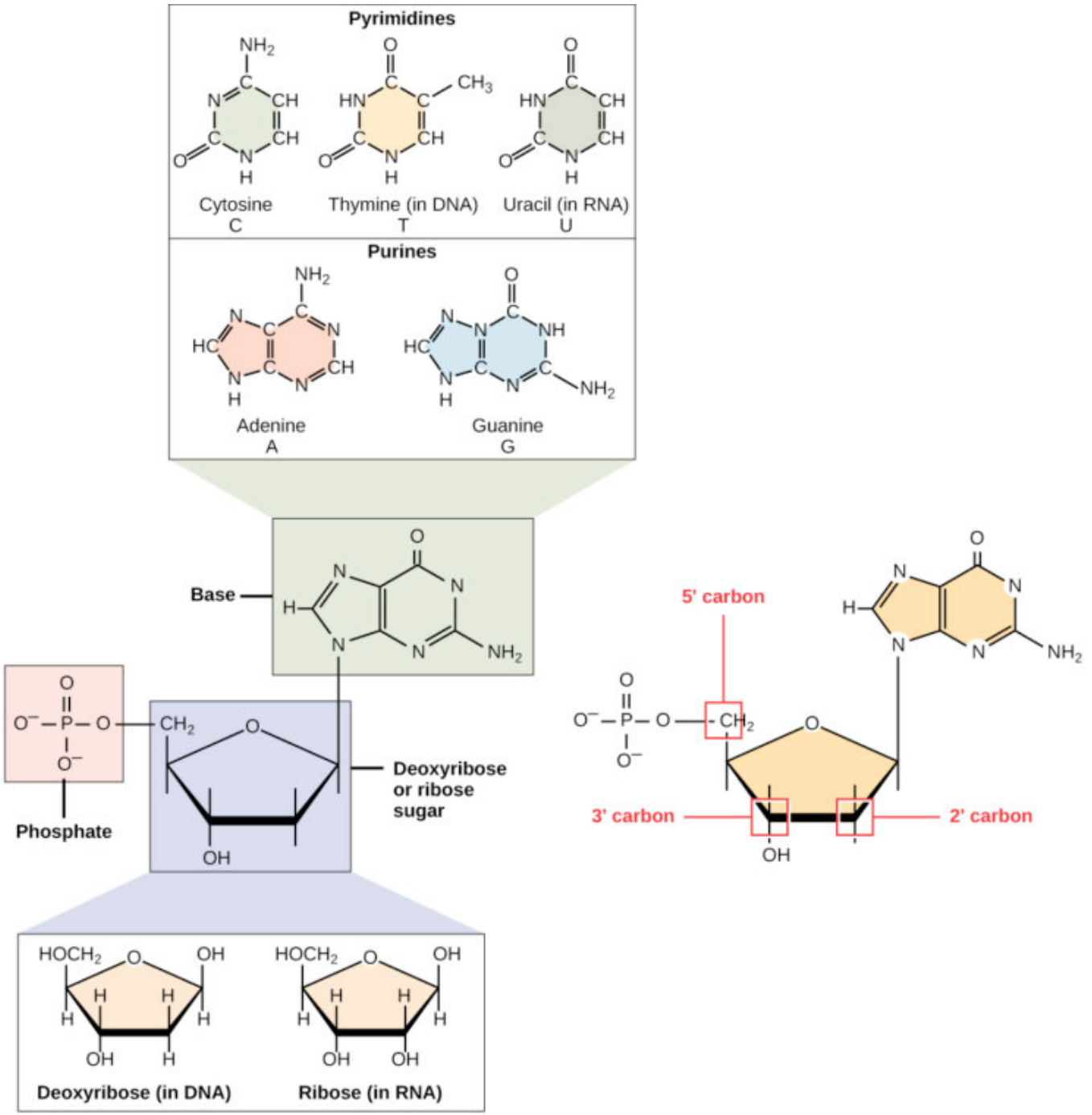
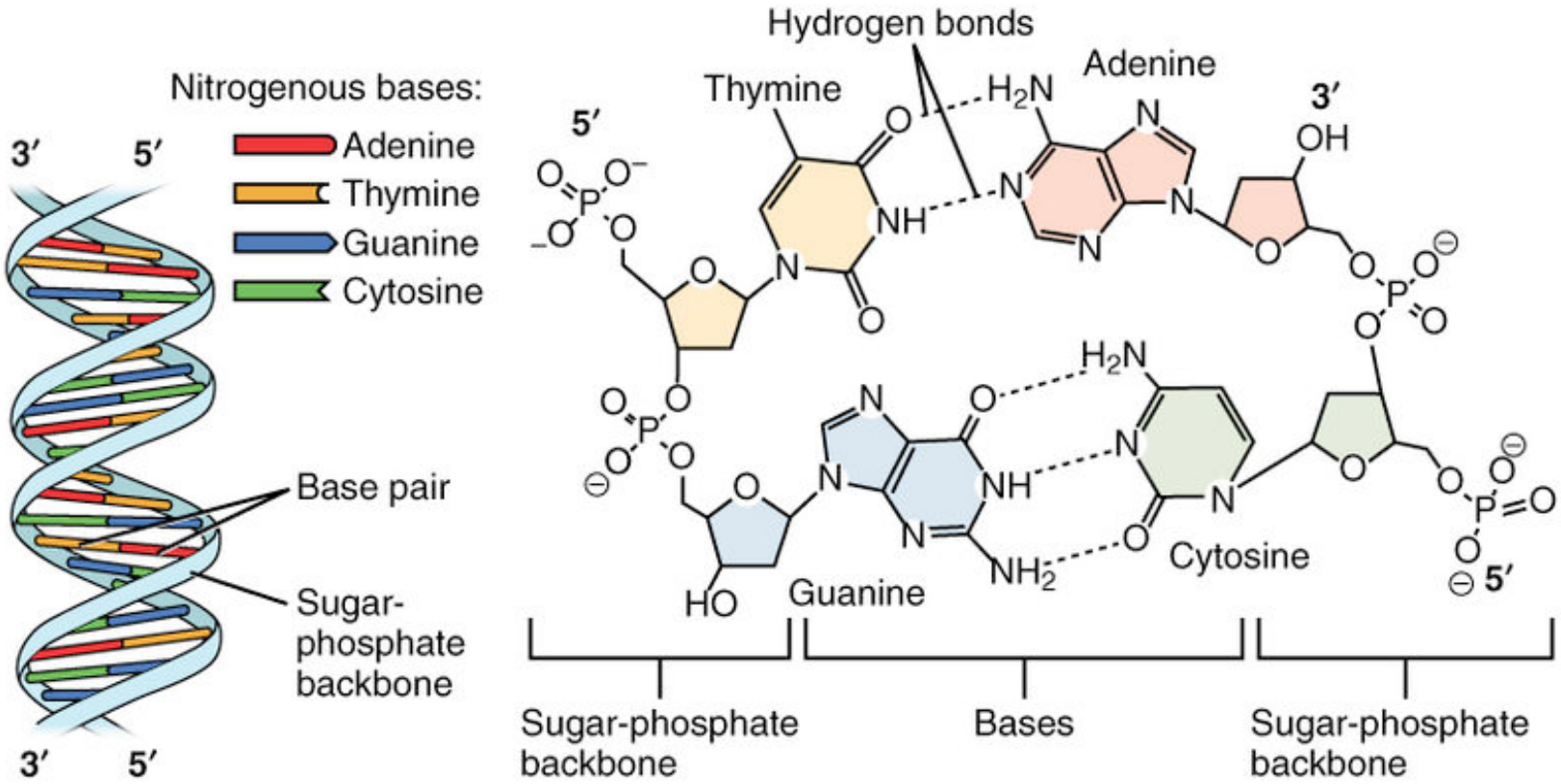
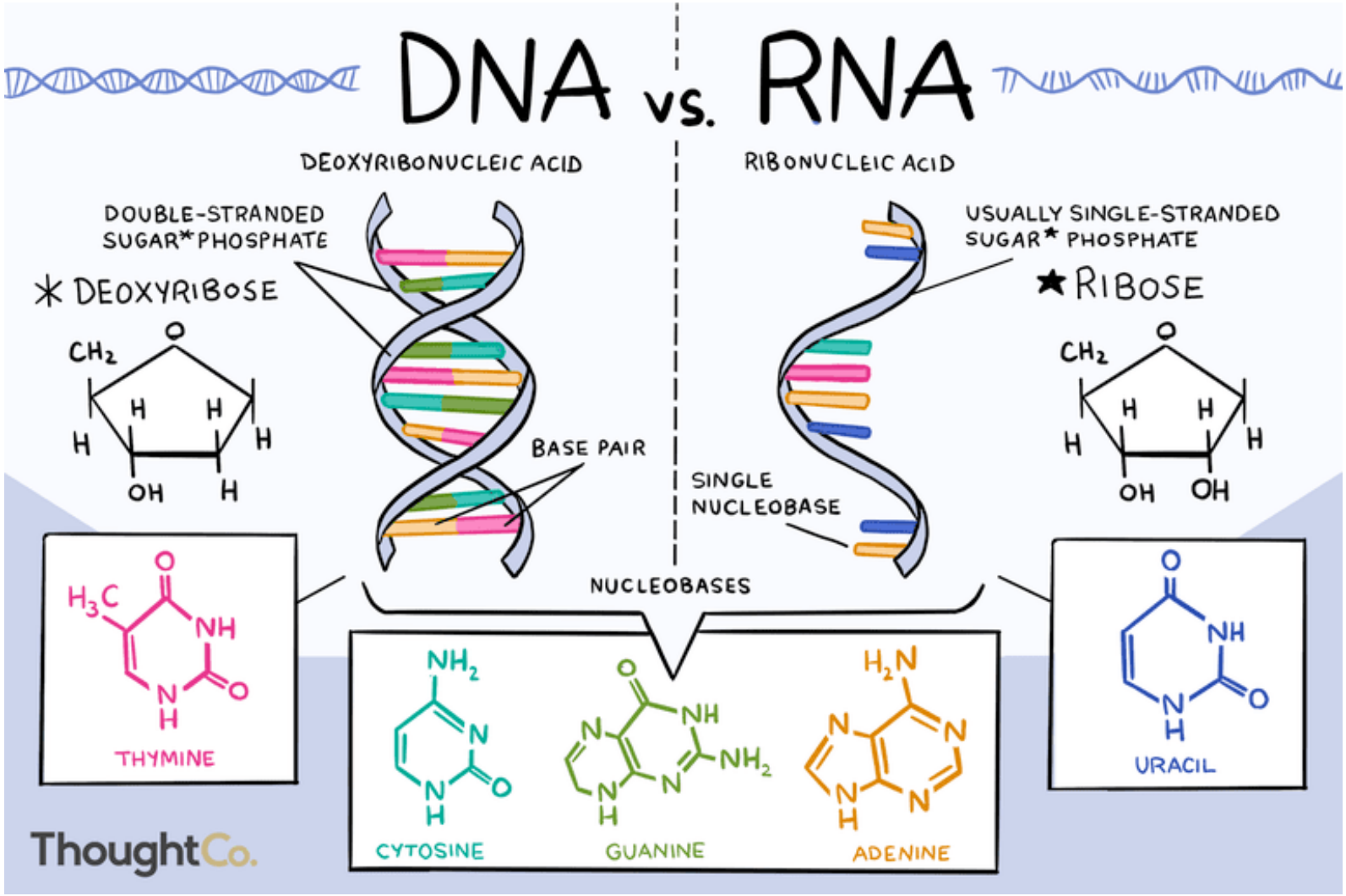
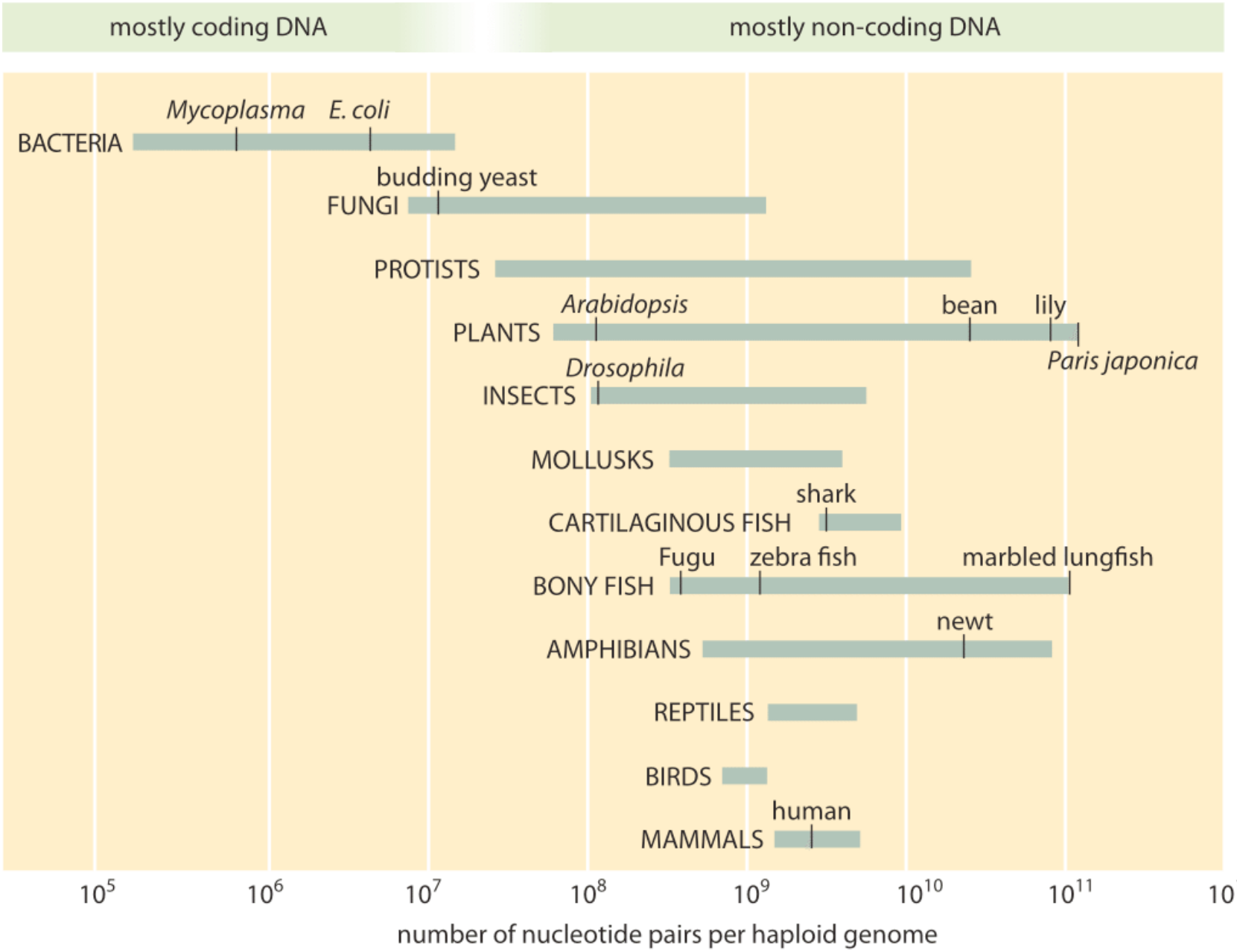

Pyrimidines
Cytosine
C
Thymine (in DNA)
T
Uracil (in RNA)
U
Purines
Adenine
A
Guanine
G
Base
Phosphate
Deoxyribose
or ribose
sugar
5' carbon
3' carbon
2' carbon
Deoxyribose (in DNA)
Ribose (in RNA)


Nitrogenous bases:
Adenine
Thymine
Guanine
Cytosine
3′
5′
Base pair
Sugar-phosphate backbone
3′
5′
Hydrogen bonds
Thymine
Adenine
5′
3′
OH
Cytosine
Guanine
HO
5′
Sugar-phosphate backbone
Bases
Sugar-phosphate backbone

A:T and C:G


DNA vs. RNA
DEOXYRIBONUCLEIC ACID
RIBONUCLEIC ACID
DOUBLE-STRANDED SUGAR* PHOSPHATE
* DEOXYRIBOSE
BASE PAIR
USUALLY SINGLE-STRANDED SUGAR* PHOSPHATE
★ RIBOSE
SINGLE NUCLEOBASE
NUCLEOBASES
THYMINE
CYTOSINE
GUANINE
ADENINE
URACIL
ThoughtCo.



Biology by the numbers - Milo + Phillips

DNA Replication (make copy)

https://dnalc.cshl.edu/resources/animations/

DNA Replication (make copy)

https://dnalc.cshl.edu/resources/animations/

Crazy Numbers

Replication Speed:

E. coli	1000 bp/sec
Humans	50 bp/sec

Replication Fidelity: 10^{-9} -10^{-11} /bp

Analogy (Tanya Baker via Rob Phillips)

DNA diameter: 1m
Size of Replication Machinery: FedEx Truck

Moving at speed 500 km/hr, making delivery on both sides of street every 10cm, finish journey in 40 min, mistakenly deliver package once every 3 years!

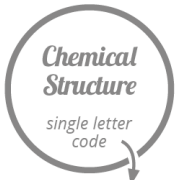
Transcription

Translation

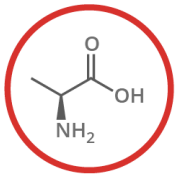
A GUIDE TO THE TWENTY COMMON AMINO ACIDS

AMINO ACIDS ARE THE BUILDING BLOCKS OF PROTEINS IN LIVING ORGANISMS. THERE ARE OVER 500 AMINO ACIDS FOUND IN NATURE - HOWEVER, THE HUMAN GENETIC CODE ONLY DIRECTLY ENCODES 20. 'ESSENTIAL' AMINO ACIDS MUST BE OBTAINED FROM THE DIET, WHILST NON-ESSENTIAL AMINO ACIDS CAN BE SYNTHESISED IN THE BODY.

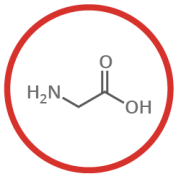
Chart Key: ALIPHATIC | AROMATIC | ACIDIC | BASIC | HYDROXYLIC | SULFUR-CONTAINING | AMIDIC | NON-ESSENTIAL | ESSENTIAL



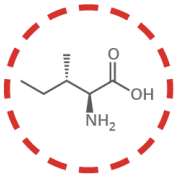
NAME A
three letter code
DNA codons



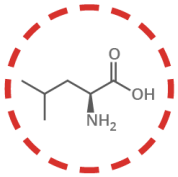
ALANINE A
Ala
GCT, GCC, GCA, GCG



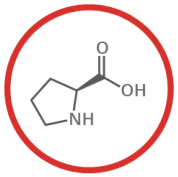
GLYCINE G
Gly
GGT, GGC, GGA, GGG



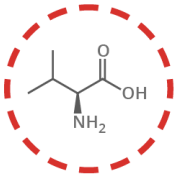
ISOLEUCINE I
Ile
ATT, ATC, ATA



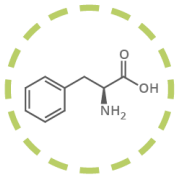
LEUCINE L
Leu
CTT, CTC, CTA, CTG, TTA, TTG



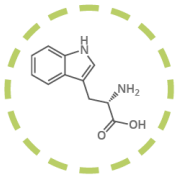
PROLINE P
Pro
CCT, CCC, CCA, CCG



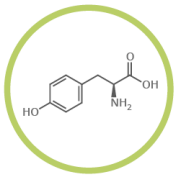
VALINE V
Val
GTT, GTC, GTA, GTG



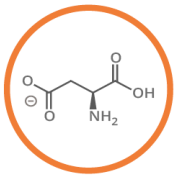
PHENYLALANINE F
Phe
TTT, TTC



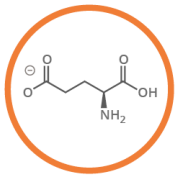
TRYPTOPHAN W
Trp
TGG



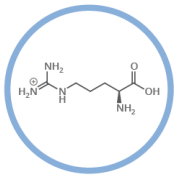
TYROSINE Y
Tyr
TAT, TAC



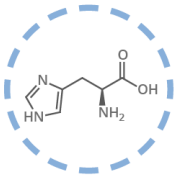
ASPARTIC ACID D
Asp
GAT, GAC



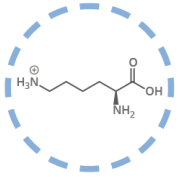
GLUTAMIC ACID E
Glu
GAA, GAG



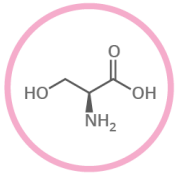
ARGININE R
Arg
CGT, CGC, CGA, CGG, AGA, AGG



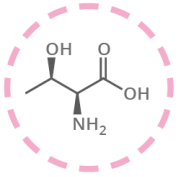
HISTIDINE H
His
CAT, CAC



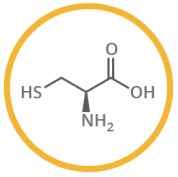
LYSINE K
Lys
AAA, AAG



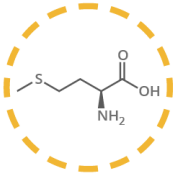
SERINE S
Ser
TCT, TCC, TCA, TCG, AGT, AGC



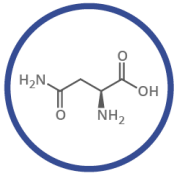
THREONINE T
Thr
ACT, ACC, ACA, ACG



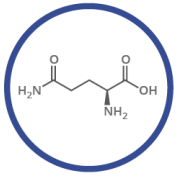
CYSTEINE C
Cys
TGT, TGC



METHIONINE M
Met
ATG



ASPARAGINE N
Asn
AAT, AAC



GLUTAMINE Q
Gln
CAA, CAG

Note: This chart only shows those amino acids for which the human genetic code directly codes for. Selenocysteine is often referred to as the 21st amino acid, but is encoded in a special manner. In some cases, distinguishing between asparagine/aspartic acid and glutamine/glutamic acid is difficult. In these cases, the codes asx (B) and glx (Z) are respectively used.

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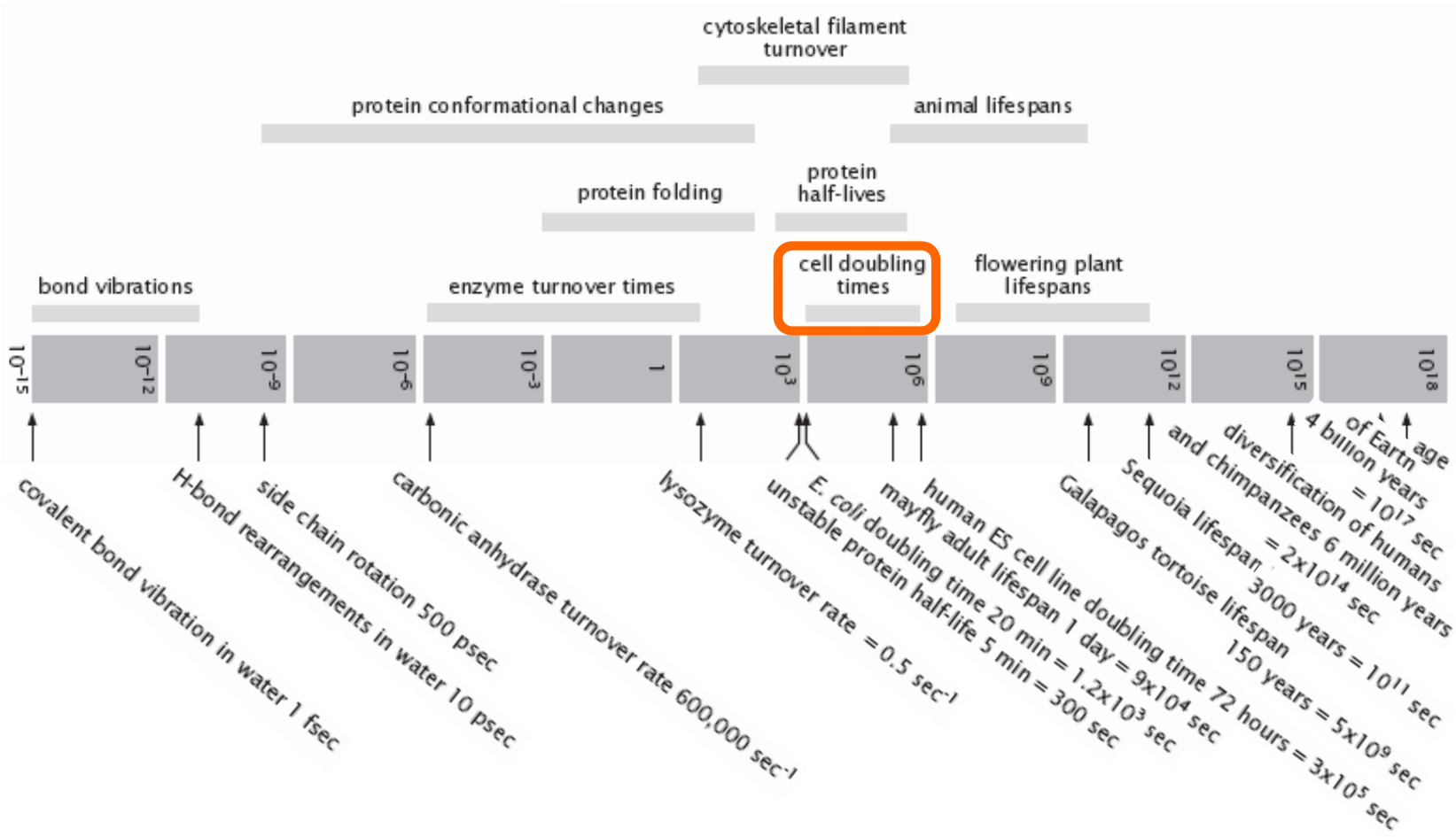
Translation

https://dnalc.cshl.edu/resources/animations/

organism	errors per base or codon	BNID and measurement methods
		transcription
E. coli	10^{-4}	111146, transition mutations based on sequencing at very high (10^6) coverage (2013)
E. coli	10^{-5}	105212, *In vitro* selection for rifampicin resistance and increased leakiness of an early, strongly polar nonsense mutation of lacZ (1983, 1986)
E. coli	10^{-4}	103453, activity in strains carrying lacZ mutations (1981)
S. cerevisiae	2×10^{-6}	110019, RNA pol II, determined *in vitro* (2008)
S. cerevisiae	2×10^{-4}	105213, RNA pol III, determined based on selectivity (2007)
C. elegans	4×10^{-6}	111144, determined using bar coded sequencing (2013)
		translation
E. coli	3×10^{-4}	105069, Lys-tRNA, reporter system for frequency of each type of misreading error (2007)
E. coli	$1–4\times10^{-3}$	105215, identify cases that do not contain the amino acid cysteine responsible for the missense substitution (1983)
E. coli	$10^{-4}–10^{-3}$	103454, identify cases that do not contain the amino acid cysteine responsible for the missense substitution (1977, 1983)
B. subtilis	4×10^{-3}	105466, GFP with nonsense mutation, also find 2.4% for frame-shift (!) (2010)
S. cerevisiae	$0.5–2\times10^{-5}$	105216, measurement of rescue rate of inactivating mutations of type III chloramphenicol acetyl transferase (1998)

Biology by the numbers - Milo + Phillips

THE HIERARCHY OF TEMPORAL SCALES



Molecular motion of biochem. species as they interact and change identity → *Unfolding of the lives of individual cells* → *Trajectories of entire species*

Rob Phillips

Reading DNA- DNA Sequencing

https://dnalc.cshl.edu/resources/animations/