BENG 230A - Biochemistry

Mi

22

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emisBiyomole

What is in a cell?

Water

H_2O
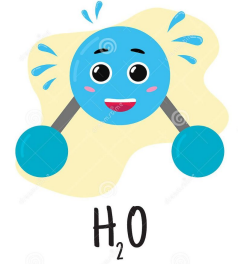
Most abundant molecule (70% of cell mass)

Universal solvent, medium of transportation between intracellular and extracellular compartments

Structure

Glycerol + Fatty Acids + Phosphate group	Sugar (Ribose/Deoxyribose) + Phosphate group + Nitrogenous base (A/T/G/C/U)	Polymers of monosaccharides linked by glycosidic bonds

Functions

Plasma Membrane, Signaling Molecules, Hormones	Genetic Material (DNA and RNA)	Energy production and storage (glycolysis), Post translational modifications (glycosylation)	Enzymes, Antibodies, Hormones, Cytoskeleton

Fun drinking game:
Take a shot of water every couple hours to make sure that you are healthy and hydrated

Covalent and non-covalent interactions in biological systems

Van der Waals Interactions

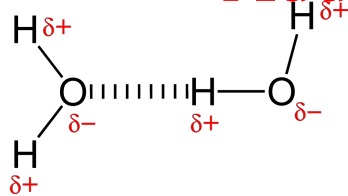Distance dependent interaction of oppositely polarized electron clouds

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Hydrogen bonding

Difference in electronegativity

H$^{\delta+}$ O H$^{\delta+}$
O$^{\delta-}$ H$^{\delta+}$ O$^{\delta-}$
H$^{\delta+}$

Hydrophobic Interactions

Polar groups - Hydrophilic
Non-polar groups - Hydrophobic

Strength: Covalent > Ionic > Hydrogen Bond > Hydrophobic > Van der Waals

nctionProtein

Amino Acids Classification

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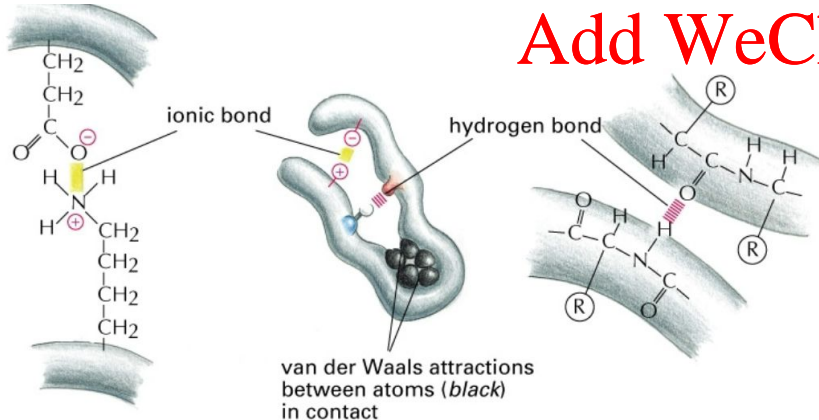
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3D Structure of Proteins

- Amino acids + Interactions: Determine protein structure
- Changes in amino acid sequence -> Misfolding of protein -> Loss of function

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ionic bond

hydrogen bond

van der Waals attractions between atoms (*black*) in contact

Energetically favorable conformation

Central Dogma of Molecular Biology

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From D eplication

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DNA replication
Separation, Base pair

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DNA Synthesis by DNA polymerase

DNA replication Fork

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DNA Proofreading

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Why 5'->3'?

The need for accu https://eduassistpro.github.io/

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DNA Replication at the
Lagging strand

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Done by DNA Ligase

DNA Heli

DNA double helix are tightly coupled.
High temperature is needed to break
them (95ºC)

DNA Binding Protein
SSB: Single Strand DNA-binding Proteins, also called helix destabilizing proteins

DNA Clamping Pro

Protein machinery for DNA replication

Telomerase and its function

Retrovirus-based Transposition

Non-retroviral retrotransposition

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From D anscription

DNA->RNA-> Proteins

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Genes expressed with different efficiency

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The chemical structure differences between DNAs and RNAs

1. ribose, deoxyribose
2. Uracil and thymi

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RNA base pairs
A-U; G-C

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RNA Structures
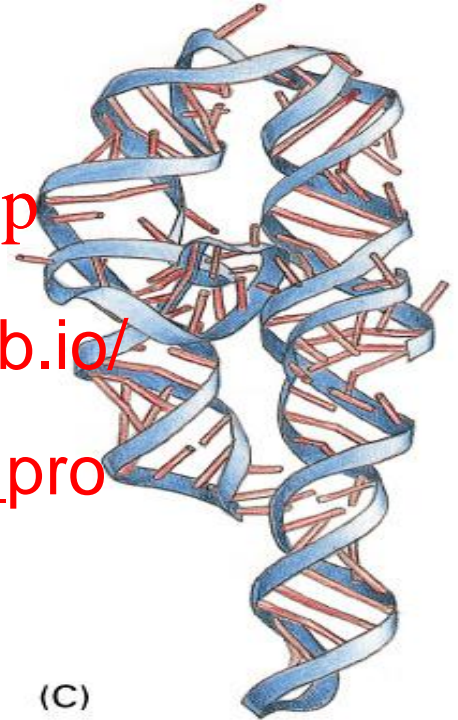
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Figure 6–6 part 2 of 2. Mol

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Initiation of transcription with RNA polymerase II in eucaryotes

TF: transcription factor

TBP: TATA box binding protein

Promoter upstream of real starting sequence of transcription

TFIIH open DNA double helix and phosphorylate C-tail of polymerase and allow the release and transcription

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The importance
polymerase I

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Initiation of transcription with RNA polymerase II in eucaryotic cells
Remember Nucleasomes
Enhancer, mediator, chromatin remodeling complex, histone acetylase

mRNA between procaryotic and eucaryotic cells
5' capping and 3' polyadenylation

Genes to proteins
The comparison between eucaryotes (substantially complex) and procaryotes (simple)

From RN

ranslation

Key Player #1: Transfer RNA (tRNA)

Amino acid attachment and
interaction with the ribosome

Interacts with mRNA

Aminoacylation of tRNA by aminoacyl-tRNA synthetase

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Proofreading ability for
translational fidelity

Key Player #2: Messenger RNA (mRNA)

The Genetic Code

Wobble position in codon

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20 Amino Acids, 64 Codons
Redundancy but no ambiguity

Key Player #3: Ribosome

Protein synthesizing organelle

Aminoacyl site
Peptidyl site
Exit site

Ribosomal RNA (rRNA) - Binds to tRNA and
mRNA to ensure accurate translation

Translation: Initiation, elongation, release

Start codon:
AUG, codes for
Methionine

Peptidyl
transferase activity
of large ribosomal
subunit (ribozyme)

Ribosomal
translocation

Stop Codons:
UAA, UAG, UGA

From DN

echniques

Why do cells in your body behave differently despite having mostly identical ge

Gene Expression Evaluation: An Overview

For each of the key technique, you need to master:

- Use case Assignment Project Exam Help
- Pitfalls
- Compensati https://eduassistpro.github.io/

A good format to following ribing an
experiment on the test: Add WeChat edu_assist_pro

- Control/experimental groups
- Technique
- Expectation from analysis
- pitfalls

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RT-qPCR: Things to Consider

- Limitations in target selection (primers)
- Scalability
- Normaliz

nes

Bulk v.s. Single-Cell RNA Sequencing

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Sample scRNA-seq Output

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Sample scRNA-seq Output

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Nona Farbehi, Ralph Patrick, Aude Dorison, Munira Xaymardan, Vaibhao Janbandhu, Katharina Wystub-Lis, Joshua WK Ho, Robert E Nordon, Richard P Harvey (2019) Single-cell expression profiling reveals dynamic flux of cardiac stromal, vascular and immune cells in health and injury eLife 8:e43882
https://doi.org/10.7554/eLife.43882

Bulk RNA-seq: Things to Consider

- Sequencing depth
- Read length
  - Gene1: AAA
  - Read1: AA
- Normalization across s
  - Gene1: 100/1000 reads Gene2: 200/2000
- Heterogeneity

scRNA-seq: Things to Consider

- Extreme cost
- Dropout effect
- Batch eff

Complete list of challenge und here:

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