Week 5 – September 30, 2003
Blackbody radiation:

Monochromatic irradiance of radiation emitted by a blackbody at (absolute) temperature $T$ is given by:

$$E_\lambda = \frac{C_1}{\lambda^5 \left(e^{\frac{C_2}{\lambda T}} - 1\right)}$$

When $C_2 = 3.74 \times 10^{-16}$ W m$^2$ K$^{-4}$

$C_2 = 1.44 \times 10^{-2}$ m$^2$ K$^{-1}$

Blackbody radiation is isotropic

$$E_\lambda \equiv C_1 \lambda^{-5} e^{-\frac{C_2}{\lambda T}}$$

$$\lambda m \approx \frac{2897}{T}$$

Weins Displacement Law
The Maximum wavelength of emission of the Sun is 0.475 µm (475 nm)

What is the “color temperature” of the sun?

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Integrating the Planck blackbody irradiance over all wavelengths

$$E^* = \sigma T^4$$

$\sigma$ is the Stefan – Boltzman constant

$$5.67 \times 10^{-8} \text{wm}^{-2}\text{degree}^{-4}$$
Let $S_o$ be solar irradiance incident on Earth ($=1380 \text{ wm}^{-2}$)-the solar “constant”, $R_e$ is the radius of Earth, $\alpha$ is albedo.

At equilibrium, \textbf{Incoming = Outgoing} \hspace{1cm} (1-\alpha) S_o \pi R_e^2 = E \cdot 4\pi R_e^2

\therefore \hspace{1cm} E = \frac{S_o}{4} (1-\alpha)

\sigma T^4 = \frac{1}{4} S_o (1-\alpha) \hspace{0.5cm} \text{key radiant Eqn for climate}
Solar spectrum at the top of the atmosphere

After scattering by the atmosphere

O_3

H_2O, O_2

H_2O

Solar radiation at sea level

H_2O

H_2O, CO_2

H_2O, CO_2

H_2O, CO_2

Solar spectral irradiance (W m\(^{-2}\) nm\(^{-1}\))

Wavelength (nm)

150 400 800 1200 1600 2000 2400 2800 3200 3600 4000

U.V. Visible Infra red
Fig. 5.15. a Solar energy absorbed and terrestrial radiative energy emitted by the earth atmosphere system. b Earth's albedo measured by satellite. (Von der Haar and Suomi 1971)
GLOBAL ENERGY BALANCE
(Unit: W m\(^{-2}\))

\[ \frac{1}{4} S_0 = 1 - \alpha \]

\[ \frac{1}{4} S_0 (1 - \alpha) = \]

SHORT WAVE

\[ \alpha = 31\% \]

V. RAMANATHAN

The Role of Earth Radiation Budget Studies in Climate and General Circulation Research
Week 5 – October 2, 2003
Figure 1.1 Prokaryotic and eukaryotic cells, showing their principal differences (see Table 1.1). The prokaryotic cell lacks a nucleus, chromosomes, mitochondria, and chloroplasts, and generally ranges in size between 0.5 and 15 μm. Eukaryotic cells possess a variety of organelles, one or more nuclei, 2–600 chromosomes, mitochondria, and in some, chloroplasts. They are generally much larger than prokaryotic cells.
<table>
<thead>
<tr>
<th>Prokaryotes</th>
<th>Eukaryotes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nucleus absent</td>
<td>Nucleus present</td>
</tr>
<tr>
<td>Meiosis absent</td>
<td>Meiosis</td>
</tr>
<tr>
<td>One basic genome</td>
<td>Chromosome number 2–600</td>
</tr>
<tr>
<td>Mitochondria absent</td>
<td>Mitochondria present</td>
</tr>
<tr>
<td>Chloroplasts absent</td>
<td>Chloroplasts may be present</td>
</tr>
<tr>
<td>Endoplasmic reticulum absent</td>
<td>Endoplasmic reticulum present</td>
</tr>
<tr>
<td>Vacuoles absent</td>
<td>Vacuoles present</td>
</tr>
</tbody>
</table>
Figure 1.3 RNA phylogeny of life, showing the deep separation between the archaebacteria, eubacteria, and eukaryotes, as well as the close relationship between eukaryotic chloroplasts, mitochondria, and the eubacteria.
Figure 1.5 Representation of the endosymbiosis theory for the development of the eukaryotic cell. A preexisting eukaryotic lineage with a cell structure and nucleus acquires first a purple bacterium followed by a cyanobacterium as endosymbionts. These transfer genetic material to the nucleus of the cell, thus making an integrated eukaryotic cell.
Figure 3–59  Bacteria, chloroplasts, and mitochondria all contain an electron-transport complex that closely resembles the b-c1 complex of mitochondria. The complexes all accept electrons from a ubiquinonelike carrier (here designated as Q) and pump protons across their respective membranes. They are assumed to be evolutionarily related.
The codon wheel