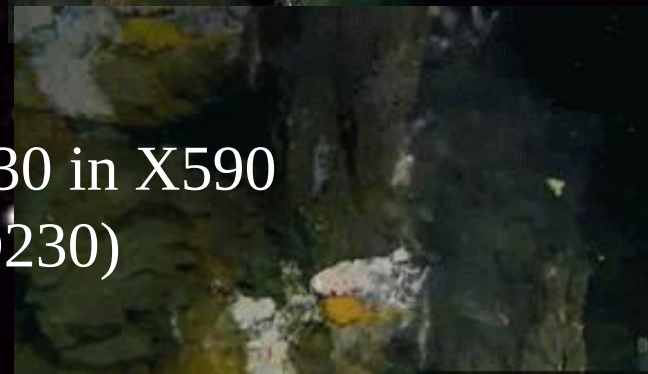
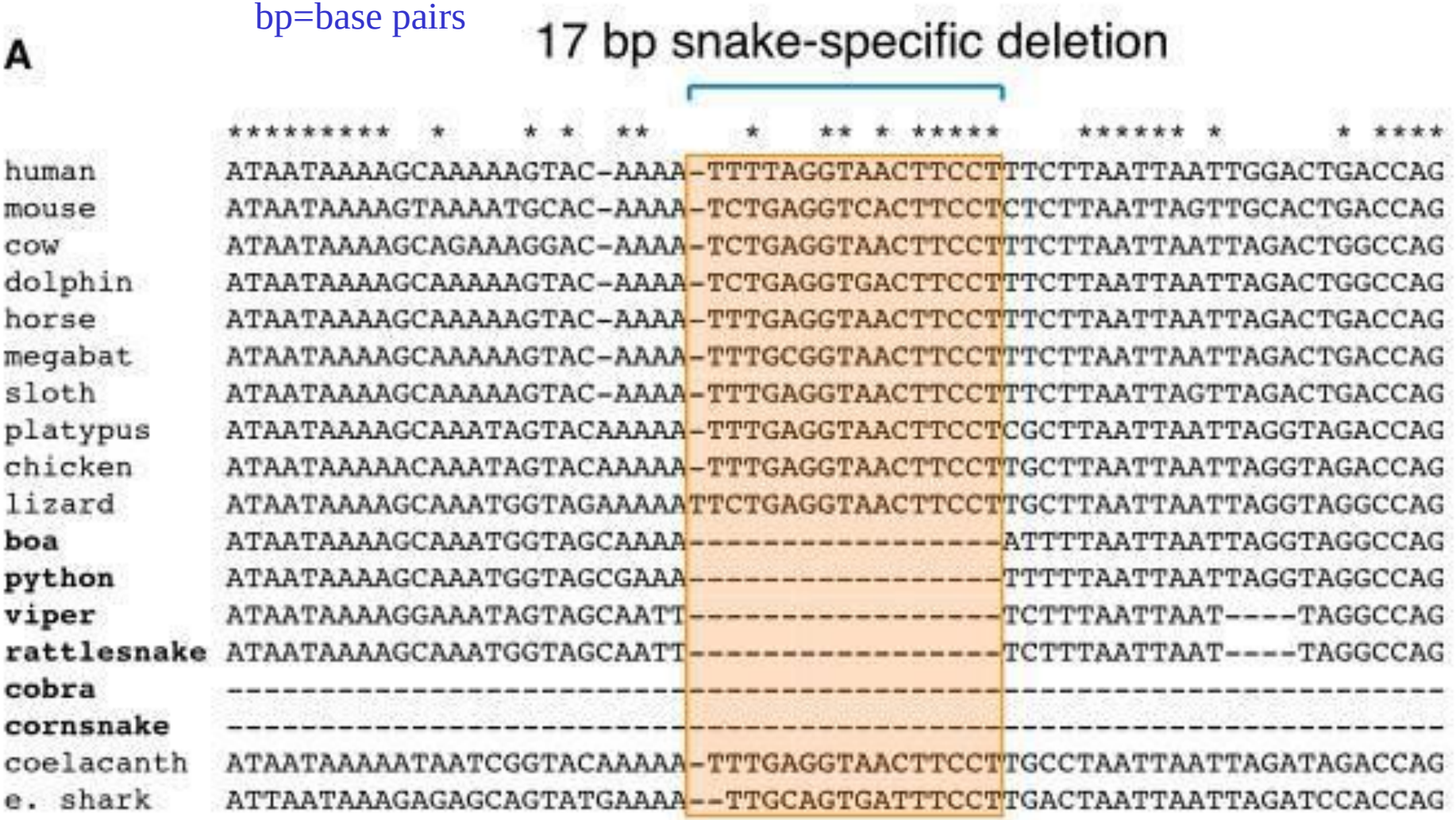
ASTR/GEOL-2040: Search for life in the Universe, Lecture 6



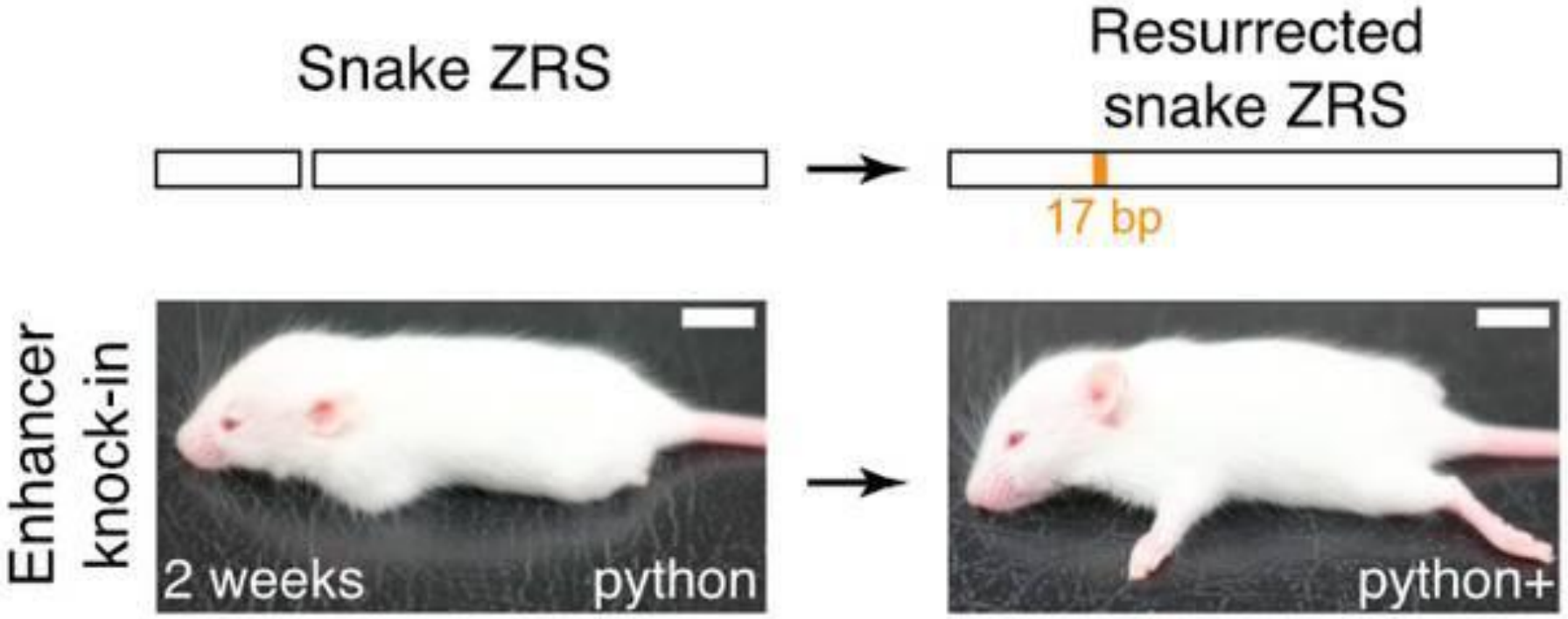
Axel Brandenburg
(Office hours: Mondays 2:30 – 3:30 in X590
and Wednesdays 11-12 in D230)

Regarding question of last time…

bp=base pairs



Some genes: large variations

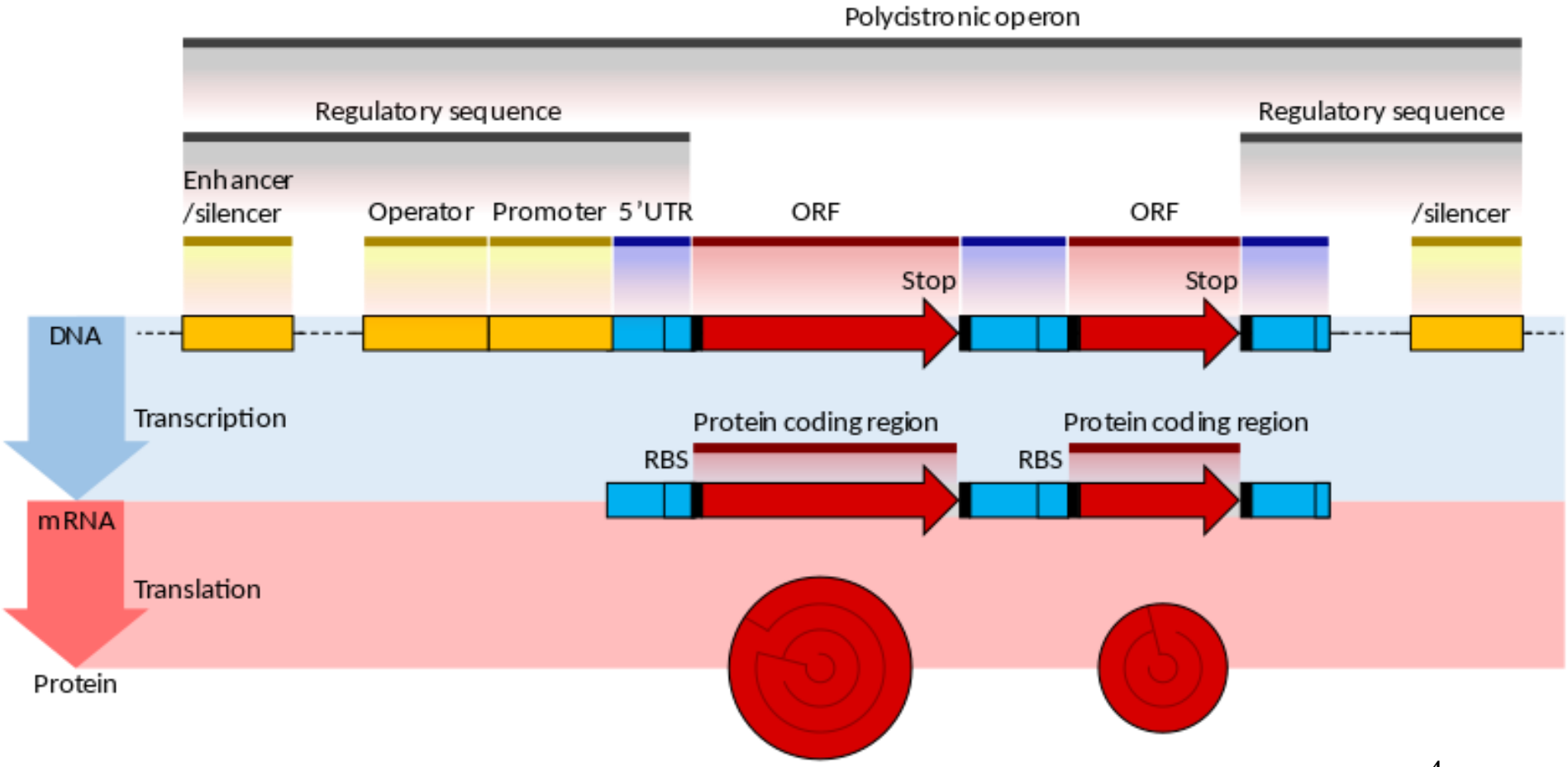


http://www.bestchinanews.com/Explore/2003.html

Not all DNA codon based

Regulatory sequence: does not code for protein

Sometimes called “junk DNA”



Last time

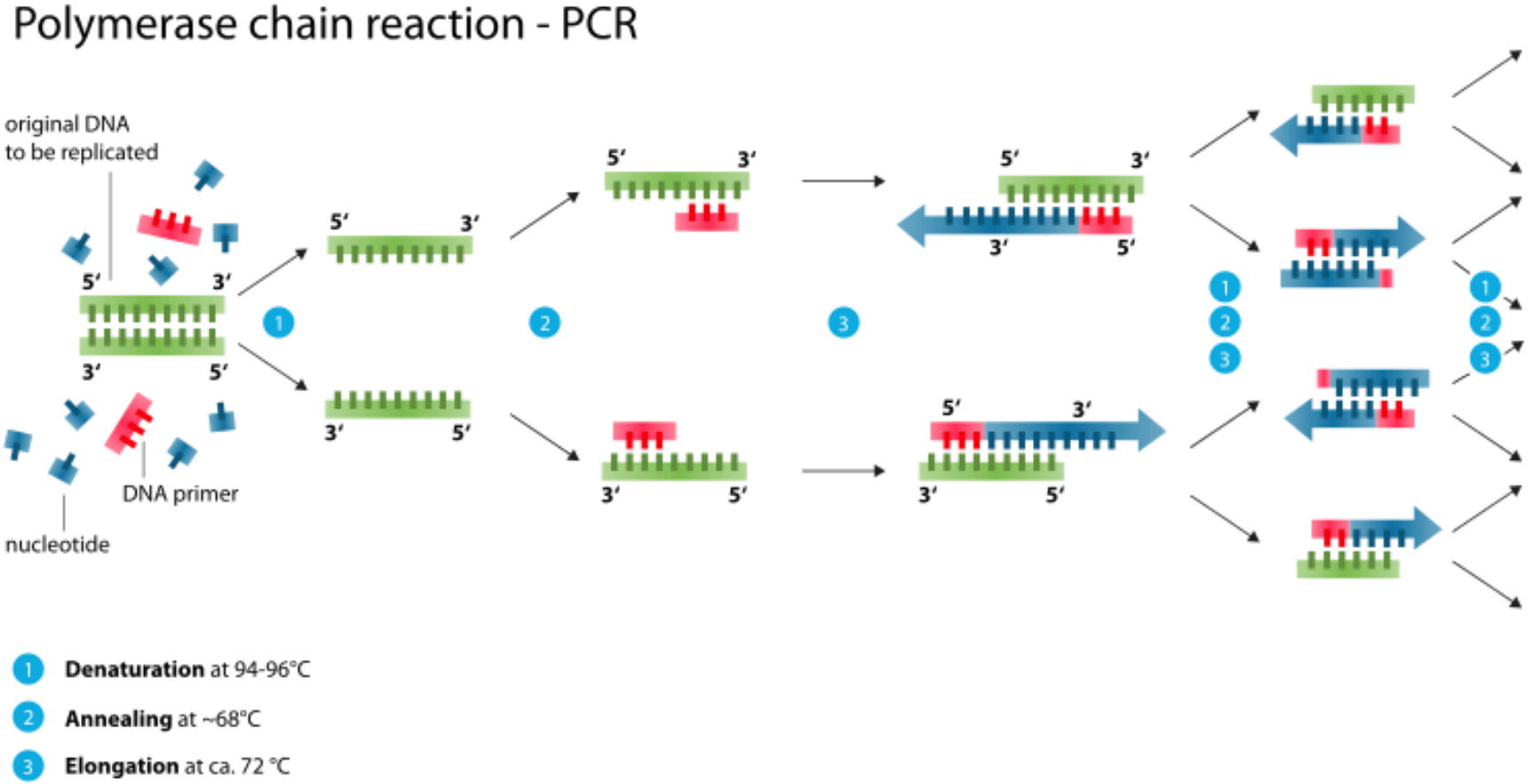
- Alphabet of 4 letters
- Words with 3 letters
- Each word → a particular amino acid
- Gene → a particular protein

3-letter words

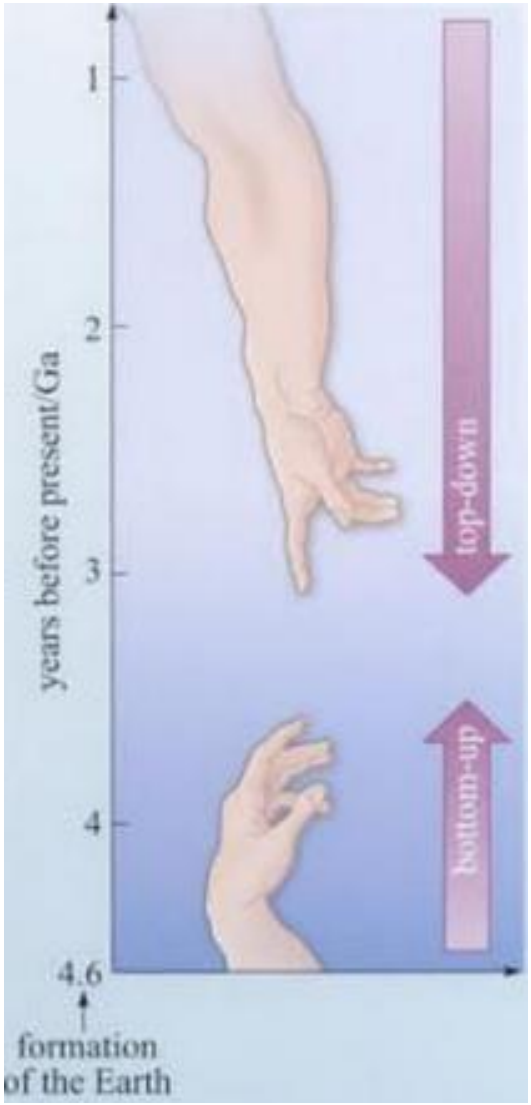
1st letter	Second Letter: U	Second Letter: C	Second Letter: A	Second Letter: G	3rd letter
U	UUU Phe UUC UUA Leu UUG	UCU UCC Ser UCA UCG	UAU Tyr UAC UAA Stop UAG Stop	UGU Cys UGC UGA Stop UGG Trp	U C A G
C	CUU CUC Leu CUA CUG	CCU CCC Pro CCA CCG	CAU His CAC CAA Gln CAG	CGU CGC Arg CGA CGG	U C A G
A	AUU AUC Ile AUA AUG Met	ACU ACC Thr ACA ACG	AAU Asn AAC AAA Lys AAG	AGU Ser AGC AGA Arg AGG	U C A G
G	GUU GUC Val GUA GUG	GCU GCC Ala GCA GCG	GAU Asp GAC GAA Glu GAG	GGU GGC Gly GGA GGG	U C A G

- Lethal mutation: UAC → UAA or UAG
- No effect: UAC → UAU (both **Tyr**osine)

Base pairing in forensics



How to study origins & remains of life?



- Top-down versus bottom-up
  - Bottom-up: how nonliving matter combines to make living matter
  - Top-down: extrapolate biology toward simplest living organism
- Biomarkers/biosignatures
  - Extinct life (no longer alive)
  - Extant life (currently living)

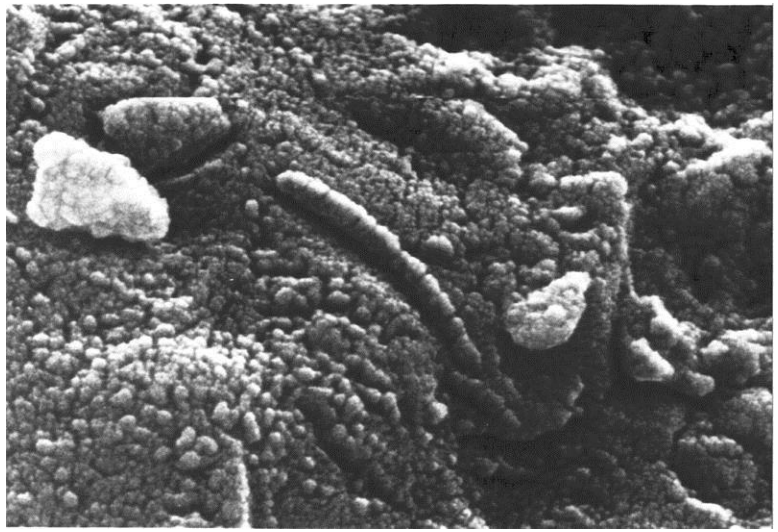
Biomarkers

- Petroleum, fossil fuel
  - Molecular fossils
  - Organic-rich rocks

- Astrobiology
  - Cellular remains
  - Textual fabrics in sediments: structure & function
  - Biogenic (biologially produced) org. Matter
  - Minerals deposition affected by biological processes
  - Stable isotopes reflecting biological activity
  - Atmospheric constituents: concentrations ← biol source

Subjectivity

- Textual fabrics or organics
  - Difficult to tell whether biogenic or not
  - Giant stars produce carbon compounds
- Martian meteorite
  - controversial
  - abiogenic
- ^{13}C also not unchallenged
- Contamination (for meteorites)



Biosignatures from space

A search for life on Earth from the Galileo spacecraft

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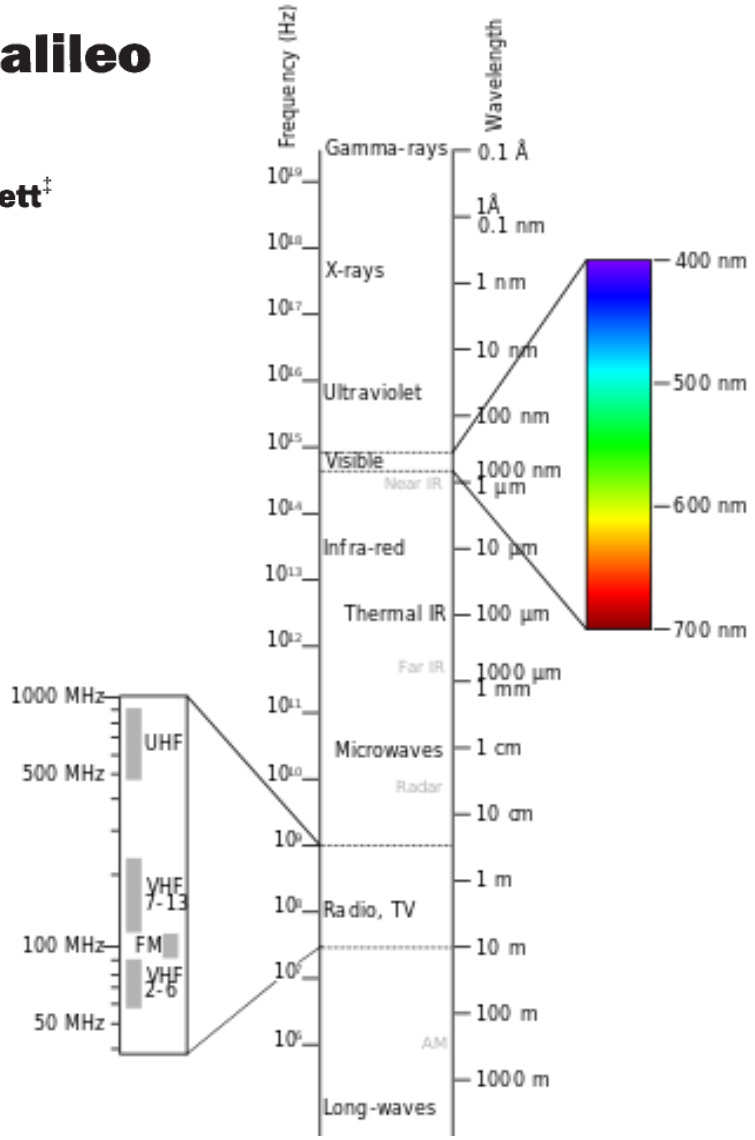
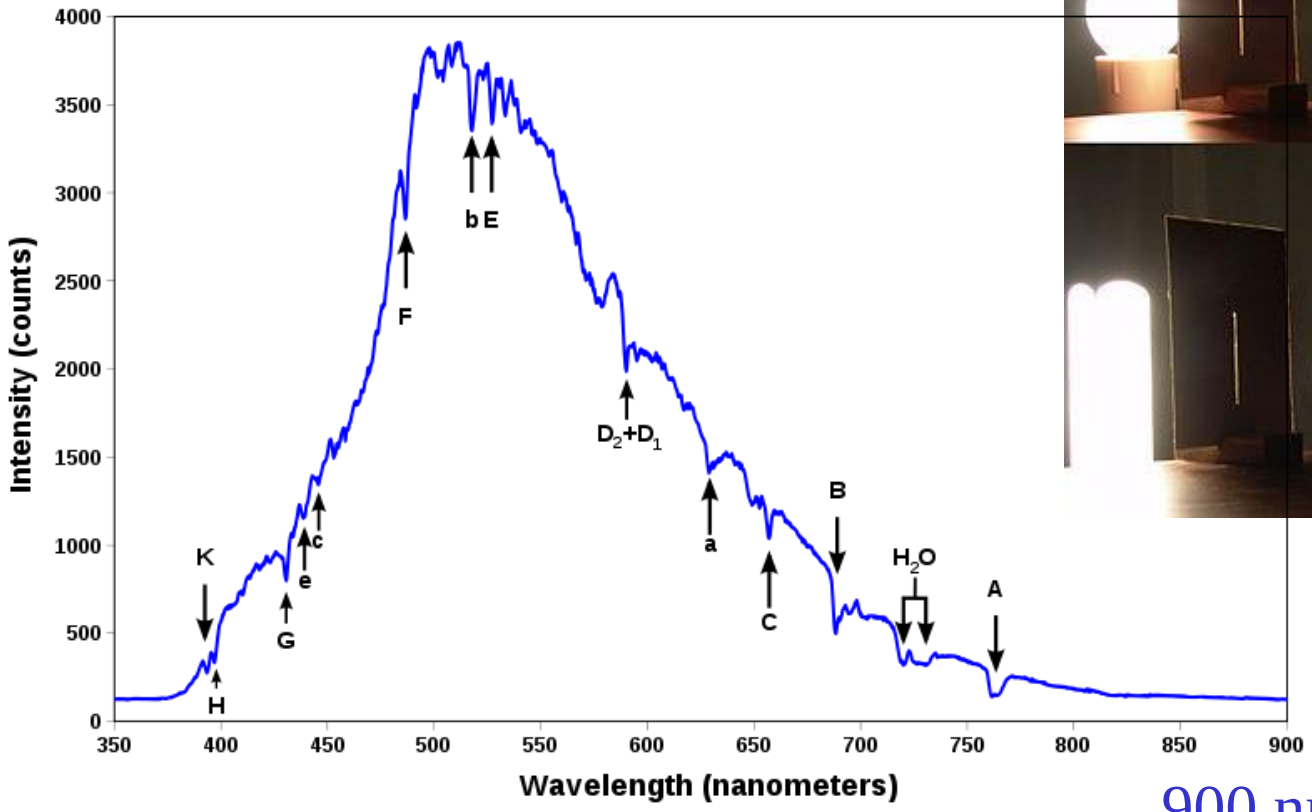


Spectral lines

- Emission spectrum
- Absorption lines



Spectrum of air

900 nm = 0.9 μm

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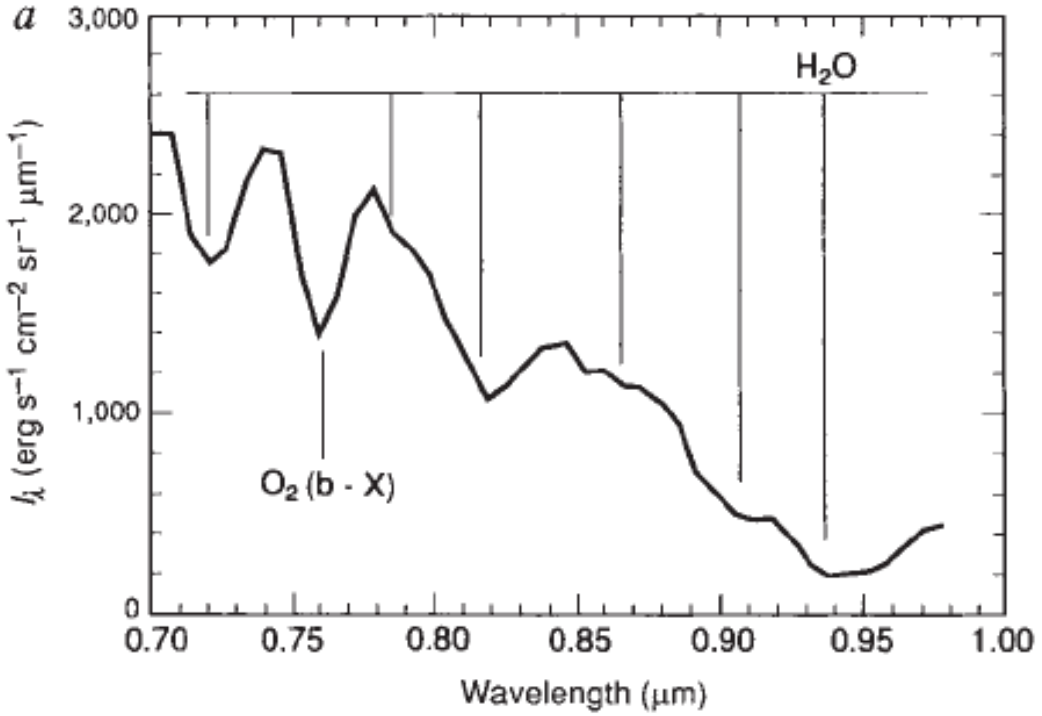


Think about other non-equilibrium processes

- ….
- ……..
- ……….
- ……….

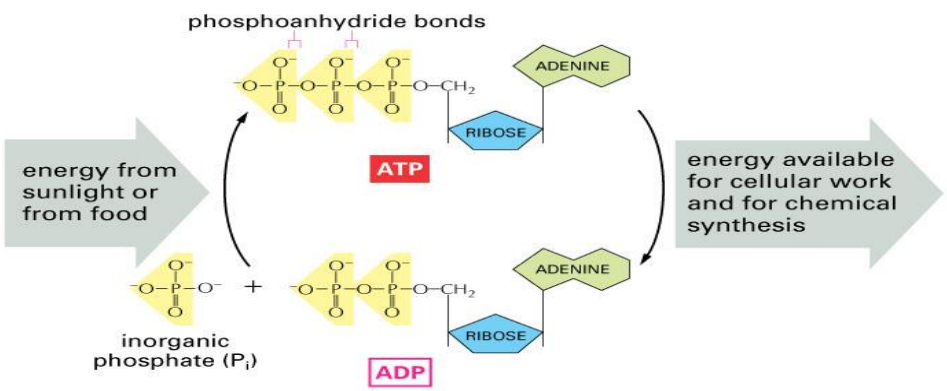
What is the energy source?

Example	Energy source	Resulting activity
mountains	geothermal heat	Keeps rock rolling

What is the energy source?

Example	Energy source	Resulting activity
mountains	geothermal heat	Keeps rock rolling
Atmosphere	Solar heating	Keeps rain coming
El circuit	Electric energy	Keeps motor running
living cell	Carbon supply	ADP → ATP

$CO_2+h\nu$
or CH_2O



adenosine
triphosphate

Commonalities:

- All life uses ATP
- All life uses same genetic code

→ Common origin?

Next time

- Organic matter in the Universe
- Synthesis of organics on early Earth
  - Miller/Urey experiment, Murchison
  - Chirality
- Biomolecule delivery from space
- Reading:
  - RGS pp. 18-29, Lon pp. 214-218
  - BS pp. 204-212