DNA as the Genetic Material Cheat Sheet

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Four Key Criteria for Genetic Material:

Information:	Contains instructions to build an organism.
Replication:	Capable of accurate copying (DNA replication).
Transmission:	Passed from parent to offspring and between cells during division.
Variation:	Accounts for differences within and between species.

Discovery of Genetic Material:

Early Hypotheses (Late 1800s):	August Weismann and Karl Nägeli proposed a biochemical basis for inheritance.
Chromosome Insight:	Chromosomes, composed of proteins and DNA, identified as carriers of genetic information.

Griffith's Bacterial Transformation Experiments:

Experiment Background:	☐ Studied *Streptococcus pneumoniae*. ✔ Type S (smooth, virulent) strains produce a polysaccharide capsule. ✔ Type R (rough, non-virulent) strains lack this capsule.

Experimental Steps:

Step 1:	Injected live type R bacteria into a mouse → Mouse survived, no live bacteria found.
Step 2:	Injected live type S bacteria into a mouse → Mouse died, live type S bacteria found in blood.
Step 3:	Injected heat-killed type S bacteria into a mouse → Mouse survived, no live bacteria found.
Step 4:	Mixed heat-killed type S with live type R bacteria → Injected into a mouse → Mouse died, live type S bacteria found in blood.

Conclusion:

☐ Genetic material from heat-killed type S bacteria transformed live type R bacteria.

☐ This phenomenon was called **"transformation"** without knowing the biochemical nature of the transforming substance.

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Transformation Concept:

Living type R bacteria transformed into type S, gaining the ability to produce a capsule.

This transformation indicated transfer of genetic material.

Avery, MacLeod, and McCarty

Focus: Investigated bacterial transformation, following up on Griffith's observations to identify the biochemical nature of the genetic material.

Experimental Approach:

Question: What substance from dead type S bacteria transforms live type R bacteria?

Purification Process: ☐ Purified macromolecules (proteins, DNA, RNA) from type S *Streptococcus pneumoniae.*

☐ Found only purified DNA could convert type R to type S bacteria initially.

Detailed Experiment:

Step 1:	Mixed purified DNA from type S bacteria with type R bacteria. Allowed DNA uptake by type R bacteria, converting some to type S.
Step 2:	Enzyme Treatments : ☐ DNase: Digests DNA. ☐ RNase: Digests RNA. ☐ Protease: Digests proteins.
Step 3:	Aggregated type R cells (non-transformed) removed by centrifugation.
Step 4:	Type S cells (transformed) remain in the supernatant.
Step 5:	Supernatant plated on growth media to observe bacterial colony formation.
Step 6:	Control plates (without DNA extract) showed no type S colonies.

Conclusion:

☐ DNA from type S bacteria alone could convert type R bacteria to type S, proving DNA as the genetic material.

☐ Elimination of transformation with DNase confirmed DNA's essential role.

Hershey and Chase Experiment

Researchers: Alfred Hershey and Martha Chase (1952)
Objective: To determine whether DNA or protein is the genetic material in the T2 bacteriophage, a virus that infects E. coli.
☐ **Virus Structure Components:**
✔ Capsid (phage coat): Made entirely of protein, consisting of a head, sheath, tail fibers, and base plate.
✔ DNA: Found inside the head of the capsid.
Simplicity: Composed of only DNA and proteins.

Experimental Design

Goal: To identify which component, DNA or protein, enters the bacterial cell and directs the synthesis of new viruses.

Key Insight: T2 phage injects its genetic material into the bacterial cell while the protein coat remains outside.

Methodology

Labeling:	☐ DNA labeled with 32P (radioactive phosphorus). ☐ Protein labeled with 35S (radioactive sulfur).
Infection Process:	E. coli cells are infected with either 32P-labeled phage or 35S-labeled phage.
Shearing Force:	Use a blender to detach phage coats from bacterial cells after allowing the phages to inject their genetic material.
Centrifug-ation:	Separate heavier bacterial cells (pellet) from lighter phage coats (supernatant).
Detection:	Measure the radioactivity in the pellet and supernatant using a Geiger counter.

Results

☐ 35S (Protein): Majority found in the supernatant.
☐ 32P (DNA): Majority found in the bacterial pellet.

Conclusion:

DNA enters the bacterial cell, not protein. This indicates that DNA is the genetic material responsible for the production of new viruses.

Significance

Impact: The experiment provided convincing evidence that DNA, not protein, is the genetic material.
Scientific Legacy: This study was crucial in establishing DNA's role in heredity, greatly influencing molecular biology.