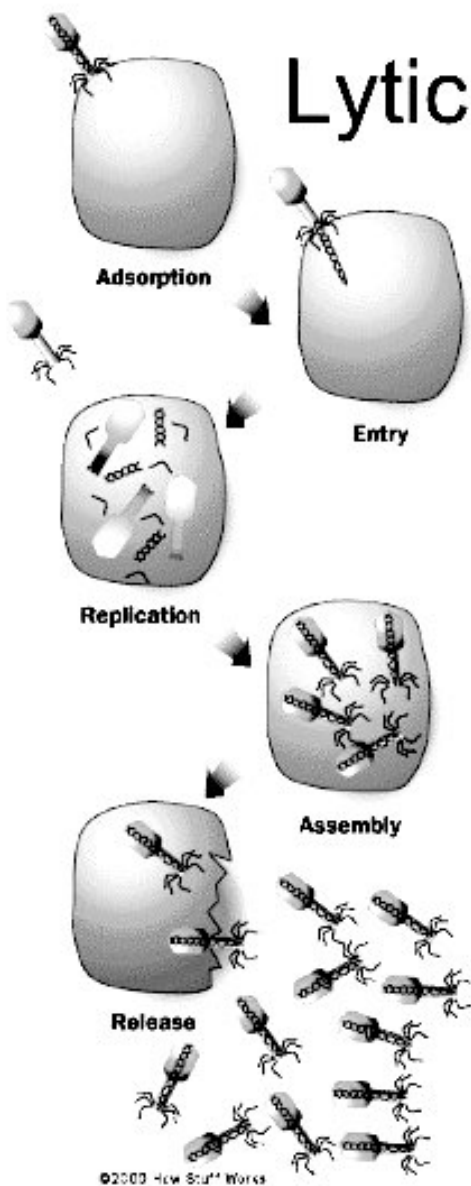
- "Gene Therapy Targets Sickle-Cell Disease" - Anna Nowogrodzki, *Nature.com*, 12/12/18
- "Design of a Promising Gene Therapy Method to Treat Wilson's Disease" - *EurekAlert.org*, 5/16/17
- "Gene Therapy" - Genetic Science Learning Center (<https://learn.genetics.utah.edu/content/genetherapy/>)

QUESTION 8: How can viruses integrate genetic information into a host cell's genome?

VOCABULARY:

bacteriophage lytic cycle lysogenic cycle receptors replication assembly integration
 genome host human immunodeficiency virus (HIV) auto-immune deficiency syndrome (AIDS)
 CD4 cells retrovirus reverse transcriptase integrase

DIAGRAMS:



HIV and AIDS: What's the difference?



HIV

- HIV is the virus that causes HIV infection.
- HIV damages the immune system by killing CD4 cells.

CD4 Cells



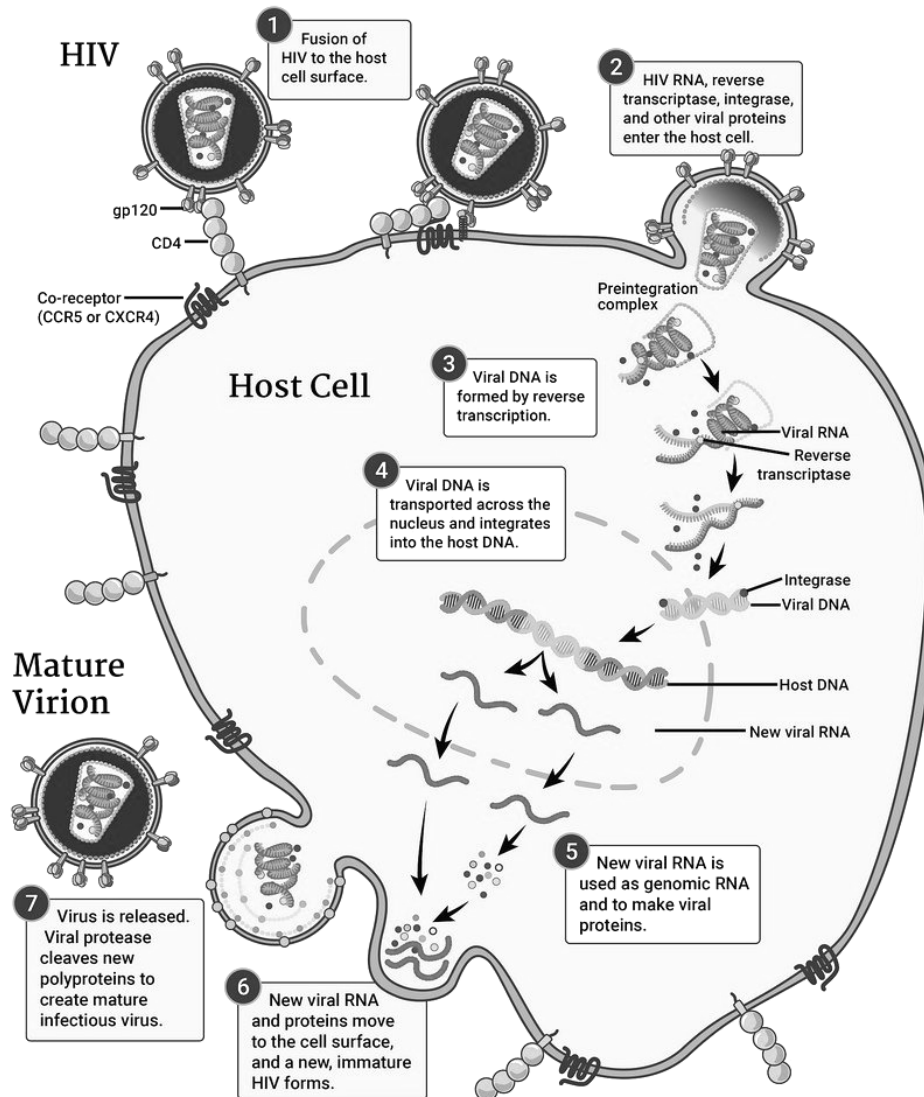
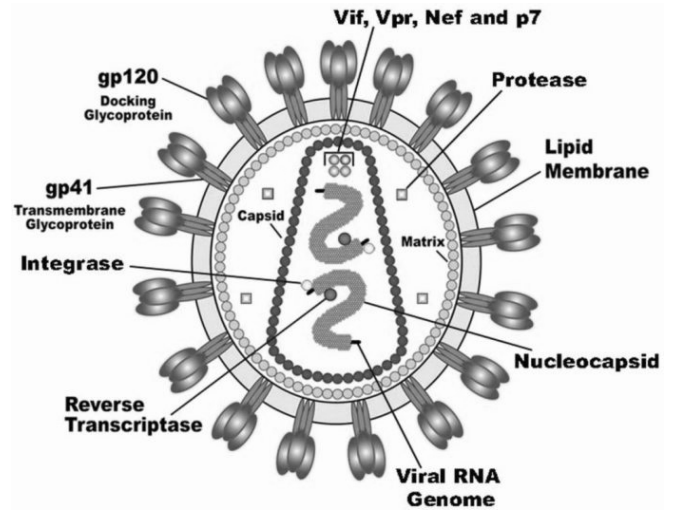
- CD4 cells are part of the immune system.
- HIV attacks and kills CD4 cells.
- Loss of CD4 cells makes it hard for the body to fight off infections.



AIDS

- AIDS is the last stage of HIV infection.
- As HIV infection advances to AIDS, the amount of HIV in the body increases and the number of CD4 cells decreases.
- HIV medicines can stop HIV infection from advancing to AIDS.
- Without HIV medicines, HIV advances to AIDS in about 10 years.

For more information, visit AIDSinfo



GUIDING QUESTIONS:

- 1) Why might it benefit a virus to enter the lysogenic cycle of reproduction as opposed to the lytic cycle?
- 2) How are HIV and AIDS related?
- 3) What role does reverse transcriptase play in an HIV infection?

ADDITIONAL RESOURCES:

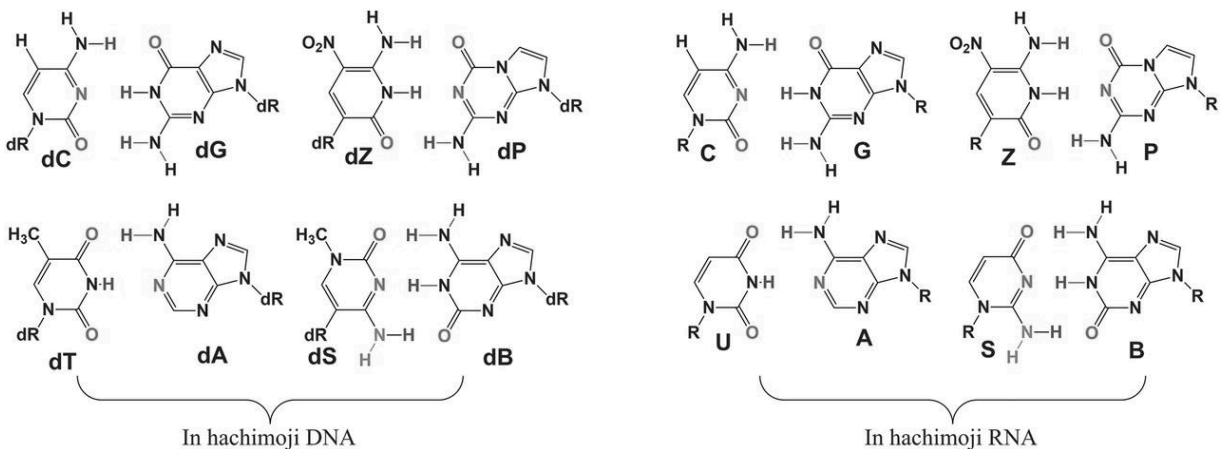
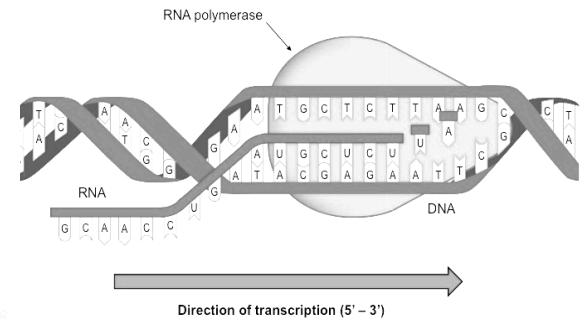
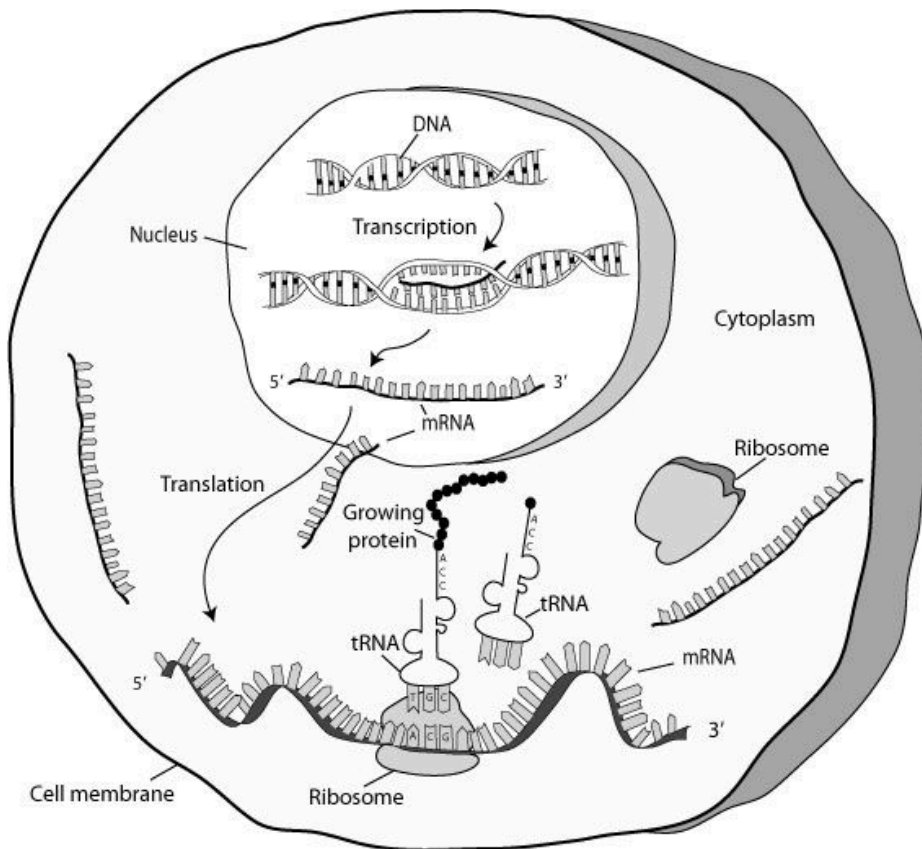
- "H.I.V. Is Reported Cured in a Second Patient, a Milestone in the Global AIDS Epidemic" - Apoorva Mandavilli, *NYTimes.com*, 3/4/19
- "Biologists Discover How Viruses Hijack Cell's Machinery" - *ScienceDaily.com*, 1/12/17

QUESTION 9: What might alien life look like, and where might we find it?

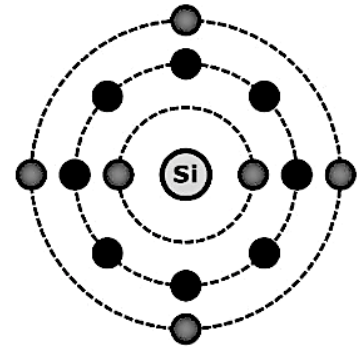
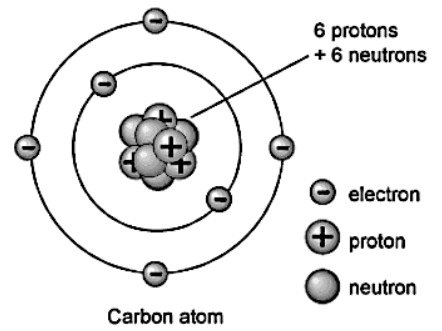
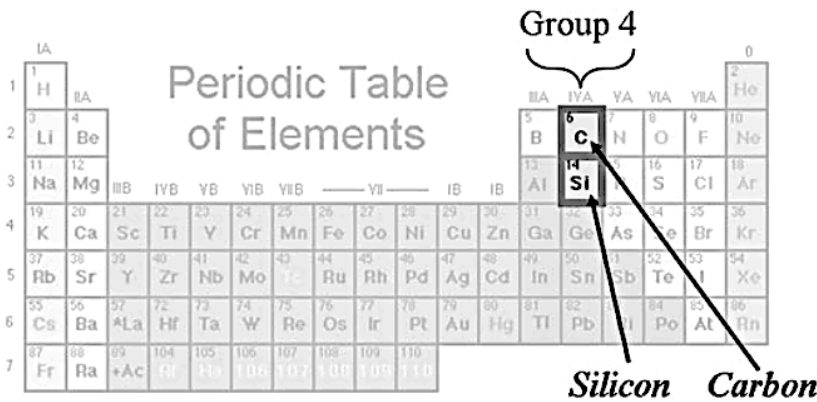
VOCABULARY:

meteorite asteroid genetic information self-replicating compressible transcription factor
 enzyme translation ribosome nucleotide nitrogenous base hachimoji DNA silicon-based life
 transit method habitable zone exoplanet gravity atmospheric composition Fermi paradox

DIAGRAMS:



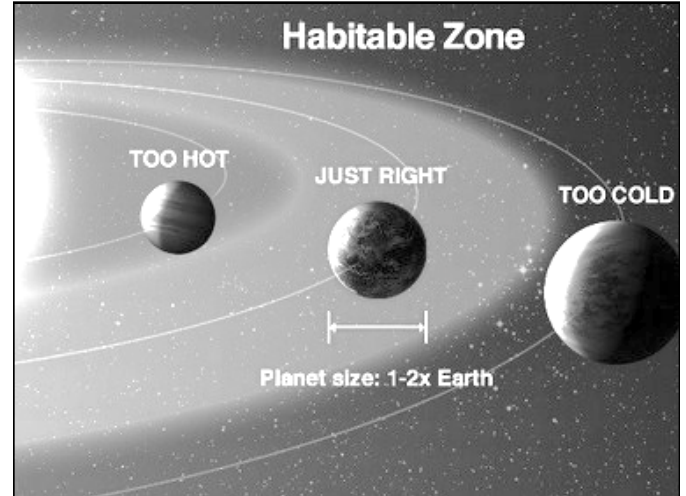
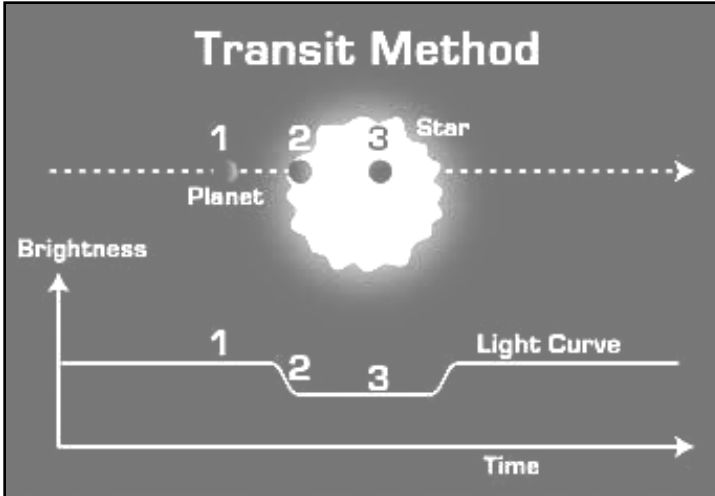
What might alien life look like?



58	59	60	61	62	63	64	65	66	67	68	69	70	71
Ce	Pr	Nd		Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu
90	91	92	93	94	95	96	97	98	99	100	101	102	103
Th	Pa	U											

Legend - click to find out more...

H - gas	Li - solid	Br - liquid	Tc - synthetic
Non-Metals	Transition Metals	Rare Earth Metals	Halogens
Alkali Metals	Alkali Earth Metals	Other Metals	Inert Elements



GUIDING QUESTIONS:

- 1) What does a cell need in order to reliably copy itself?
- 2) What enables a molecule like DNA to serve as a template for its own replication?
- 3) What makes carbon the "element of life," and can any other elements fill that role?
- 4) What challenges do scientists face in using the transit method to detect exoplanets and exomoons?
- 5) What makes a planet habitable, other than its closeness to the nearest star?

ADDITIONAL RESOURCES:

- “Neptune’s Moon Triton Is Destination of Proposed NASA Mission” - David W. Brown, *NYTimes.com*, 3/19/19
- “Here’s Why Alien Life, Habitable Worlds Might Be Found Near ‘Goldilocks’ Stars” - *IBTimes.com*, 3/13/19
- “Possibility of Silicon-Based Life Grows” - *AstroBio.net*, 2/8/17