Hanahan & Weinberg:

![Diagram of signaling pathways]

BE.440 uses $\downarrow$ to understand $\uparrow$.

Conventional biochemical pathways

Topic: Evolution
(Replication, Recombination, Transcription, Translation)

Board: Storage, Replication, Evolution, and Transmission of biological info.

Some Definitions:

Chemistry: the synthesis & properties of matter
Engineering: measurement, modeling, mining, manipulating
Biology: the science of life

LIFE
1) maintain order (crystals do this!)
2) reproduce (what about mules?)
3) evolve (mutation is sometimes an asset)

Life is hard to define!

DNA
- Inheritance
- Expression
- Evolution

RNA
- Expression
  - (Inheritance)
- Catalyst
Central Dogma (expanded from Ram's PPT)

DNA replication
\[ \text{DNA} \xrightarrow{\text{transcription}} \text{RNA} \xrightarrow{\text{RNA replication}} \text{protein} \xrightarrow{\text{enzymes}} \text{sugars} \xrightarrow{\text{post-transl. modification}} \text{protein} \]

Prions

DNA, RNA = Biopolymers.

\[
\begin{align*}
\text{B} & \quad \text{B} & \quad \text{B} \\
\text{P} - \text{S} - \text{P} - \text{S} - \text{P}
\end{align*}
\]

Configuration

Pka ≈ 1

\( \beta \) anomer

CHECKLIST:
1. \( \text{Pka} = 1 \)
2. \( \beta \) anomer (stereochemistry)
3. PDE
4. \( \text{H, OH at 2'} \)
5. \( 5' \rightarrow 3' \) (synthesis, encoding)
even more detail (DNA)

H-bonding preferences & energetics

10 bp = 34 Å

3.4 Å

Base Pairing

\[
\begin{align*}
G \equiv C & \quad 2-3 \text{ Kcal/mol} \\
A = T & \quad \text{per H-bond}
\end{align*}
\]

Note: dR vs. R

T vs. U

prototypes

purine

pyrimidines
Back to Arkin paper...

Two ways to get evolution:

1. Replication/repair error
2. Transposon-like mutation
   (Mismatch repair $\Rightarrow$ causes hyperrecombinogenic phenotype.)

Example 1: Natural Tautomerism

$$\text{Keto} \rightleftharpoons \text{enol}$$

$10^4:1$

$$\text{Amino} \rightleftharpoons \text{Imino}$$

$10^4:1$
Example 2:

\[
\begin{align*}
\text{NO} & \quad \xrightarrow{\text{H}_3\text{C} - \text{N} - \text{CH}_3} \quad \text{H}_3\text{C} - \text{N} = \text{N} \\
\text{N}_2 & \quad \xrightarrow{\text{O}_2^-} \quad 8\text{-oxo} \quad \xrightarrow{\text{free radicals}} \quad \text{G} \quad \xrightarrow{G + T} \quad \text{A}
\end{align*}
\]