GENOME

Physical & Chemical properties

PRESENTED BY,
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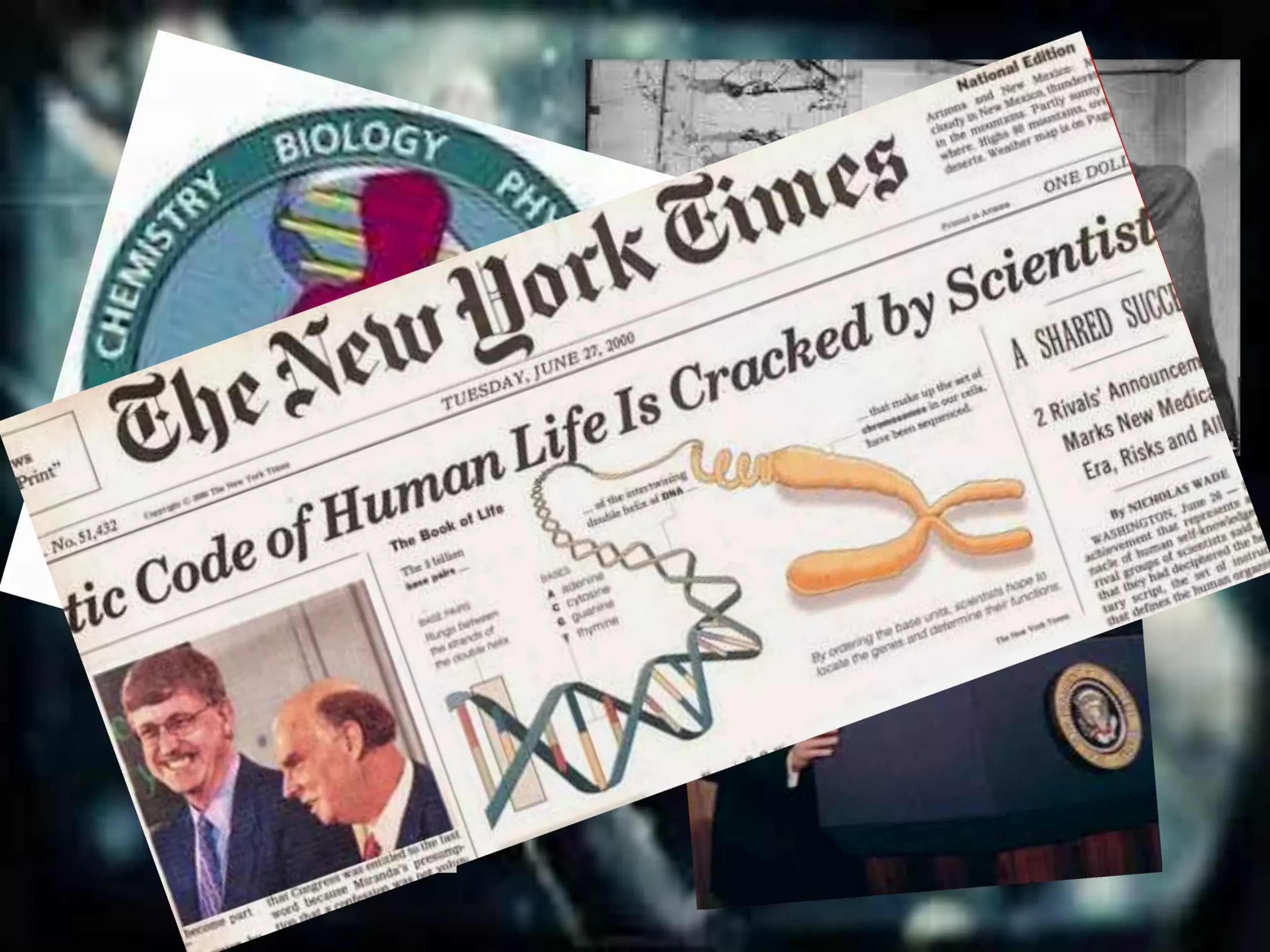
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The New York Times
TUESDAY, JUNE 27, 2000
National Edition
Arizona and New Mexico: M
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ONE DOLL
tic Code of Human Life Is Cracked by Scientist
A SHARED SUCCE
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Era, Risks and All
By NICHOLAS WADE
WASHINGTON, June 26 —
achievement that represents
The Book of Life
The 3 billion base pairs —
Solid rails flunge between the strands of the double helix
BASES
A adenine
C cytosine
G guanine
T thymine
— that make up the set of chromosomes in our cells, have been sequenced.
— of the intertwining double helix of DNA —
By ordering the base units, scientists hope to locate the genes and determine their functions.
The New York Times
become part
that Congress was entitled to the last word because Miranda's presump-

Genomics is the study of all genes present in an organism

Genomics

Genomics is the study of genomes, including large chromosomal segments containing many genes.

The *initial phase of genomics* aims to map and sequence an initial set of entire genomes.

Functional genomics aims to deduce information about the function of DNA sequences.

- Should continue long after the initial genome sequences have been completed.

Components of the Human Genome

- Human genome has 3.2 billion base pairs of DNA
- About 3% codes for proteins
- About 40-50% is repetitive.

What is the function of the remaining 50%?

Genome

The genome is all the DNA in a cell.

All the DNA on all the chromosomes

Includes genes, introns, repetitive sequence

TYPES

- Prokaryotic genomes
- Eukaryotic Genomes
- Nuclear Genomes
- Mitochondrial genomes
- Choloroplast genomes

GENOME SIZE

- Genome size is the total amount of DNA contained within one copy of a single genome
- It is typically measured in terms of mass in picograms
- or in Daltons or as the total number of nucleotide base pairs(mb)
- 1 picogram = 978 megabases
- In diploid organisms, genome size is used interchangeably with the term C-value
- An organism's complexity is not directly proportional to its genome size; some single cell organisms have much more DNA than humans

Genome size comparison

	Species	Chromosomes	Genes	Base pairs
	**Human** *(Homo sapiens)*	46 (23 pairs)	26-35,000	3.1 billion
	**Mouse** *(Mus musculus)*	40	22.5-30,000	2.7 billion
	**Puffer fish** *(Fugu rubripes)*	44	31,000	365 million
	**Malaria mosquito** *(Anopheles gambiae)*	6	14,000	289 million
	Fruit fly *(Drosophila melanogaster)*	8	14,000	137 million
	**Roundworm** *(C. elegans)*	12	19,000	97 million
	**Bacterium*** *(E. coli)*	1	5,000	4.1 million

*Bacterial chromosomes are chromonemes, not true chromosomes

JOHN BLANCHARD / The Chronicle

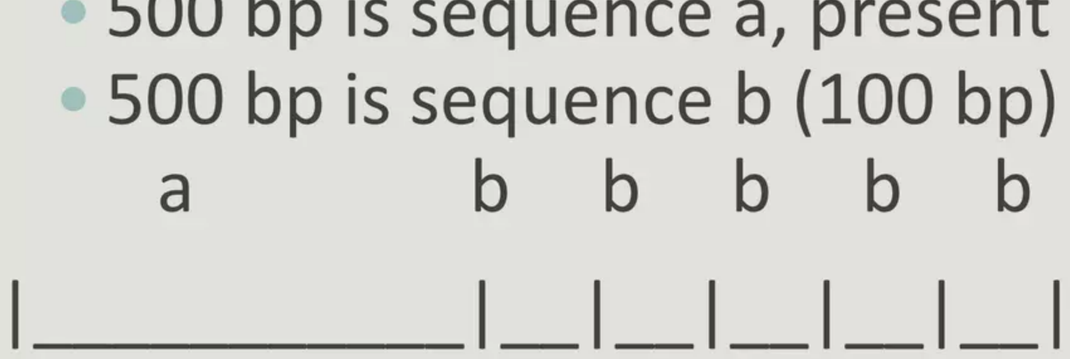
Sequence complexity is not the same as length

Complexity is the number of base pairs of unique,

i.e. non-repeating, DNA.

E.g. consider 1000 bp DNA.

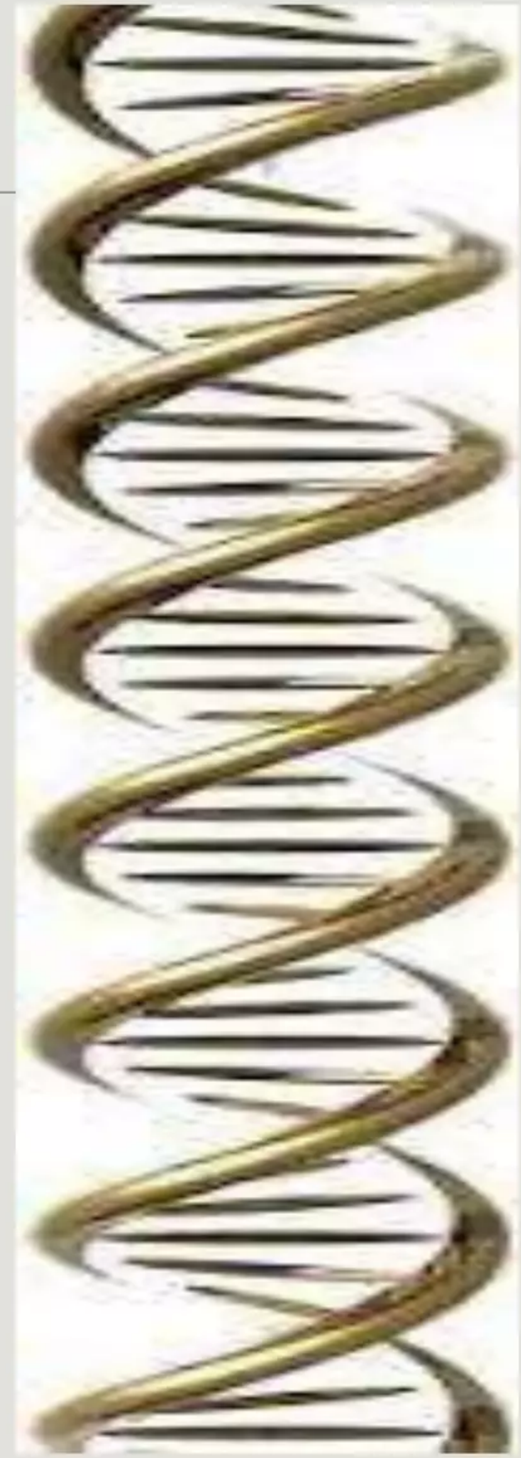
- 500 bp is sequence a, present in a single copy.
- 500 bp is sequence b (100 bp) repeated 5X



length = 1000 bp = a + 5b

complexity = 600 bp = a + b

Distinct components in complex genomes



- ✓ Highly repeated DNA
  - *R* (repetition frequency) ≥100,000
  - Almost no information, low complexity

- ✓ Moderately repeated DNA
  - 10<*R*<10,000
  - ✓ Little information, moderate complexity

"Single copy" DNA
  - *R*=1 or 2
  - Much information, high complexity

Chromosomal organization

- *The total complement of genes in an organism or cell :* genome

- In prokaryotes, the vast majority of genes are located on a single chromosome of circular DNA

- In eukaryotes,usually possess multiple individual linear DNA helices packed into dense DNA-protein complexes: chromosomes

- Many species carry more than one copy of their genome within each of their somatic cells

- Cells /organisms with only 1 copy of each chromosome :***Haploid***

- Those with two copies: ***Diploid***

- Those with more than two copies : ***Polyploid***

- The copies of genes on the chromosomes are not necessarily identical.

- In sexually reproducing organisms, one copy is normally Inherited from each parent.

genome

cell

chromosomes

genes

DNA

proteins

Genes contain instructions for making proteins

Proteins act alone or in complexes to perform many cellular functions

U.S. DEPARTMENT OF ENERGY

Much DNA in large genomes is non-coding

- Complex genomes have roughly 10x to 30x more DNA is required to encode all the RNAs or proteins in the organism.

- Contributors to the non-coding DNA include:

  - Introns in genes
  - Regulatory elements of genes
  - Multiple copies of genes, including pseudogenes
  - Intergenic sequences
  - Interspersed repeats

Chemical Aspect

- Nucleic acid thermodynamics is the study of how temperature affects the nucleic acid structure of double-stranded DNA.

- The melting temperature (T_m) is defined as the temperature at which half of the DNA strands are in the random coil or single-stranded (ssDNA) state.

- T_m depends on
  length of the DNA molecule
  specific nucleotide sequence

- DNA, when in a state where its two strands are dissociated is referred to as having been denatured by the high temperature.

RENATURING

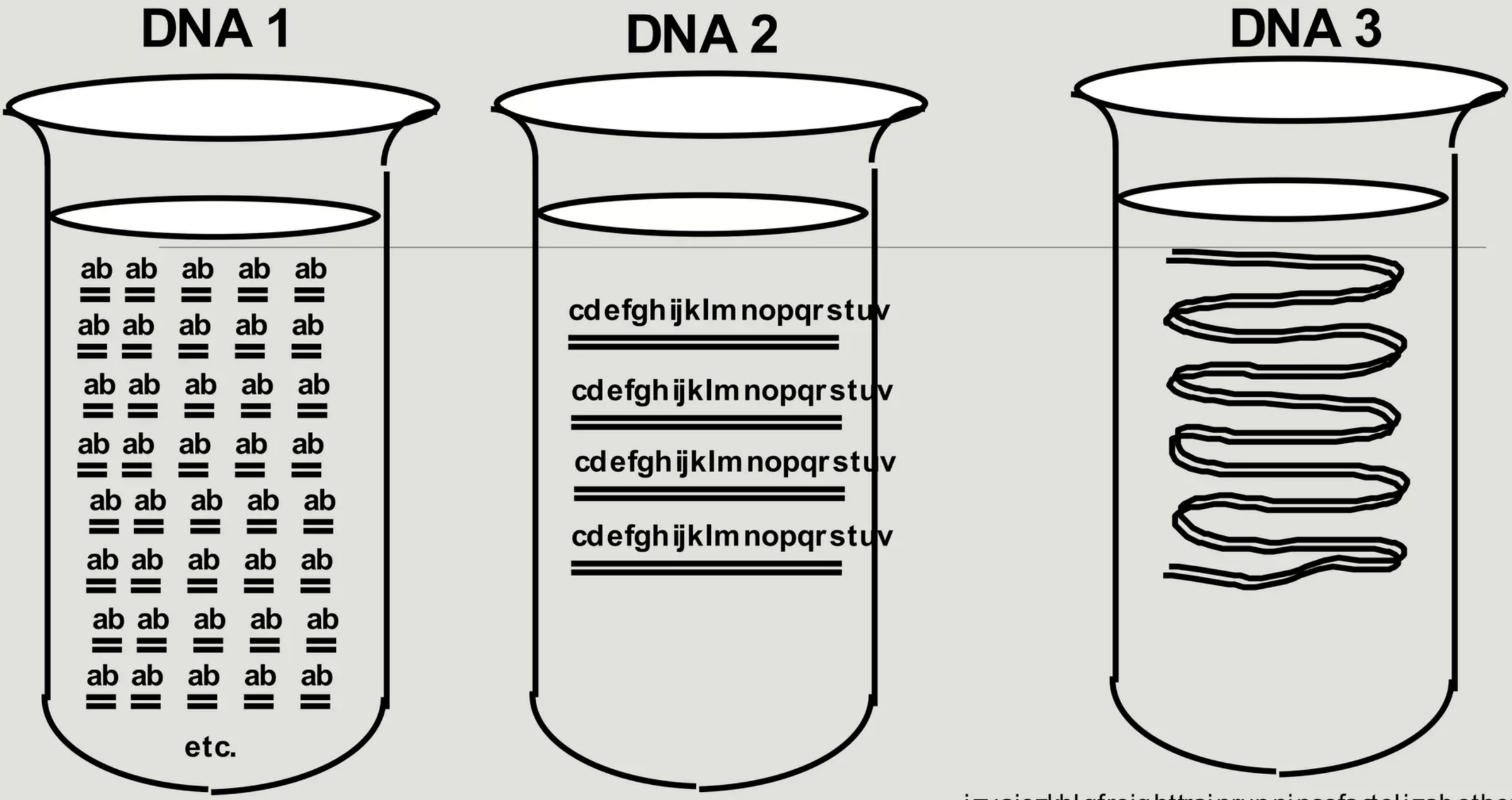
Less complex DNA renatures faster

Let a, b, ... z represent a string of base pairs in DNA that can hybridize. For simplicity in arithmetic, we will use 10 bp per letter.

DNA 1 = ab. This is very low sequence complexity, 2 letters or 20 bp.

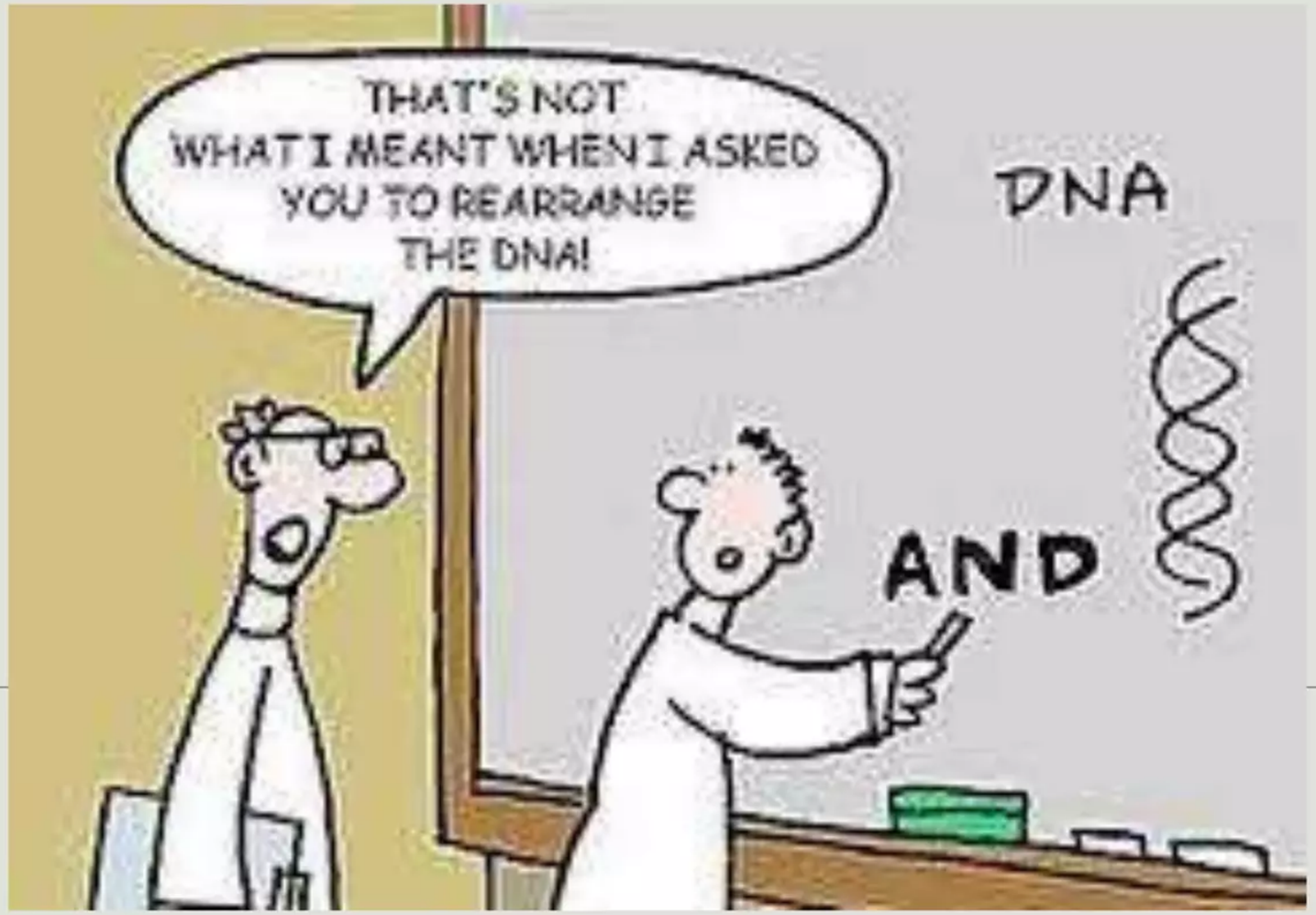
DNA 2 = cdefghijklmnopqrstuv. This is 10 times more complex (20 letters or 200 bp).

DNA 3 =
izyajczkblqfreighttrainrunninsofastelizabethcottonqwftzxvbifyoudontbelieveimleavingyoujustcountthedaysimgonerxcvwpowentdowntothecrossroadstriedtocatcharidero bertjohnsonpzvmwcomeonhomeintomykitchentrad.
This is 100 times more complex (200 letters or 2000 bp).



Molar concentration of each sequence:

150 microM **15 microM** **1.5 microM**


THAT'S NOT WHAT I MEANT WHEN I ASKED YOU TO REARRANGE THE DNA!
DNA
&
AND

Interesting genetic facts

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✓**Two individuals share as much as 99.9% of the same genetic material and differ in only 0.1% of it.**

✓**Genetic similarity.**

People share 7% of genetic material with the E.coli bacteria, 21% with worms, 90% with mice and 98% with chimpanzees

✓*Humans and cabbage share about 40-50% common DNA*.

✓*You have 98% of your DNA in common with a chimpanzee.*

✓*A parent and child share 99.5% of the same DNA.*

Sequencing electric eel genome unlocks shocking secrets

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THANK YOU