Chem 452 - Lecture 1 Introduction to Biochemistry Part 3

- **Question of the Day:** This (last) week, big news was made in the field of genomic. It was not only reported in the journals Nature and Science, but was also picked up by the New York Times and the Eau Claire Leader-Telegram. What was this news?

Acid and Base Chemistry

- Biological systems are typically 70% water.
  - Self ionization of water
  - Addition of acids and bases to water
    - Arrhenius acids and bases
    - Brønsted-Lowry acids and bases
  - Buffers
    - Henderson-Hasselbalch Equation

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Check out the Elaborations on the class website.

Problem

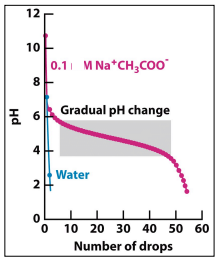
What is the *pH* of a 0.1 M solution of HCl?

Problem 1.7

What is the *pH* of a 0.1 M solution of acetic acid (pK_a = 4.75)?

Acid and Base Chemistry

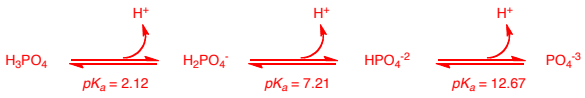
- Buffers
  - A mixture of a weak acid and its conjugate base
  - Henderson-Hasselbalch Equation



Adding 1M HCl to water and to a solution of 0.1M sodium acetate

Acid and Base Chemistry

- Buffers
  - Henderson-Hasselbalch Equation
  - Phosphate buffers

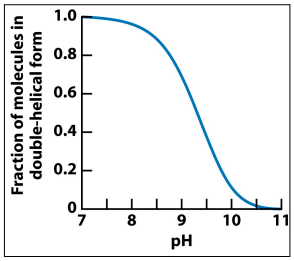


Problem 1.14

For an acid, HA, the concentrations of HA and A^- at *pH* 6.0 are 0.075 and 0.025, respectively. What is the pK_a value for the acid?

Acid and Base Chemistry

- Double-stranded DNA denatures at high pH values.



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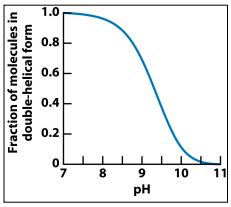

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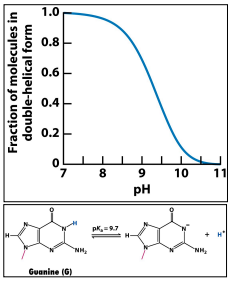

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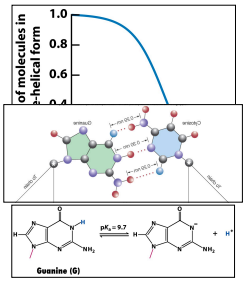

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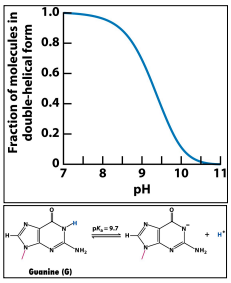

Genomics

ge•no•mics |jēˈnōmiks; -ˈnäm-|,

plural noun [treated as sing.]
the branch of molecular biology concerned with the structure, function, evolution, and mapping of genomes.

ORIGIN 1980s: from *genome* [the complete set of genes present in an organism] + *-ics*.

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Click here for timeline

Genomics

- The genetic code (1960's)

DNA: A G T C
↓ transcription ↓ transcription
mRNA: U C A G
↓ translation ↓ translation
Protein: A C D E F G H I K L M N P Q R S T V W Y

Genomics

- The "Central Dogma"

DNA $\xrightarrow{\text{transcription}}$ mRNA $\xrightarrow{\text{translation}}$ Protein

- Concept was initially proposed by Francis Crick.
- What is shown above is not what Crick proposed.
- Crick tried to clear this up in a 1970 letter in Nature

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NATURE VOL. 227 AUGUST 8 1970 561

Central Dogma of Molecular Biology

by
FRANCIS CRICK
MRC Laboratory of Molecular Biology,
Hills Road,
Cambridge CB2 2QH

The central dogma of molecular biology deals with the detailed residue-by-residue transfer of sequential information. It states that such information cannot be transferred from protein to either protein or nucleic acid.

Genomics

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	U	C	A	G	
U	Phe	Ser	Tyr	Cys	U
	Phe	Ser	Tyr	Cys	C
	Leu	Ser	STOP	STOP	A
	Leu	Ser	STOP	Trp	G
C	Leu	Pro	His	Arg	U
	Leu	Pro	His	Arg	C
	Leu	Pro	Gln	Arg	A
	Leu	Pro	Gln	Arg	G
A	Ile	Thr	Asn	Ser	U
	Ile	Thr	Asn	Ser	C
	Ile	Thr	Lys	Arg	A
	Met	Thr	Lys	Arg	G
G	Val	Ala	Asp	Gly	U
	Val	Ala	Asp	Gly	C
	Val	Ala	Glu	Gly	A
	Val	Ala	Glu	Gly	G

Genomics

- Recombinant DNA technologies
  - Breakthroughs in the 1970's led to the ability to cut & paste and to sequence DNA.

Click here for timeline

Genomics

- The 1990's saw the sequencing of complete genomes.

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Genomics

- Human Genome Project completed in 2003
  - The Sequencing and mapping of the human genome
  - Human genome contains 3 billion base pairs(bp)
  - Codes for ≈20,000 proteins
  - Coding regions only account for around 1% of the total DNA in the genome.

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- Identifying cause of genetic mutation, e.g.Sickle cell anemia
  - Due to a 1 base pair change in the gene for the β subunit of hemoglobin

Hb-A: ...ATG GTG CAC CTG ACT CCT **GAG** GAG AAG TCT GCC GTT ACT...
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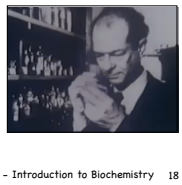
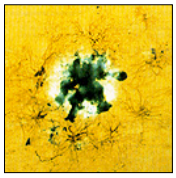


Genomics

- Pinpointing the locations of genetic lesions.
  - e.g. Alzheimer's Disease



Human Genome Map http://www.ncbi.nlm.nih.gov/SCIENCE96/

Genomics

- Tracking human migration

Genomics

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> During the new study, researchers linked more than 80 percent of the human genome sequence to a specific biological function and mapped more than 4 million regulatory regions where proteins specifically interact with the DNA. These findings represent a significant advance in understanding the precise and complex controls over the expression of genetic information within a cell. The findings bring into much sharper focus the continually active genome in which proteins routinely turn genes on and off using sites that are sometimes at great distances from the genes themselves. They also identify where chemical modifications of DNA influence gene expression and where various functional forms of RNA, a form of nucleic acid related to DNA, help regulate the whole system

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  - Natures ENCODE Explorer

Proteomics

proteomics |ˌprōtē'ämiks|

plural noun [treated as singular]
the branch of molecular biology concerned with determining the proteome.

DERIVATIVES
proteomic adjective

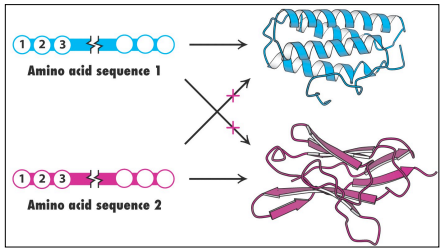
Proteomics

proteome |ˈprōtēˌōm|

noun Genetics
the entire complement of proteins that is or can be expressed by a cell, tissue, or organism *: now that the human genome has been deciphered, much of the fanfare surrounding it has transferred to the proteome.*

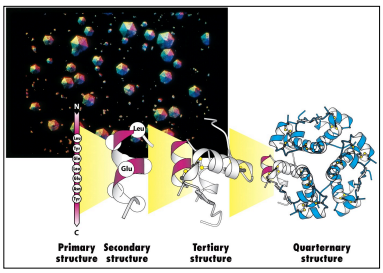
ORIGIN 1990s: a blend of *protein* and *genome.*

Proteomics



Next up

- Protein Structure



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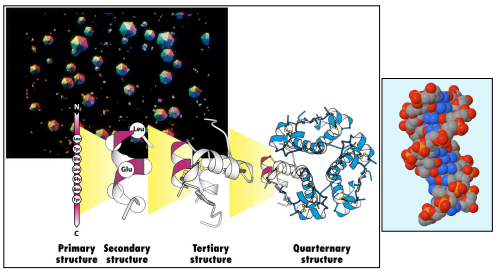

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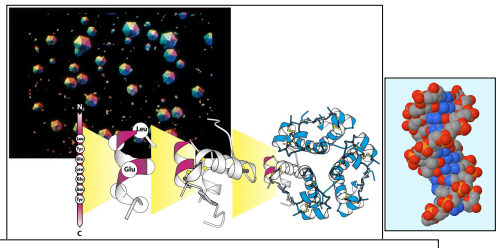

Question of the Day: Proteins are created in a 1-dimensional world but go on to function in the 3-dimensional world. Explain how this works.