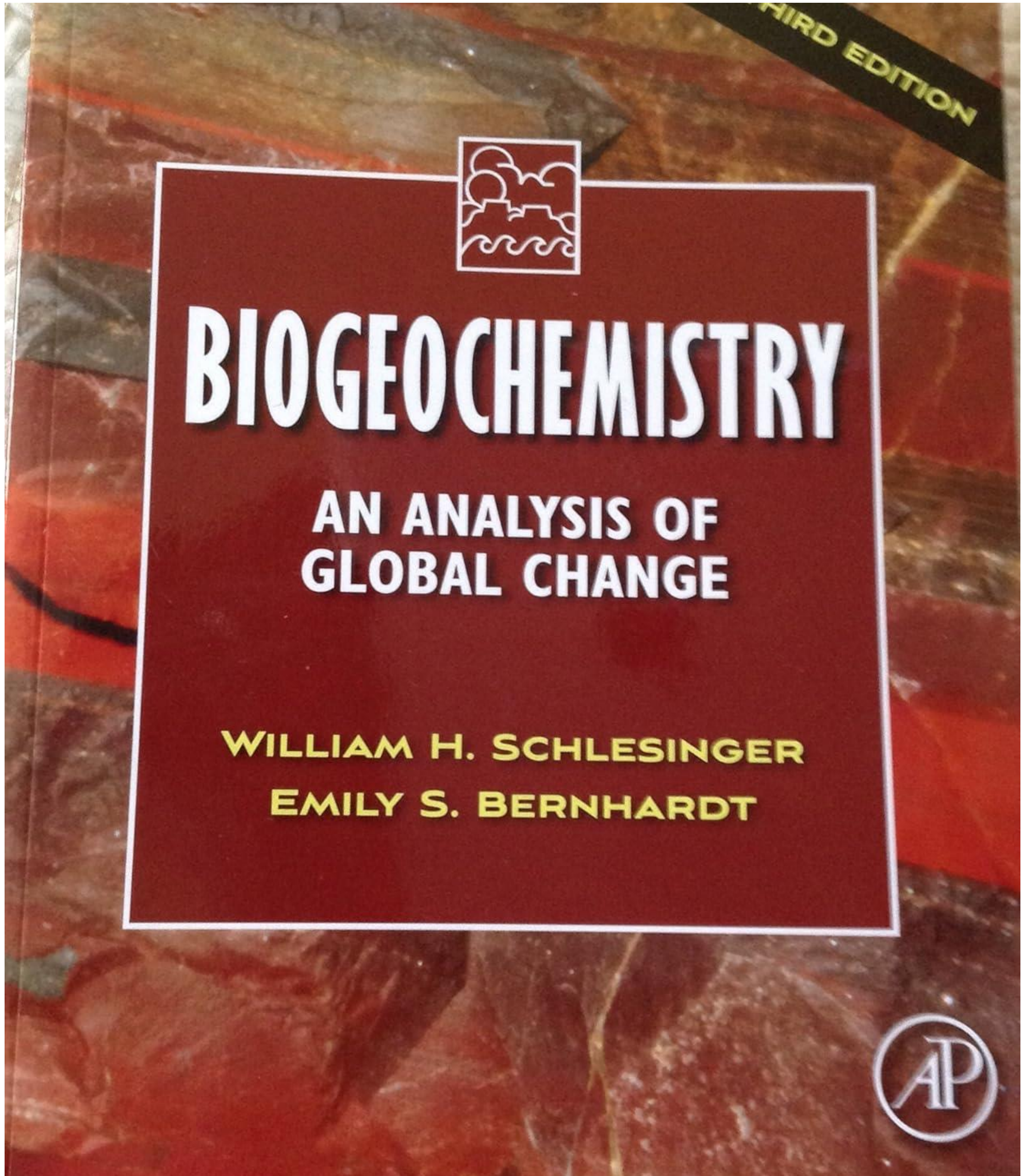
Week 1 Reflections

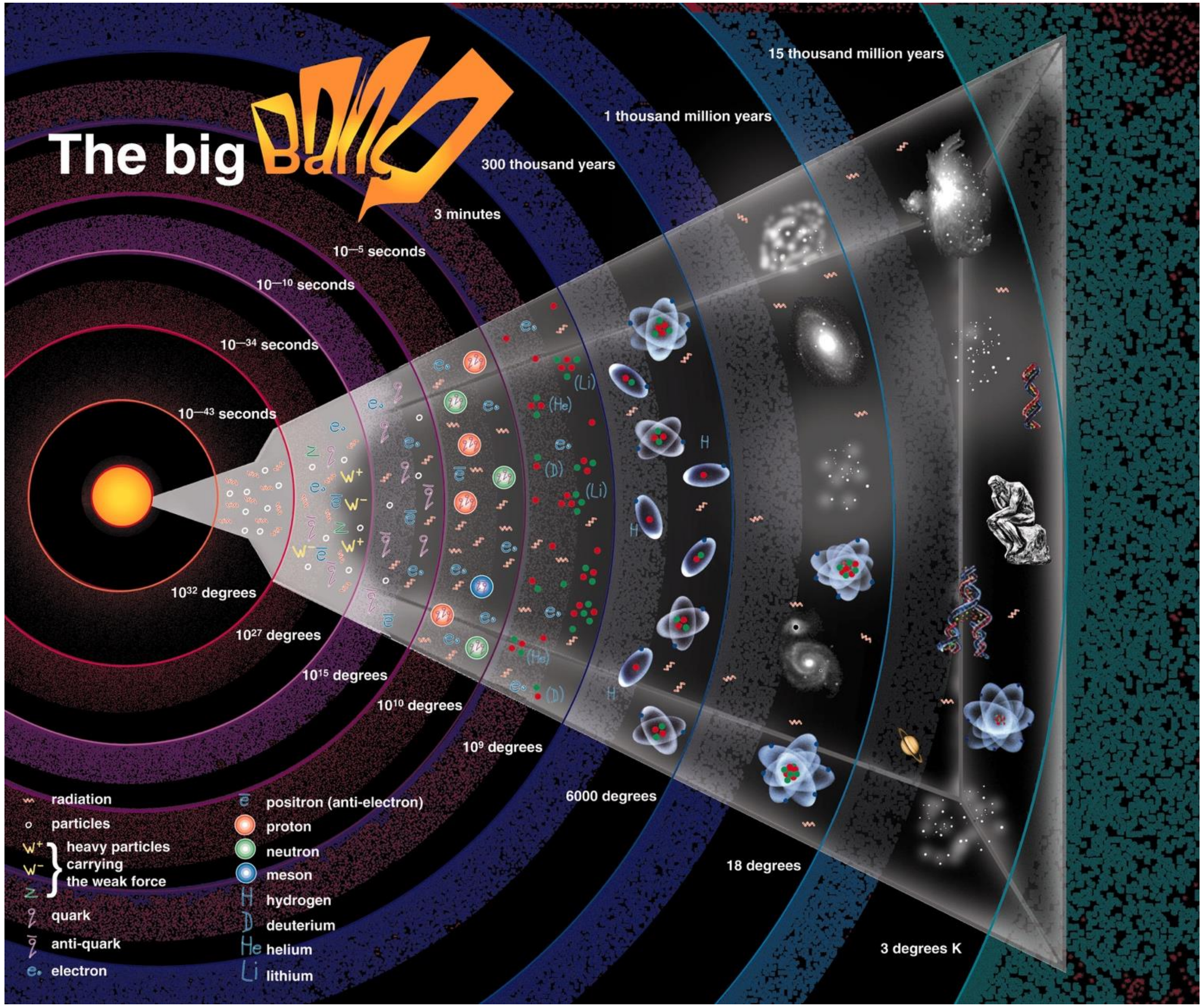
This week was an introductory week to the material. It gave an overreaching understanding of what we will cover this semester. I found it helpful to go over material learned in past semesters as a refresh of material. I look forward to furthering my understanding of human related climate change and our role as stewards of the land to remediate it.

The discussion of open versus closed systems also stood out because it helped my verbalize the nutrient dynamics I saw at Boyd Lake. I initially assumed the organic carbon came from something within the lake itself. In reality, the large amount of organic carbons came from algae blooms. The lake is not a closed system, it has been fueled by exterior nutrient inputs, which caused the algae to no longer be limited by those nutrients. This week helped me understand how to explain those principles through scientific theory.

- Natural/Water Resource Management
- Conservation
- Forestry
- Ecological Restoration
- Wildlife Rehabilitation
- Urban Planning
- Environmental Consulting
- Research
- Policy
- Science Teaching

Chapter 2 - Origins





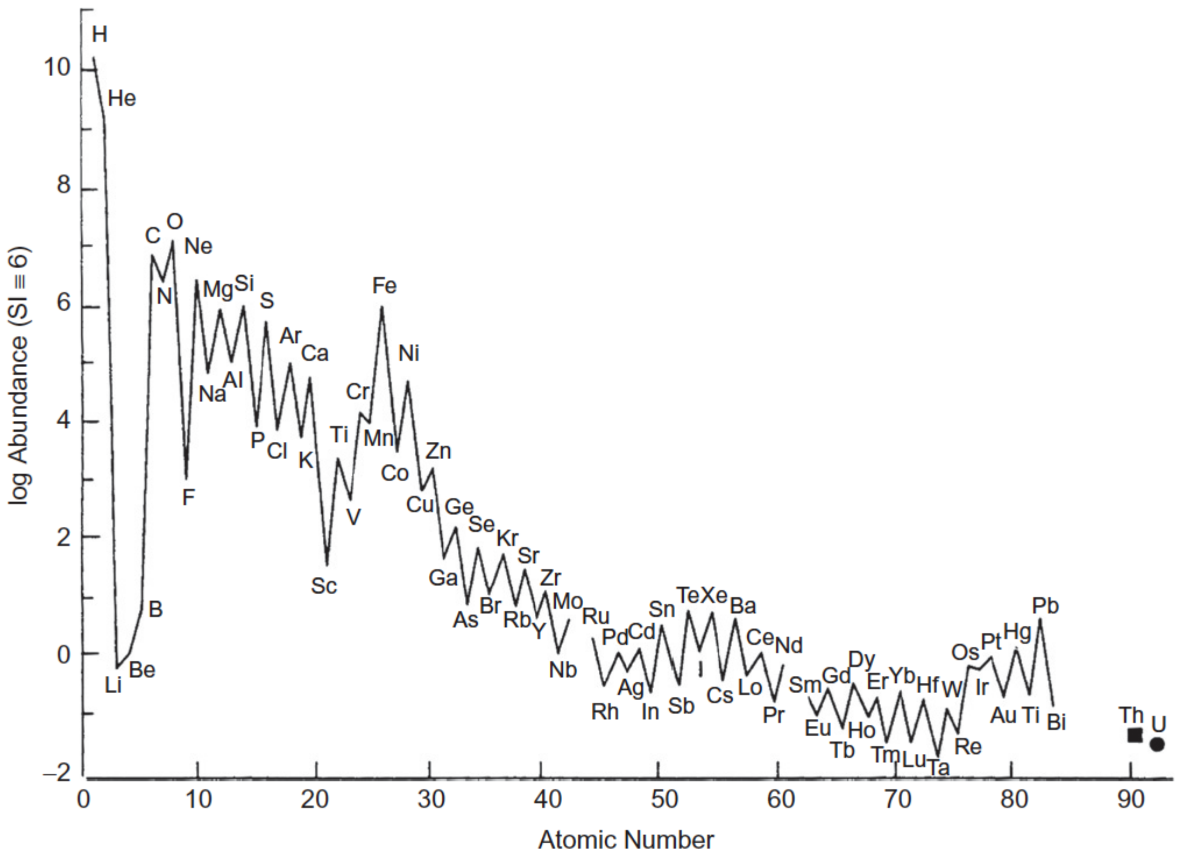


FIGURE 2.1 The relative abundance of elements in the solar system, also known as the cosmic abundance, as a function of atomic number. Abundances are plotted logarithmically and scaled so that silicon (Si) = 1,000,000. *Source: From a drawing in Brownlee (1992) based on the data of Anders and Grevesse (1989).*

$$^{4}\mathrm{He} + {}^{4}\mathrm{He} \rightleftarrows {}^{8}\mathrm{Be}.$$

$$^{8}\mathrm{Be} + {}^{4}\mathrm{He} \rightarrow {}^{12}\mathrm{C}.$$

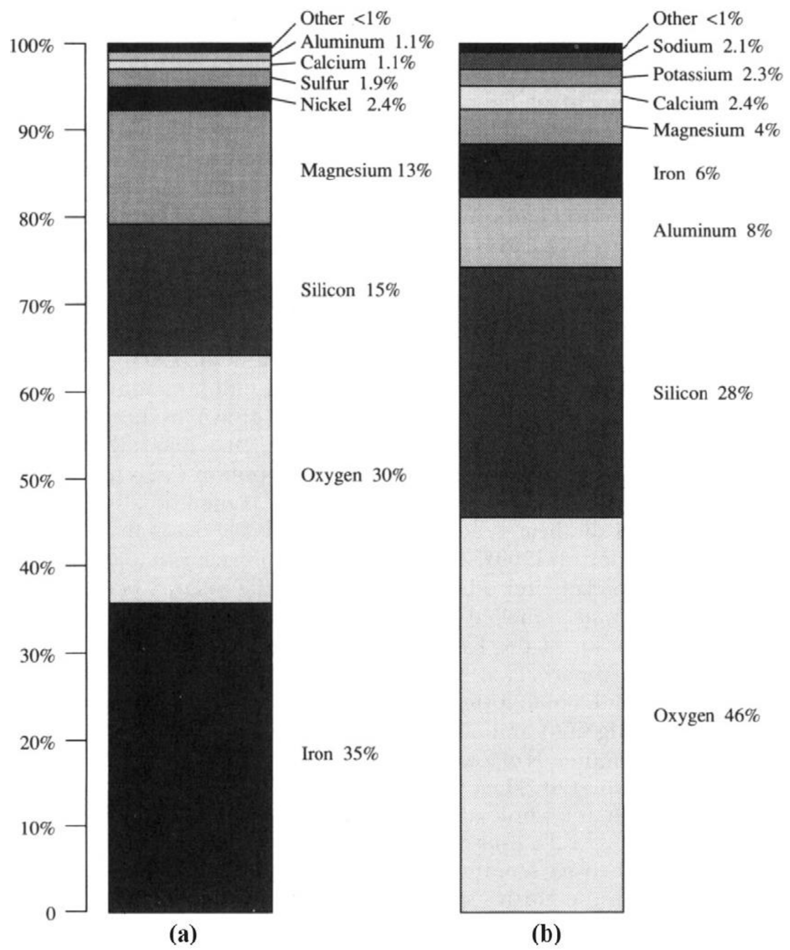


FIGURE 2.2 Relative abundance of elements by weight in the whole Earth (a) and Earth's crust (b). *Source: From Earth (fourth ed.) by Frank Press and Raymond Siever. Copyright 1986 by W.H. Freeman and Company. Used with permission.*

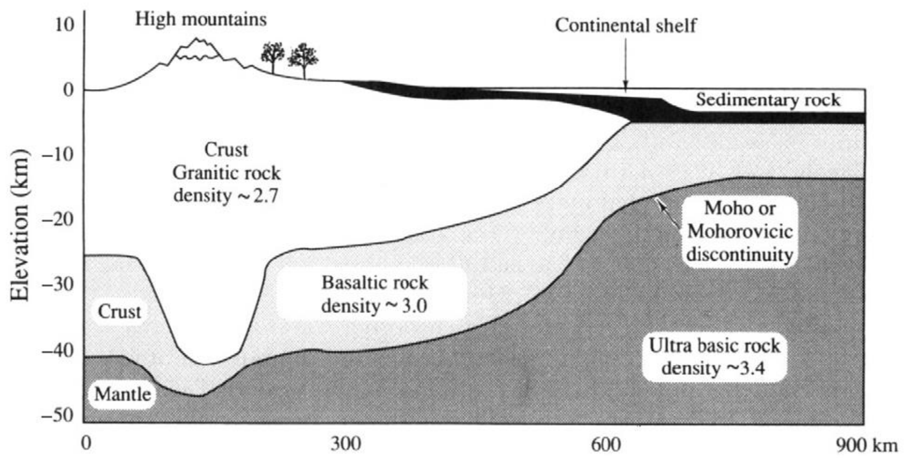
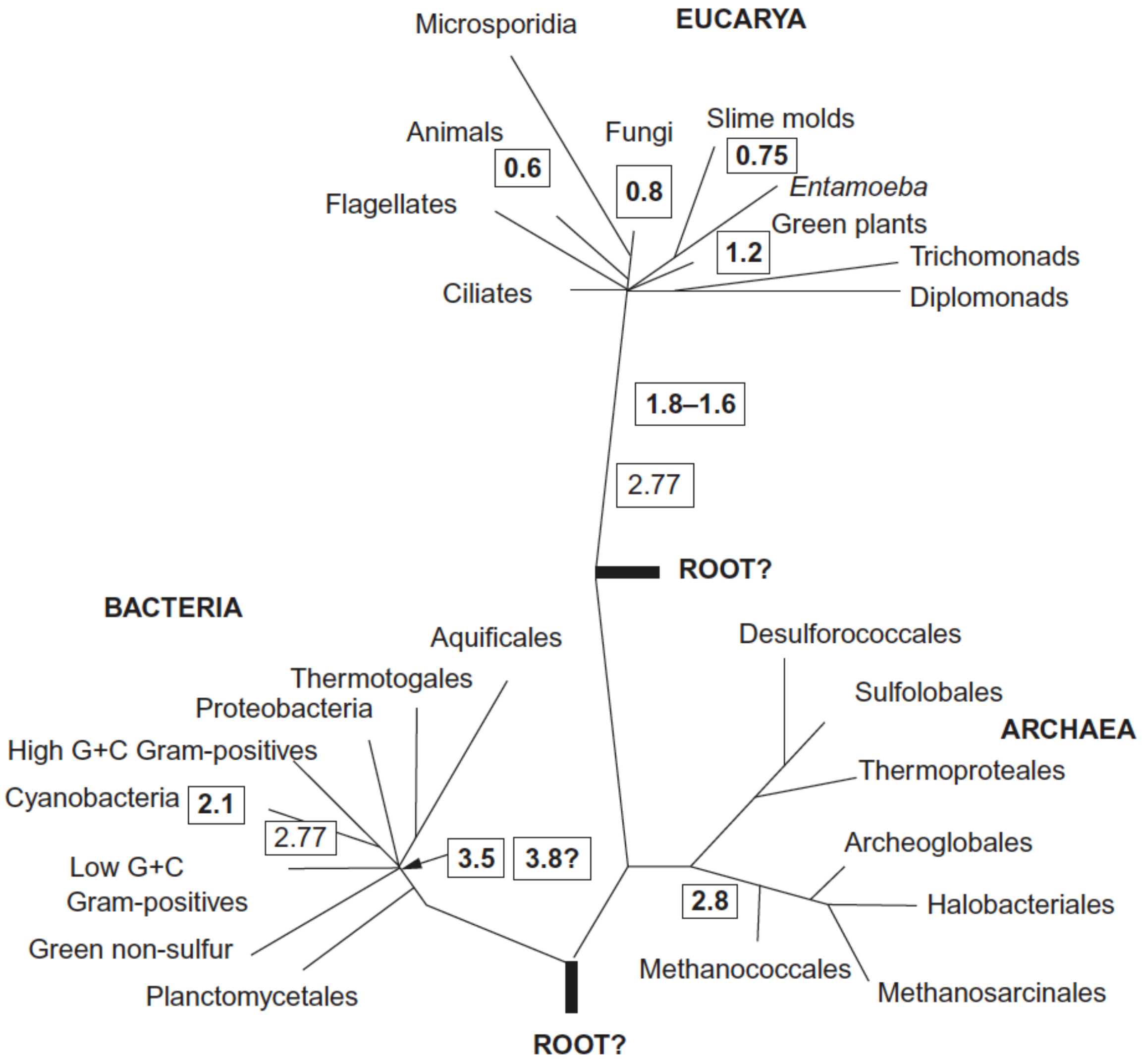


FIGURE 2.3 A geologic profile of the Earth's surface. On land the crust is dominated by granitic rocks, largely composed of Si and Al (Chapter 4). The oceanic crust is dominated by basaltic rocks with a large proportion of Si and Mg. Both granite and basalt have a lower density than the upper mantle, which contains ultrabasic rocks with the approximate composition of olivine ($FeMgSiO_4$). *Source: From Howard and Mitchell (1985).*

TABLE 2.3 Total Inventory of Volatiles at the Earth's Surface[a]

Reservoir	H_2O	CO_2	C	O_2	N	S	Cl	Ar	Total (rounded)
Atmosphere (see Table 3.1)	1.3	0.31	—	119	387	—	—	6.6	514
Oceans	135,000	19.3[b]	0.07	256[c]	2[d]	128[e]	2610	—	138,000
Land plants	0.1	—	0.06	—	0.0004	—	—	—	0.16
Soils	12	0.40[f,g]	0.15	—	0.0095	—	—	—	12.6
Freshwater (including ice and groundwater)	4850	—	—	—	—	—	—	—	4,850
Sedimentary rocks	15,000[h]	30000[g]	1560	4745[i]	200[j]	744[k]	500[h]	—	52,750
Total (rounded)	155,000	30,000	1560	5120	590	872	3100	7	196,000
See also	Fig. 10.1	Fig. 11.1	Fig. 11.1	Fig. 2.8		Table 13.1			

[a] *All data are expressed as 10^{19} g, with values derived from this text unless noted otherwise.*
[b] *Assumes the pool of inorganic C is in the form of* HCO_3^-.
[c] *Oxygen content of dissolved* SO_4^{2-}.
[d] *Dissolved* N_2.
[e] *S content of* SO_4^{2-}.
[f] *Desert soil carbonates.*
[g] *Assumes 60% of* $CaCO_3$ *is carbon and oxygen.*
[h] *Walker (1977).*
[i] O_2 *held in sedimentary* Fe_2O_3 *and evaporites* $CaSO_4$.
[j] *Goldblatt et al. (2009).*
[k] *S content of* $CaSO_4$ *and* FeS_2.



Chemoheterotrophs

$$CH_3COOH \rightarrow CO_2 + CH_4.$$

Anaerobic Respiration

$$CO_2 + 4H_2 \rightarrow CH_4 + 2H_2O,$$

Autotrophic pathways

$$CO_2 + 2H_2S \rightarrow CH_2O + 2S + H_2O$$

$$H_2O + CO_2 \rightarrow CH_2O + O_2.$$

$$4Fe^{2+} + HCO_3^- + 10H_2O \rightarrow CH_2O + 4Fe(OH)_3 + 7H^+.$$

TABLE 2.4 Estimates of Marine Primary Production about 3.5 Billion Years Ago

Process	Annual rate	See Equation
H_2-based anoxygenic photosynthesis	0.35×10^{15} gC/yr	2.11
Sulfur-based anoxygenic photosynthesis	0.03	2.12
Fe-based anoxygenic photosynthesis	4.0	2.15
Present day	~50.0	2.14; Chapter 9

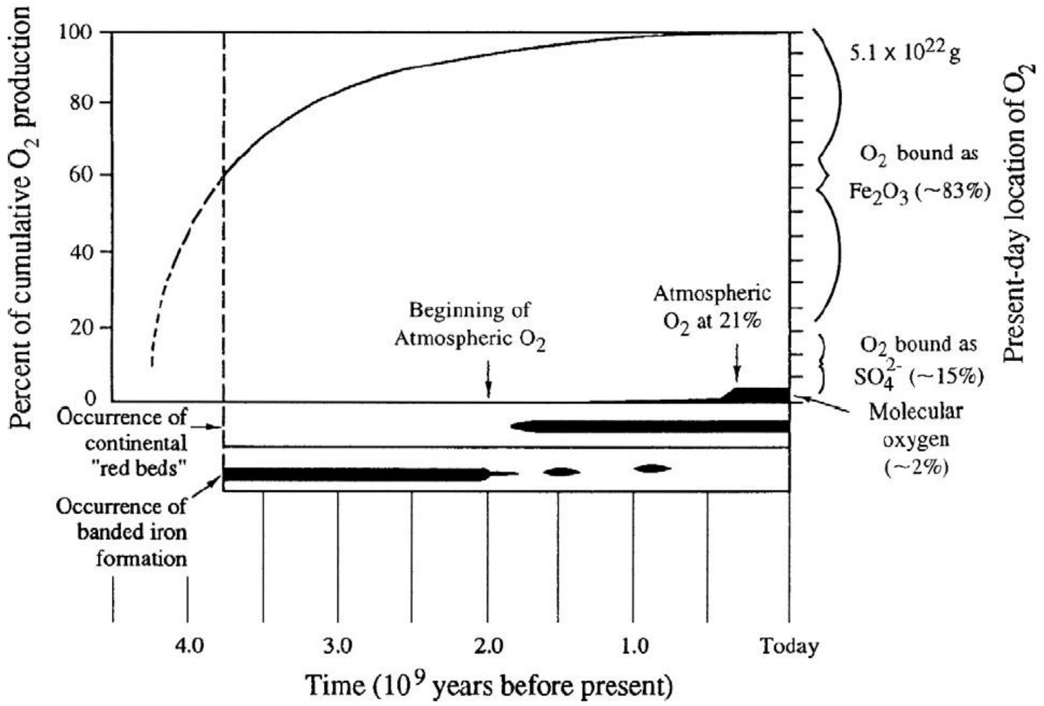


FIGURE 2.8 Cumulative history of O_2 released by photosynthesis through geologic time. Of more than 5.1×10^{22} g of O_2 released, about 98% is contained in seawater and sedimentary rocks, beginning with the occurrence of banded iron formation beginning at least 3.5 bya. Although O_2 was released to the atmosphere beginning about 2.0 bya, it was consumed in terrestrial weathering processes to form red beds, so that the accumulation of O_2 to present levels in the atmosphere was delayed to 400 mya. *Source: Modified from Schidlowski (1980).*

TABLE 2.5 Milestones in the Deep History of the Earth

Milestone	When occurred (bya)
Origin of the Universe	13.7
Origin of the Milky Way Galaxy	12.5
Origin of the Sun	4.57
Accretion of the Earth largely complete[a]	4.5
Liquid water on Earth	4.3
Last of the great impacts	3.8
Earliest evidence of photosynthesis	
Depleted ^{13}C and banded iron formations	3.8
Earliest evidence of cellular structures	3.5
First evidence of cyanobacteria	2.7
First evidence of O_2 in the atmosphere	2.45
Evidence of seawater SO_4^{2-}, thus O_2	2.4
Evidence of denitrification, hence NO_3^- and O_2	2.5
Evidence of aerobic rock weathering (red beds)	2.0
First evidence of eukaryotes	2.0
End of banded iron formation	1.8
Land plants	0.43
Genus *Homo*	0.002

[a] *Impact of Theia at 4.527 bya forms the Moon.*

$$\lambda$$

$$6CO_2 + 6H_2O = C_6H_{12}0_6 + 6O_2$$

Stoichiometery

The relationships between the quantities of reactants and products before, during, and following chemical reactions.

Primary Production
(Photosynthesis)
Inorganic → Organic
Immobilization

$$6CO_2 + 6H_20 \rightleftarrows C_6H_{12}0_6 + 60_2$$

Respiration
(Biosynthesis / Decomposition)
Organic → Organic / Inorganic
Mineralization

" ...In each of seven houses are seven cats; each cat kills seven mice; each mouse would have eaten seven ears of spelt (wheat); each ear of spelt would have produced seven hekat (half a peck) of grain. Query: How much grain is saved by the seven houses' cats?... "

Define the System in terms of the entities and components

Define the Boundaries

Identify the Controls and Feedbacks

What would Homeostasis look like

$$\frac{dX}{dt} = rX - sX^2 - cXY$$

$$\frac{dX}{dt} = rX - sX^2 - cXY$$

$$\frac{dY}{dt} = -dY - sY^2 + apcXY$$

$$\frac{dX}{dt} = rX - sX^2 - cXY$$

$$\frac{dY}{dt} = \text{-}\ dY + apcXY$$

Modeling Feeding Rates

Steady state: production of a population balances the losses through natural death and predation

$$F_j = \frac{d_j B_j + M_j}{a_j p_j}$$

Prey$_i$ ⟶ *Predator$_j$*

B_i B_j

F_j : feeding rate (kg ha^{-1} yr^{-1})
D_j : natural death rate (yr^{-1})
B_j : biomass (kg ha^{-1})
M_j : mortality due to predation (kg ha^{-1} yr^{-1})
a_j : assimilation efficiency (%)
p_j : production efficiency (%)

Consumed Biomass

$$F_j = \frac{d_j B_j + M_j}{a_j p_j}$$

↓ ↘

Assimilated Biomass

$$a_j F_j$$

Unassimilated Biomass (e.g., leavings & feces)

$$(1 - a_j)F_j$$

↓ ↘

Production Biomass (Growth & Reproduction)

$$a_j p_j F_j$$

Mineralized Biomass (e.g., CO_2 & NH_4^+)

$$C_{ij} = a_j(1 - p_j)F_{ij}$$

$$N_{ij} = a_j\left(\frac{1}{CN_i} - \frac{p_j}{CN_j}\right)F_{ij}$$

$$6CO_2 + 6H_2O \overset{\lambda}{=} C_6H_{12}0_6 + 6O_2$$

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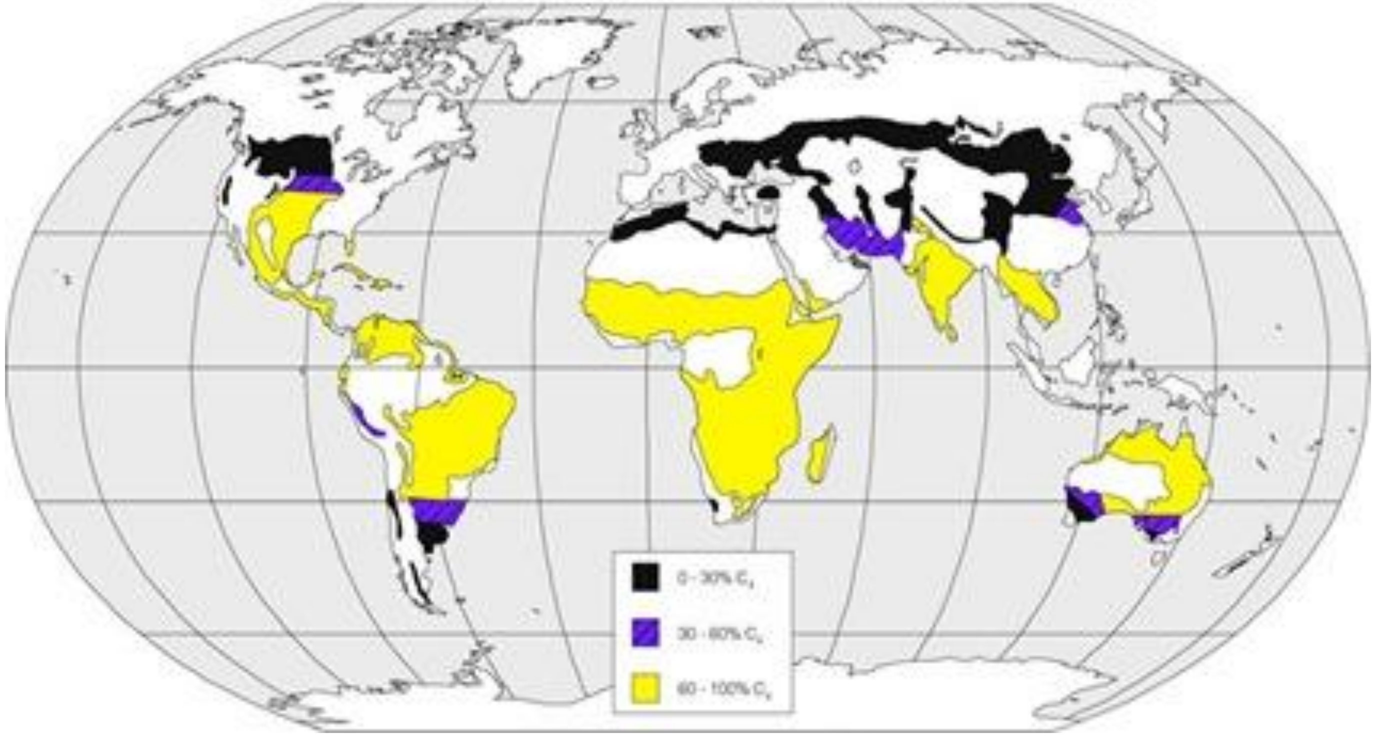
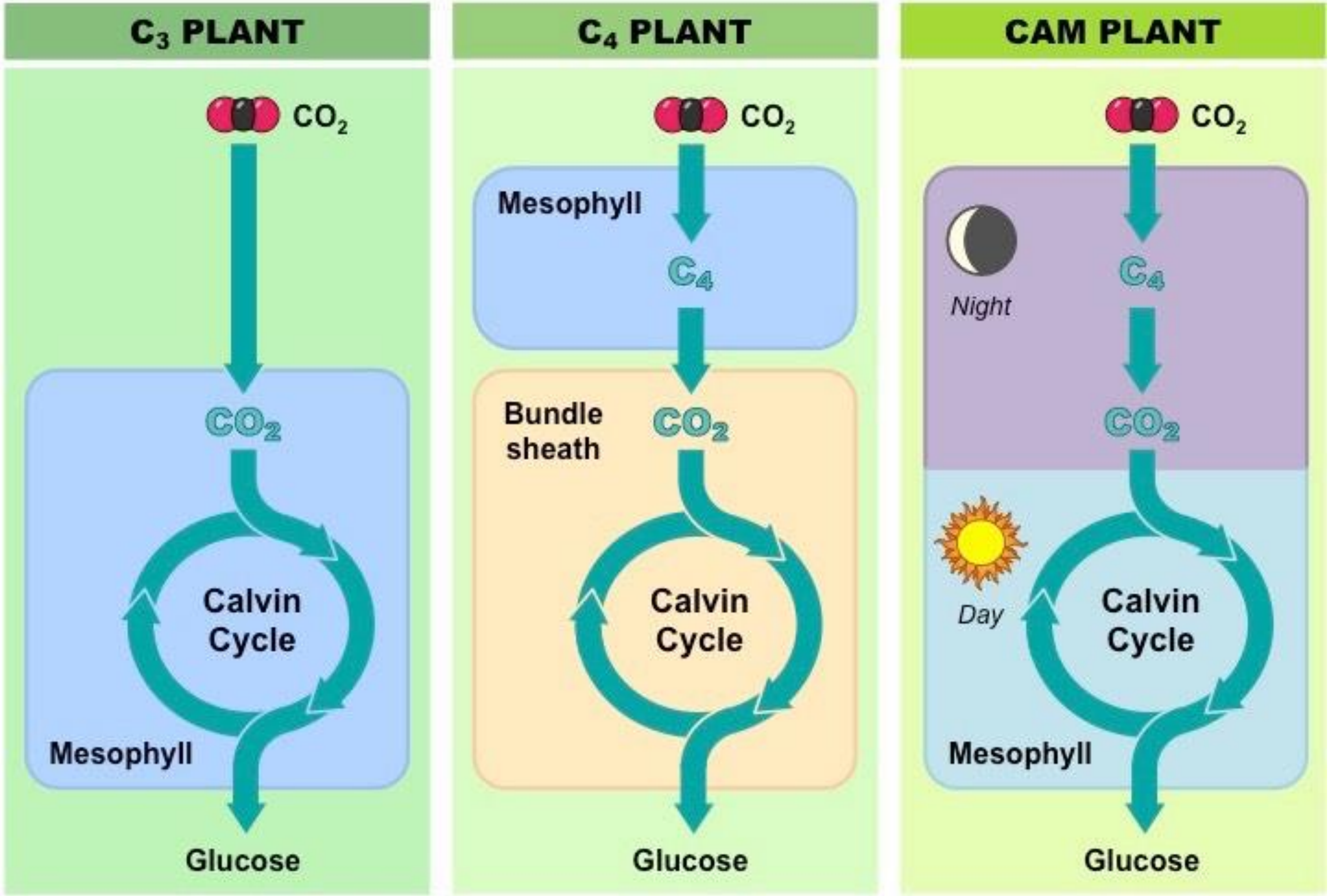
Organic → Organic / Inorganic
Mineralization

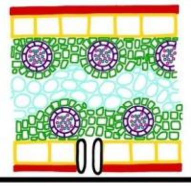
Distributions of C_3 and C_4 grasses in the savanna and steppe ecosystems



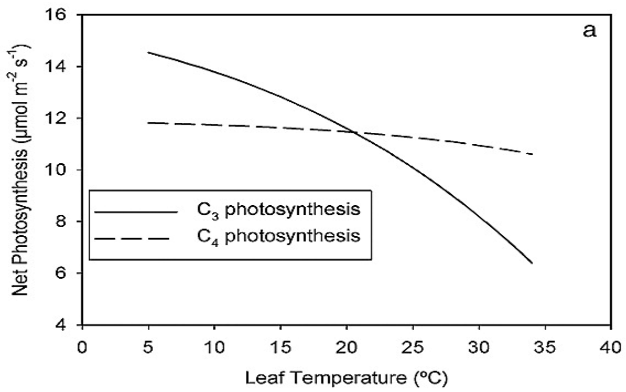


C_3 PLANT
CO_2
CO_2
Calvin Cycle
Mesophyll
Glucose
C_4 PLANT
CO_2
Mesophyll
C_4
Bundle sheath
CO_2
Calvin Cycle
Glucose
CAM PLANT
CO_2
Night
C_4
CO_2
Day
Calvin Cycle
Mesophyll
Glucose

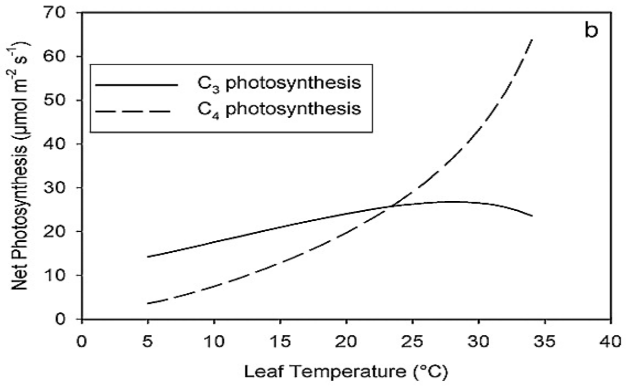
C3 C4 AND CAM PLANTS SUMMARIZED!

	C3 PLANT	C4 PLANT	CAM PLANT
SUMMARY	TEMPERATE PLANTS NO SPECIAL MODS	HOT WEATHER PLANTS SEPARATE FIXATION & CALVIN CYCLE	DESERT PLANTS NIGHT: GAS EXCHANGE DAY: PHOTOSYNTHESIS
STRUCTURE			
EXAMPLES	MOST PLANTS ARE C3 RICE, CANNABIS	CORN, SUGARCANE	CACTI, PINEAPPLES
KEY CELLS	PALISADE MESOPHYLL	PALISADE MESOPHYLL BUNDLE SHEATH	PALISADE MESOPHYLL
IDEAL TEMPERATURE	20-30°C (65-85 $^\circ$F)	30-40°C (85-105 $^\circ$F)	NIGHT: 10-15 $^\circ$C (50-60 $^\circ$F) DAY: 30-40 $^\circ$C (85-105 $^\circ$F)

Global distribution of C3 and C4 vegetation: Carbon cycle implications



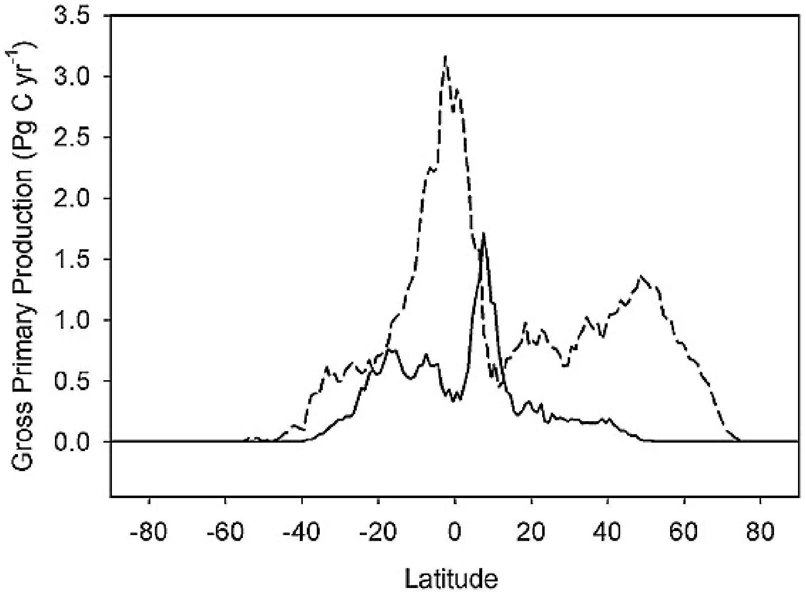
Light Limited Conditions



Light Saturated Conditions

Global Biogeochemical Cycles, Volume: 17, Issue: 1, Pages: 6-1-6-14, First published: 10 January 2003, DOI: (10.1029/2001GB001807)

Global distribution of C3 and C4 vegetation: Carbon cycle implications



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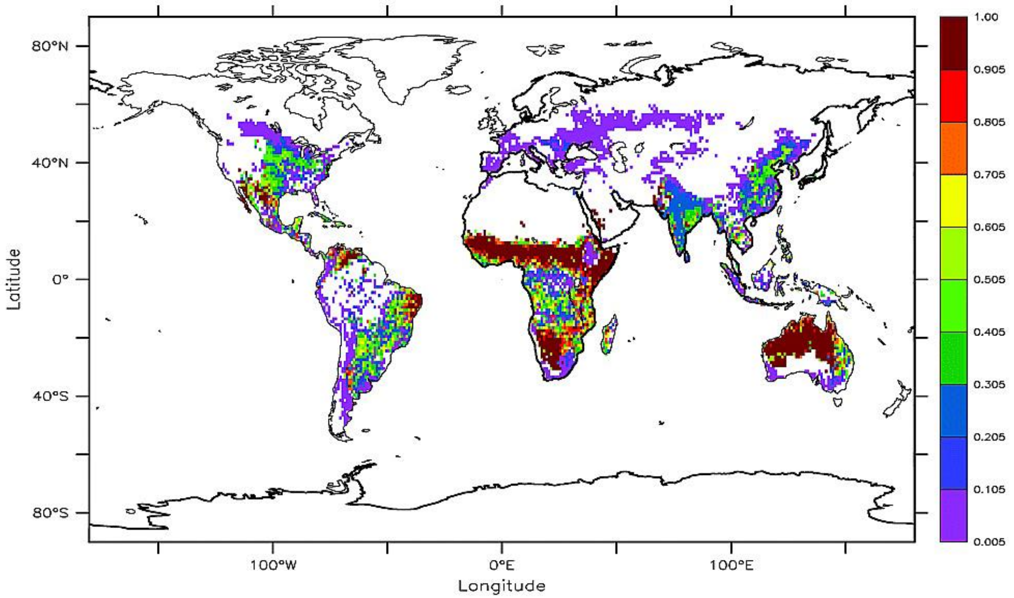

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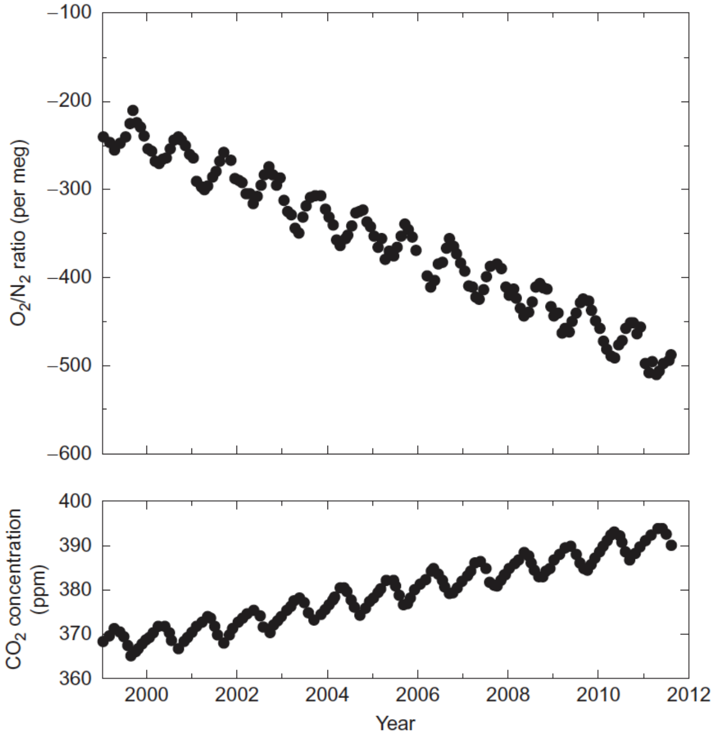
Processes and Timesteps



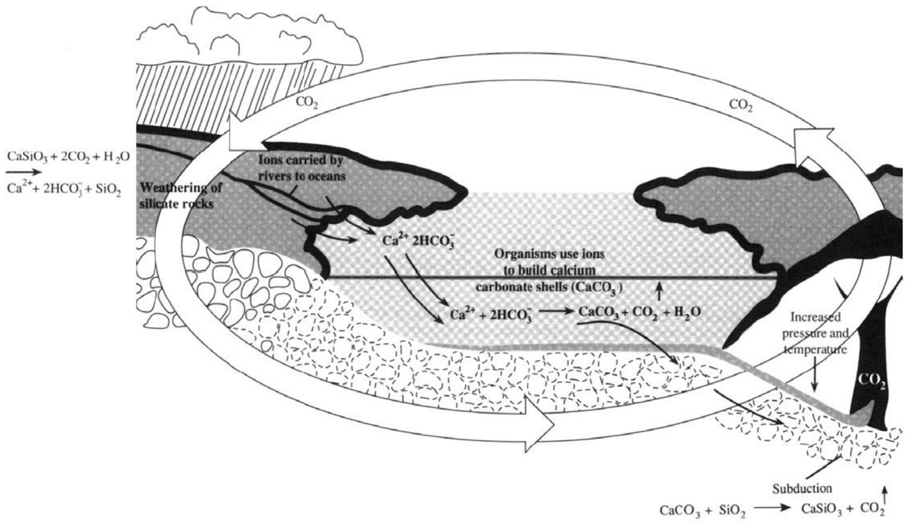


FIGURE 1.3 The interaction between the carbonate and the silicate cycles at the surface of Earth. Long-term control of atmospheric CO_2 is achieved by dissolution of CO_2 in surface waters and its participation in the weathering of rocks. This carbon is carried to the sea as bicarbonate (HCO_3^-), and it is eventually buried as part of carbonate sediments in the oceanic crust. CO_2 is released back to the atmosphere when these rocks undergo metamorphism at high temperature and pressures deep in Earth. *Source: Modified from Kasting et al. (1988).*

Assignment 1

Due: Thursday, September 18

In preparation for this assignment, please read the handout on Reverse Outlining, the RFP for the NSF Graduate Research Fellowship Program (NSF 24-591).

UNIVERSITY WRITING PROGRAM

REVERSE OUTLINING

Reverse outlining is exactly what it sounds like: a process whereby you take away the supporting writing and are left with a paper's main points or main ideas, sometimes represented by the paper's topic sentences. Your reverse outline provides a bullet-point view of the paper's structure because you are looking at the main points of the paper, whether written by yourself or by someone else.

Reverse Outlining for Comprehension

Some assignments ask you to read and analyze complex information. In such cases, reverse outlining a text or lecture can help you distill the main ideas into short, clear statements. Look for key terms and concepts that can help define these main ideas – but also make sure that you understand what they each mean in their context, since simply copying down key terms won't automatically guarantee that you understand them!

Reverse Outlining for Writing and Revision

You can also use reverse outlining to revise your own work and to ensure that your writing is clear, well-structured, and logically coherent. All writers need ways to test their drafts for the logical sequence of points – its structure – and a reverse outline allows you to read a condensed version of what you have written. This can be particularly valuable if you wrote without an outline (never recommended for academic writing!), or if you modified the structure of your draft as you wrote.

As shown in more detail on the next page, reverse outline of your own writing can help you (1) determine if your paper meets its goal, (2) discover places to expand on your evidence or analysis, and (3) see where readers might be tripped up by your organization or structure.

How to Create and Use a Reverse Outline

1. **Start a new document or use a blank piece of paper.** It's important to keep the original writing separate from the reverse outline you're about to create.
2. **List the main idea of each paragraph**, working systematically through the entire paper. If a paragraph's topic sentence provides a succinct version of the paragraph's argument, you can simply copy that sentence into the outline as a summary for that paragraph. Otherwise, write a one-sentence summary to express as concisely as possible the main point of the paragraph.
3. **Number your outline** for ease of reference.
4. **Edit your writing,** expanding or condensing passages to achieve greater concision and clarity. On the next page are specific questions that will help as you begin editing.

NSF 24-591: NSF Graduate Research Fellowship Program (GRFP)

Program Solicitation

Document Information

Document History

- **Posted:** July 12, 2024
- **Replaces:** NSF 23-605

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Application Deadline(s) (received by 5 p.m. local time of applicant's mailing address):

October 15, 2024

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- Develop a reverse outline of the RFP using the guidelines provided.
- Provide a short summary of the Goals and Objectives of the RFP, a draft of your CV, and a list of the Required documentation and information needed for a proposal.
- Use in text citations of the RFP in your short summary.
- List the papers in a formal reference section.