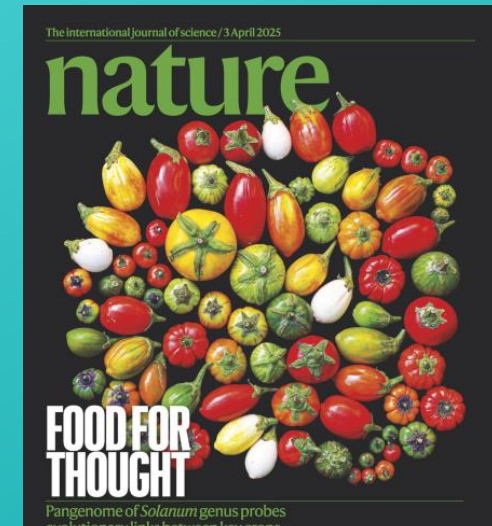
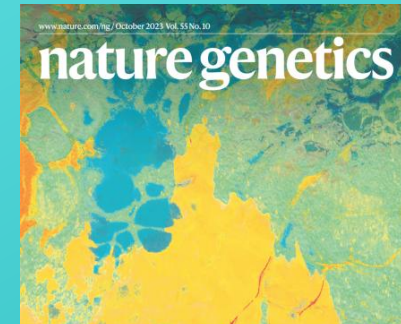
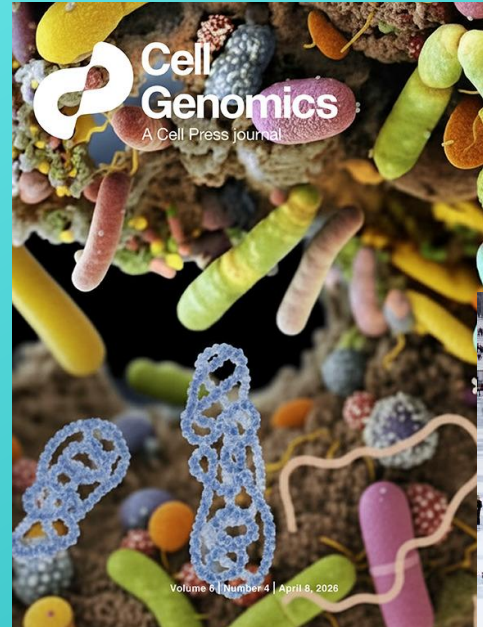


Genes, Epigenetics, and the Microbiome: Who's Really in Control?



Sources of Information



Topic Outline

DNA, Genes, Chromosomes

The Epigenome: How Your Genes are Used

Your Gut Microbiome: Hidden Regulators of Your Genes

How Food Becomes the Molecules of Life

Epinutrients: Dietary Principles for Epigenetic Health

When you eat, you are not just eating food...

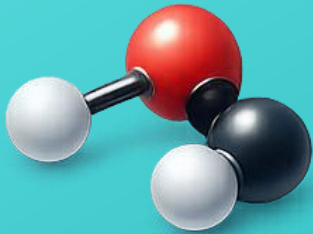


You're delivering specific molecules into your body

Chemistry is the Language of Life... and Molecules are the Words



Food



Molecules



Cells

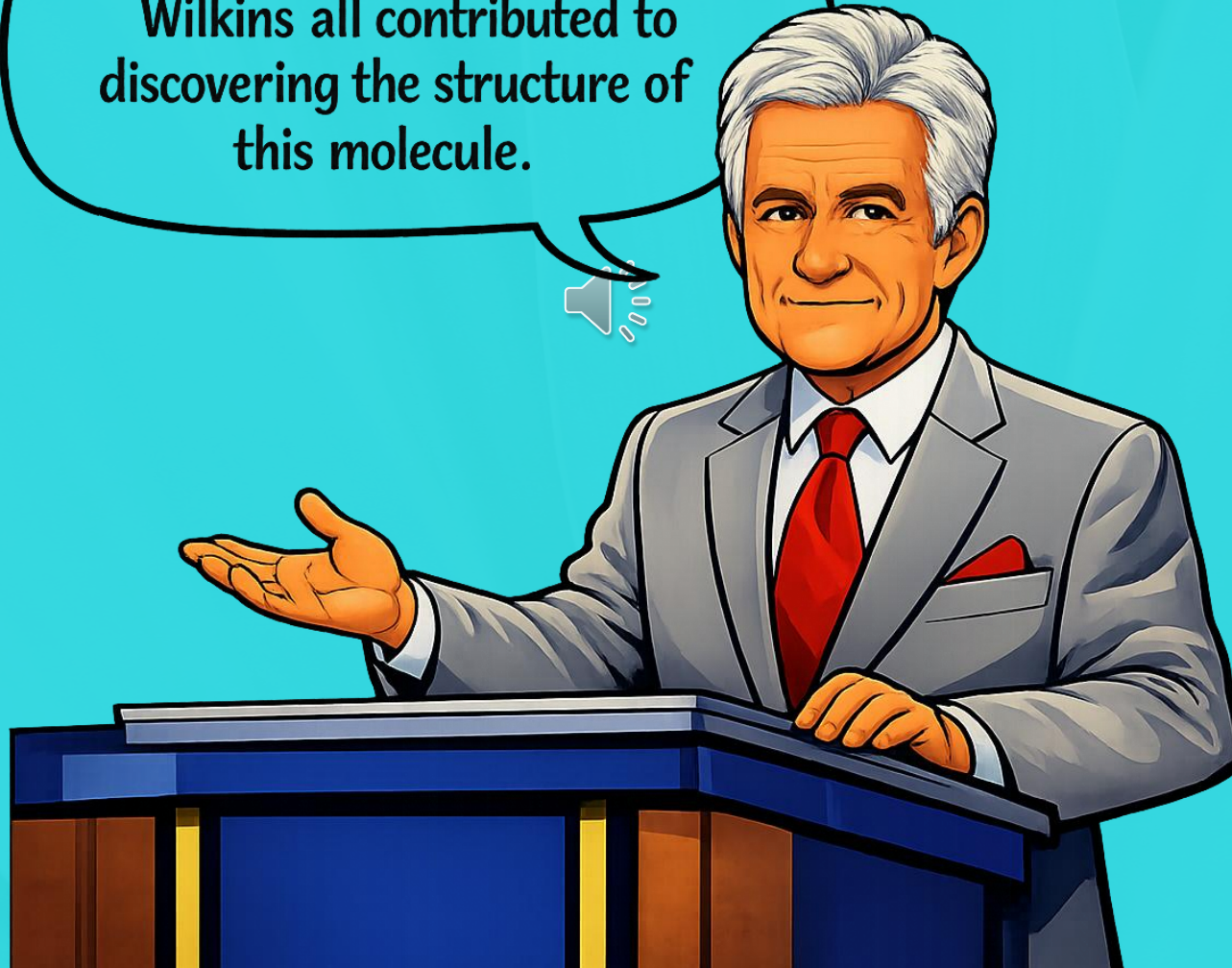


Life

Which molecule matters most?

Category: Molecules of Life

Watson, Crick, Franklin, and Wilkins all contributed to discovering the structure of this molecule.

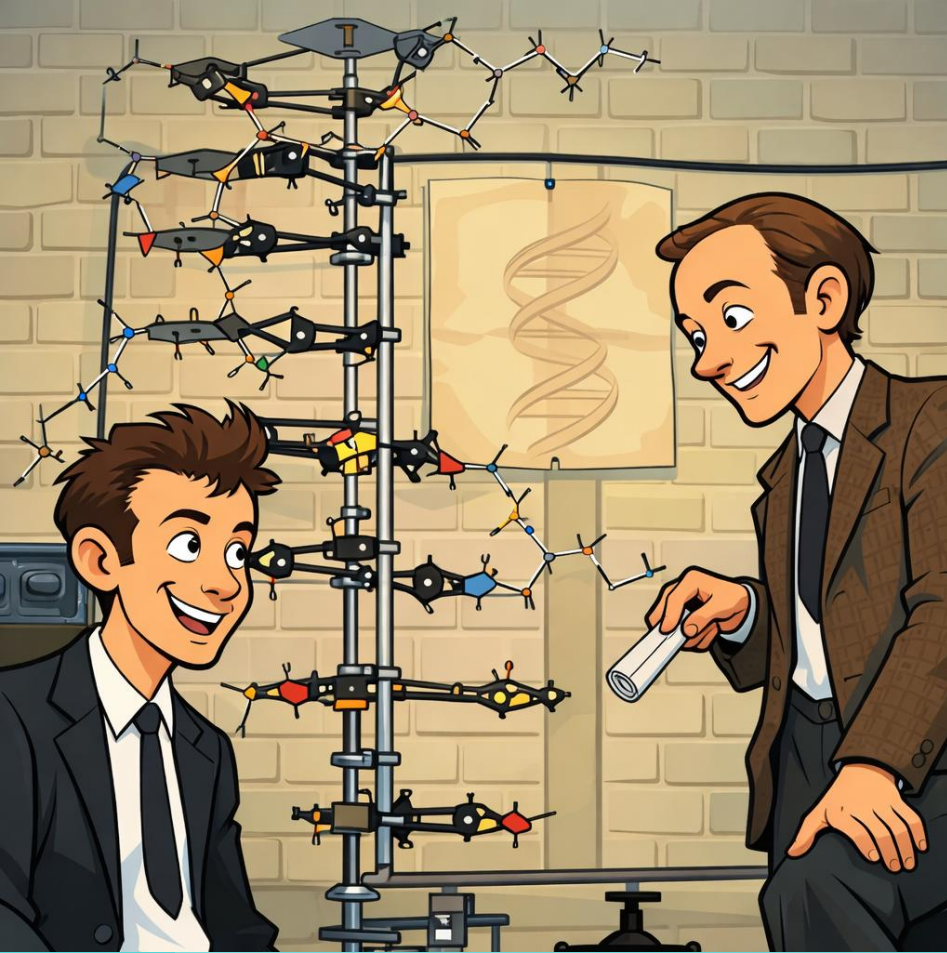


What is DNA?

Deoxyribonucleic Acid

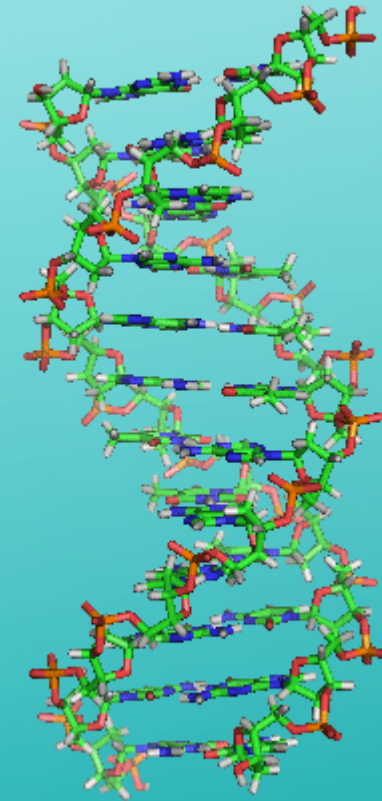


How DNA is Arranged in 3D

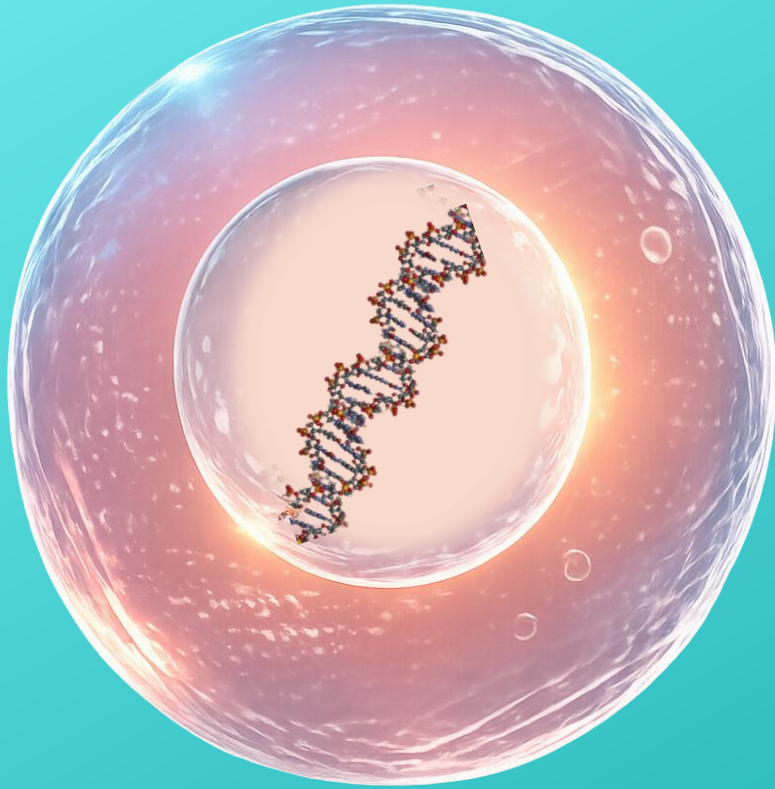


James Watson, Francis Crick, & Maurice Wilkins shared Nobel Prize in 1962 for describing the structure of DNA.

******This discovery also depended on critical data from Rosalind Franklin for producing the experimental evidence that made the model possible.



DNA: Life's Memory System



Stores genetic information

Makes copies of itself

Links all living organisms
through evolution

Passes instructions to new cells
and future generations

DNA Basics: Your Body's Instruction Manual



What Are Genes?



Segment of DNA

A set of instructions

Codes for a specific protein

What are proteins?

Built from amino acids



Amino acids



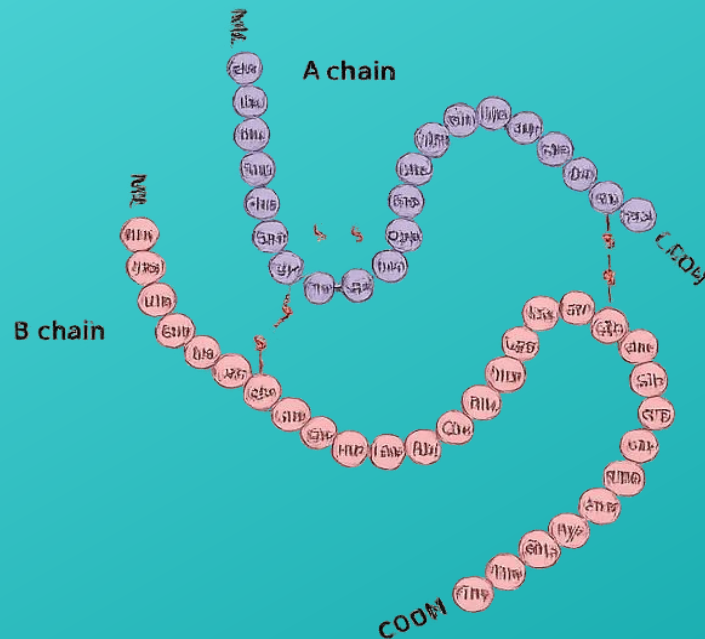
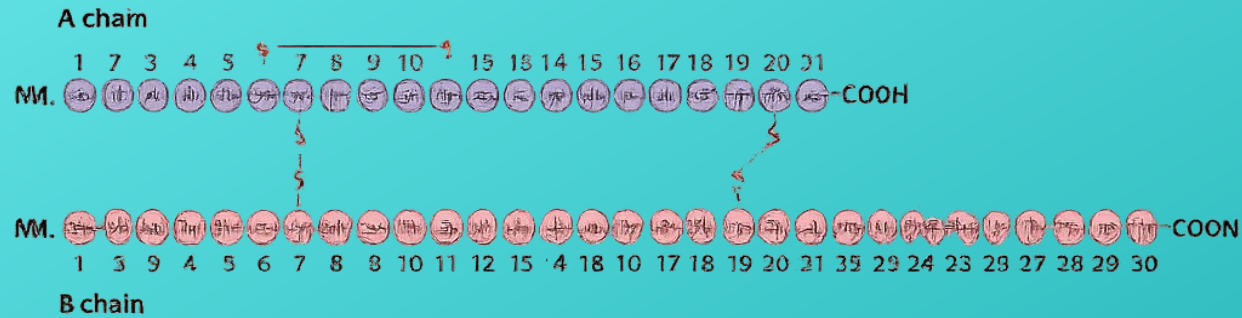
Amino acid chain



Protein

Insulin is a protein made of amino acids

Function: regulates blood sugar



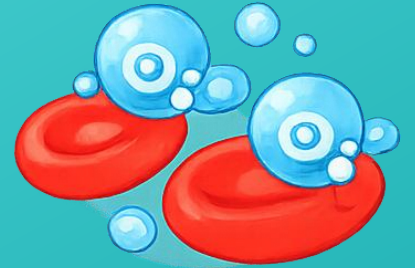
What Do Proteins Do In Your Body?

Coordinate body functions (hormones)



Hormones

Move things around (transport)



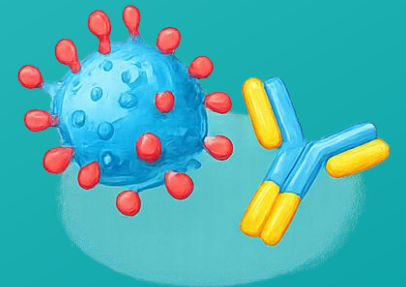
Transport

Run chemical reactions(enzymes)



Enzymes

Defend you (antibodies)



Antibodies

Build structure (muscles, skin)



Structure

Gene Expression



Gene

Instructions



Protein

Builds & regulates

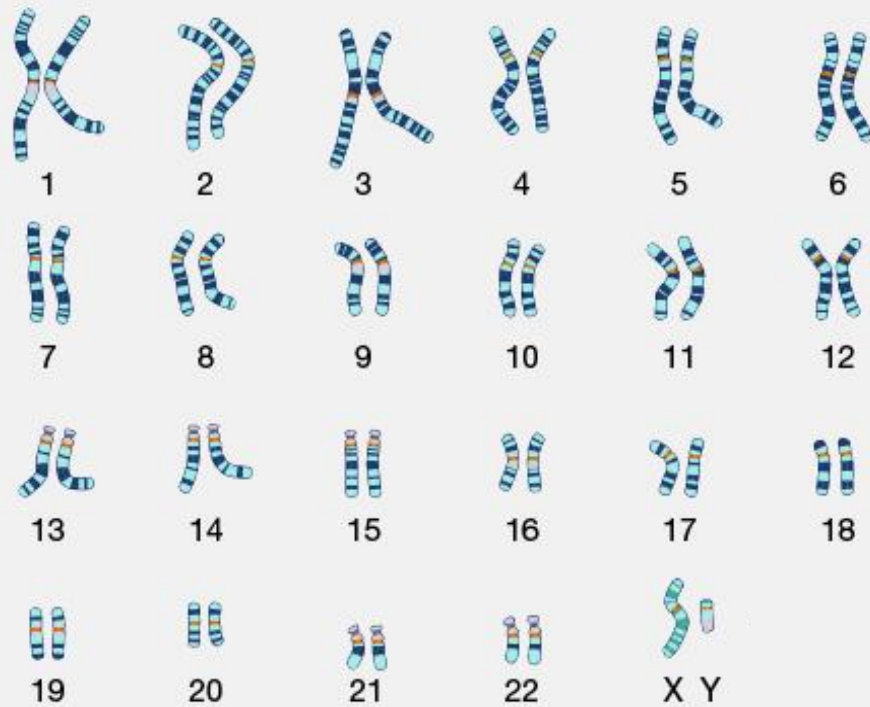


Trait

Observable outcome

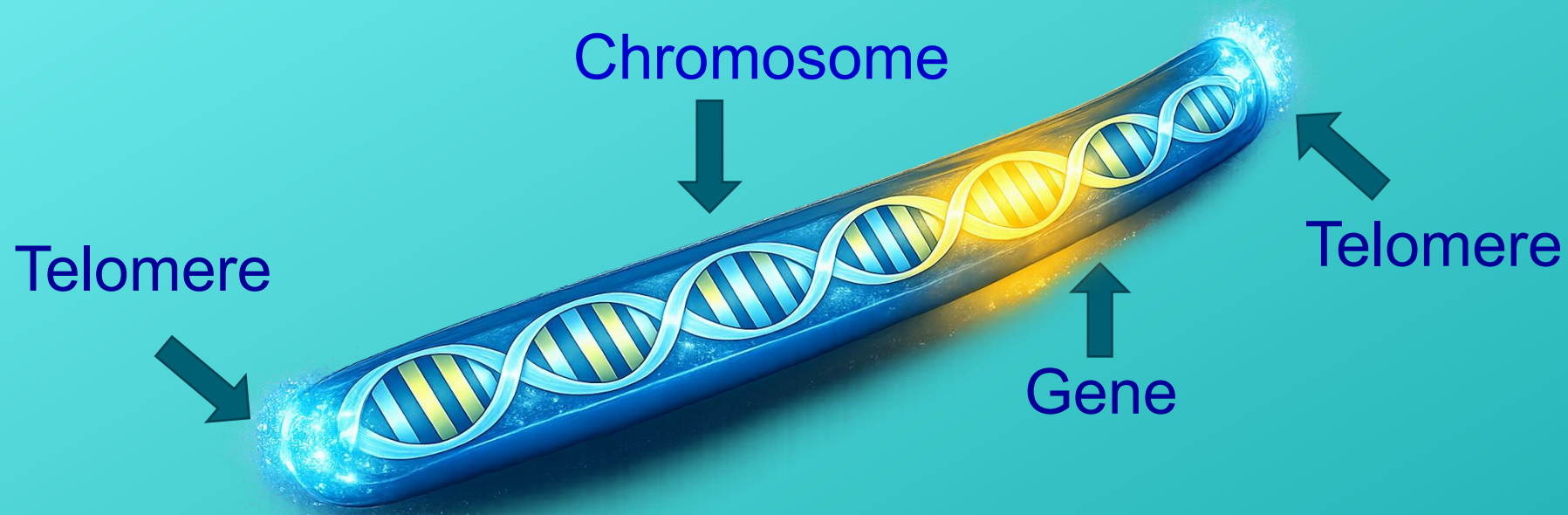
Genes influence **traits** by directing **protein** production.

DNA is Organized into Chromosomes



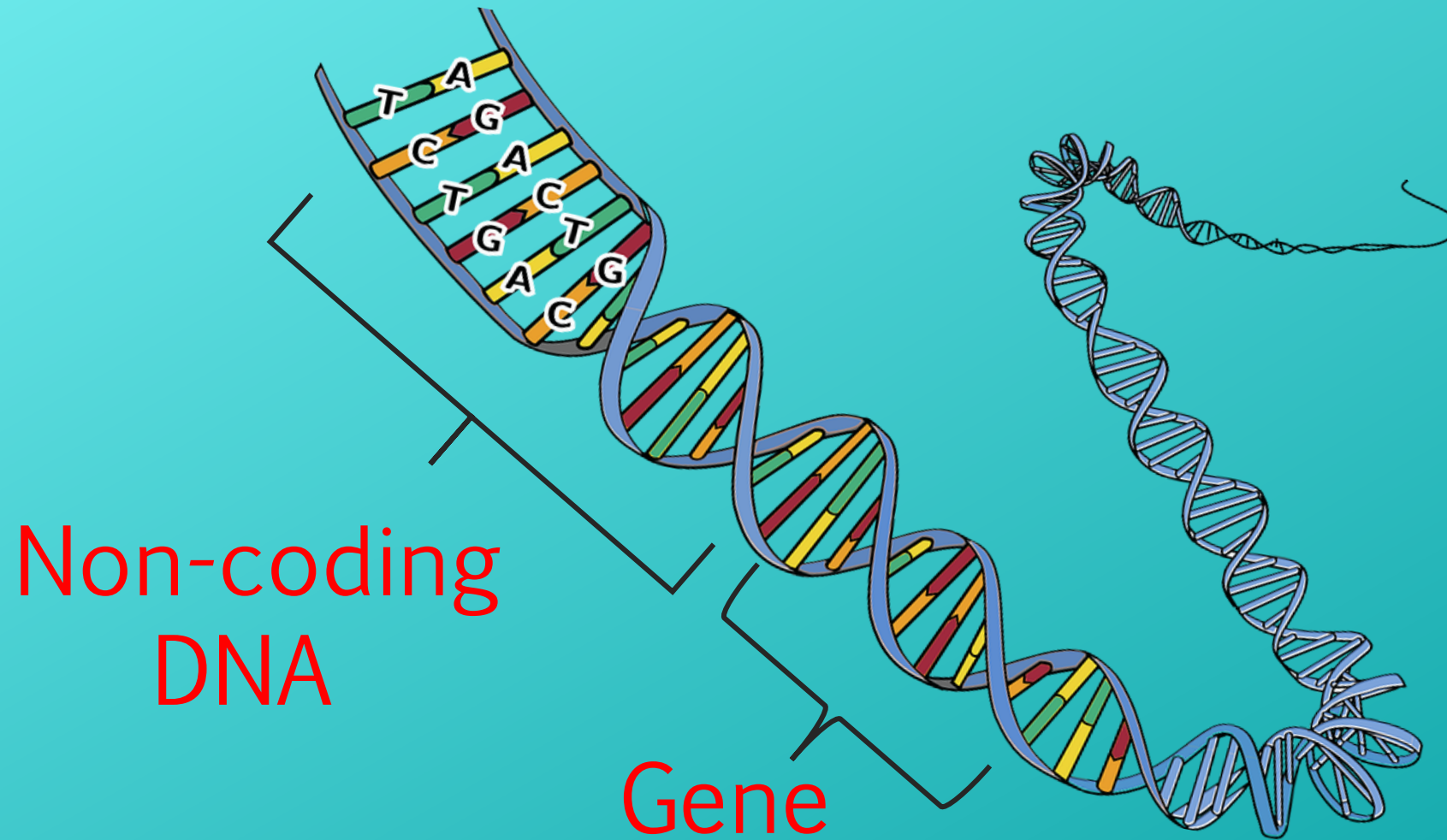
Normal Karyotype (C-1, Cell #8)

Each Chromosome Contains One Long DNA Molecule



A telomere consists of a short DNA base-pair sequence repeated thousands of times at the ends of chromosomes.

Non-coding DNA: Regulatory and Organizational System



Genome is the Entire Set of DNA Instructions Found in Every Cell

The *Human Reference Genome* is a composite, consensus sequence created from the DNA of multiple, anonymous individuals.

Genetic *variants* are alternative versions of the same gene.



National Human Genome
Research Institute

Same genetic code across life

Different genomes across organisms

Different gene expression across cells and individuals



Identical twins inherit identical DNA

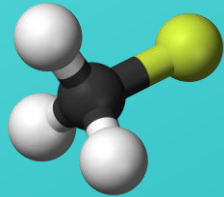
Both coding and non-coding DNA

All the base pairs are the same



Epigenetics is the system of chemical modifications that regulates how genes are used without changing the DNA sequence.

Over a lifetime, experiences and environment help shape these chemical patterns.



chemical tag (CH3)



The Major Types of Epigenetic Tags

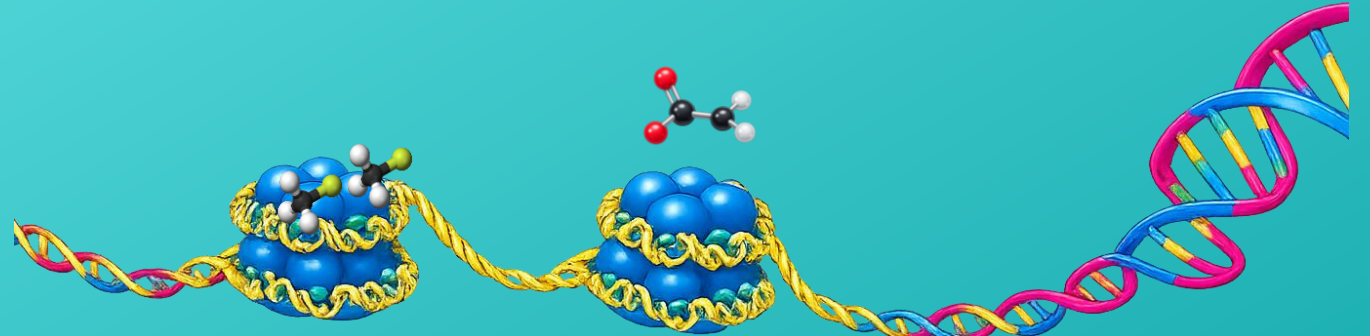
DNA methylation (CH_3) → on DNA



Tags attach to DNA

DNA sequence stays the same

Histone modifications → on histone proteins



Tags attach to histone proteins

Chemical changes loosen or tighten DNA

Control of gene access

How We Collect Epigenetic Tags Over a Lifetime

Epigenetic tags are created by our daily experiences.
These chemical tags accumulate over time and influence
which genes are turned on or off.



FOOD & NUTRITION

Nutrients provide the building blocks and energy for creating epigenetic tags



ENVIRONMENT

Toxins, pollutants, temperature, and chemicals can add or remove tags



MOVEMENT

Physical activity influences hormones and signaling pathways that affect epigenetic patterns



STRESS & EMOTIONS

Stress hormones and emotional experiences can change epigenetic tagging



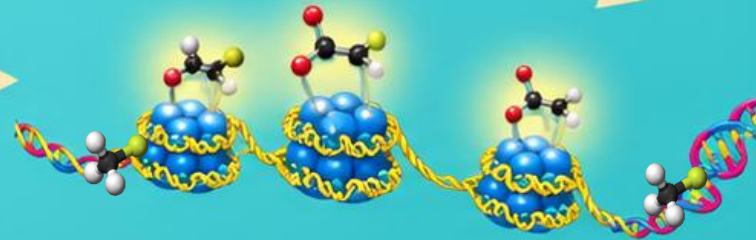
SLEEP & RECOVERY

Good sleep supports healthy epigenetic regulation and repair



SOCIAL CONNECTIONS

Relationships and social support can positively influence epigenetic patterns

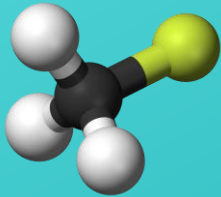


These tags accumulate throughout our lives

Our lifestyle and environment shape our epigenetic patterns,
which can influence health today and future generations.

Some Epigenetic Changes Are Reversible

Lifestyle can modify epigenetic patterns and influence disease risk



chemical tag (CH₃)



Epigenetic Reprogramming

Many epigenetic marks are erased after fertilization

New patterns are established as the embryo develops

Placenta translates maternal experiences into biological changes in the fetus



Early-life Experiences Shape Epigenetic Patterns



First exposures to air, food, light, and microbes help establish early biological tendencies

Epigenetic modifications are highly active in the developing brain

Touch, bonding, and stress wire the system

Crucial Window: From conception through age 5, the epigenome is uniquely flexible, laying the foundation for lifelong health.

FOOD is one of the **MOST**
powerful ways to influence
gene expression



Epigenetics of Bees: How Diet Determines Queens and Workers

Colony Need



Directs

Nurse Bee Action (Diet)



Triggers

Epigenetic Switch



Results in

Female Development: Queen or Worker

"Nutritional Control of Reproductive Status in Honeybees via DNA Methylation."
Science, Vol. 319, No. 5871, March 28, 2008, pp. 1827–1830.
(DOI: 10.1126/science.1153069)



The Human Body: Ongoing Construction Project

Genes $\rightarrow$ Blueprint

Food $\rightarrow$ Raw materials + Energy

Signals $\rightarrow$ Communication System

How does food become structure,
energy, and signals?

Two Nutrient Processing Systems

Small Intestine: Where the Body is Built



What enters the body:

- Glucose (simple carbs)
- Amino acids (protein)
- Fatty acids (fats)
- Vitamins & minerals

Why this matters:

- Builds cells and tissues
- Provides fuel for cellular energy
- Provides the raw materials needed for gene expression



Digestive enzymes break down protein, fat, starch

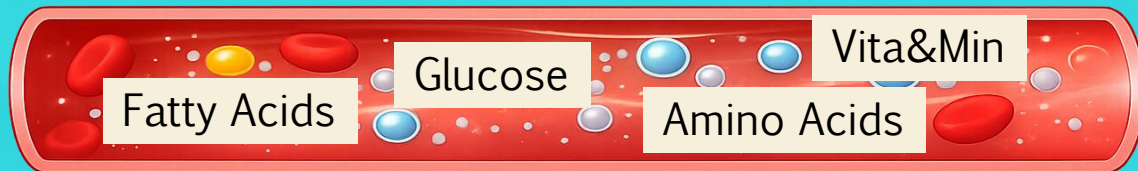
Macronutrients, vitamins, & minerals enter blood stream

Cells use nutrients to build the body
cells, tissues, membranes bone muscle, hormones, enzymes

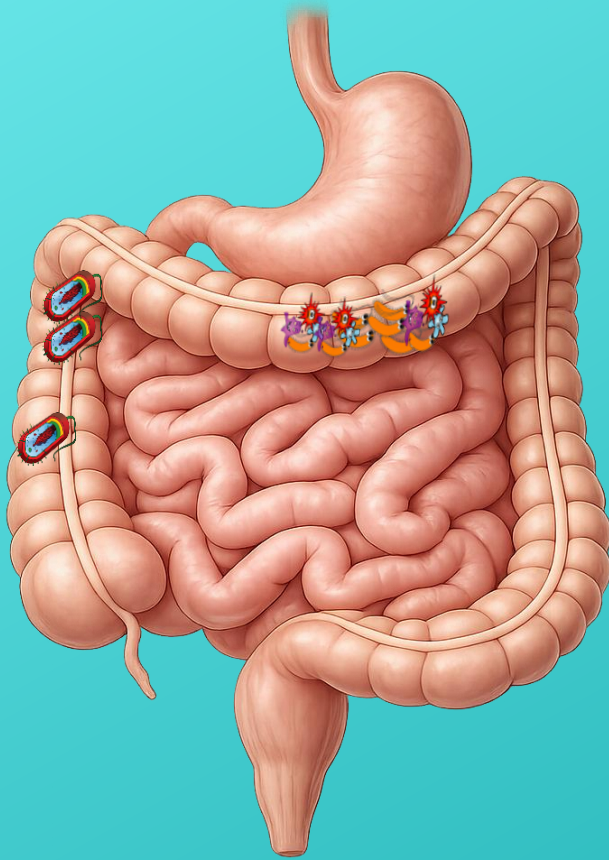
Cells transform nutrients into functional molecules
enzymes, hormones, neurotransmitters, signaling molecules

Some molecules regulate epigenetic enzymes

Gene expression patterns change



Colon: Where Microbes Transform Food into Bioactive Signals



What microbes produce & transform:

- Short chain fatty acids (SCFAs) from fiber
- Microbe-transformed phytochemicals
- Microbial chemical messengers

Why this matters:

- Communicates with your cells
- Influence inflammation, metabolism & immunity
- Influence gene expression



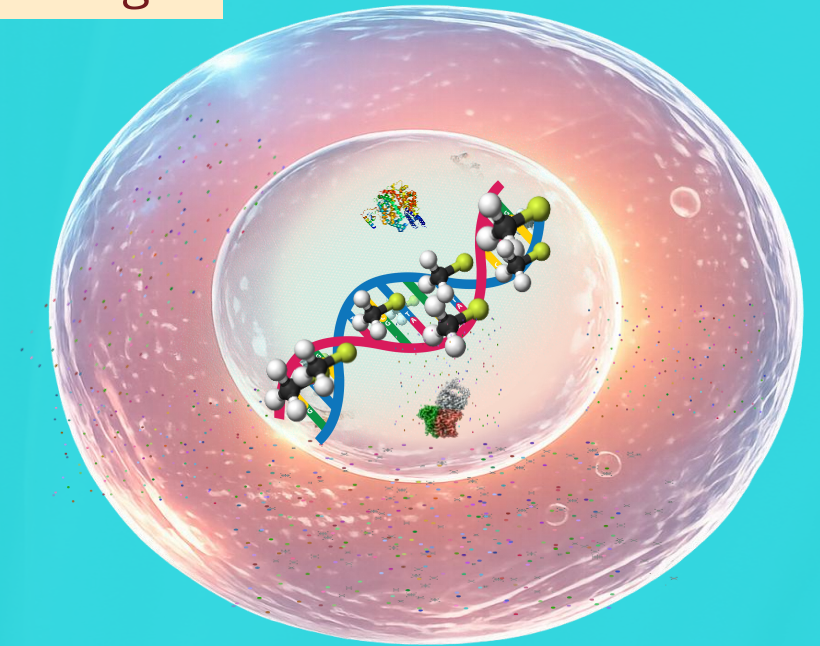
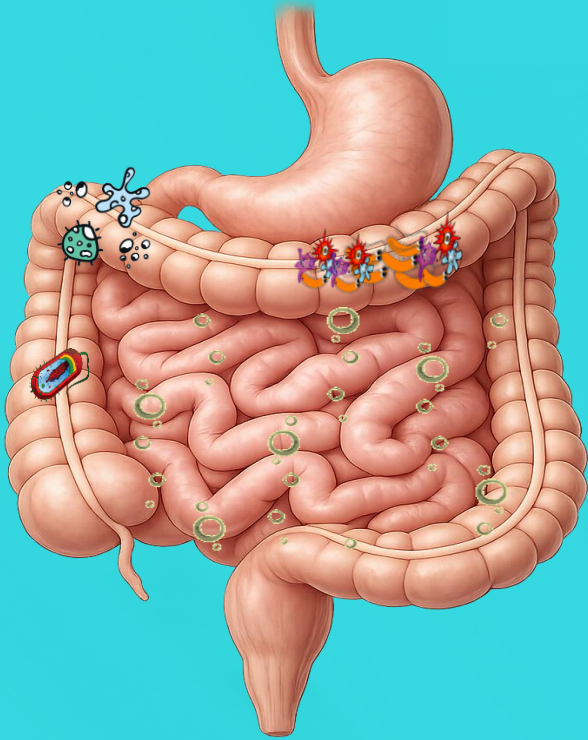
Fiber, phytochemicals, resistant starch feed gut microbes

Microbes transform them into bioactive molecules

Microbial bioactives enter the bloodstream

Some microbial bioactives influence epigenetic enzymes

Gene expression patterns change



***Epinutrients: Food That Talks to Your Genes**

Methyl Donors

Needed to build and place methyl tags

Folate

Vitamin B12

Choline

Betaine

Methionine

Epi-bioactives

Influence enzymes that add and remove tags

Polyphenols

EGCG

Allicin

Curcumin

Flavanols

Sulforaphane

Omega-3 (EPA&DHA)

Methyl Donor Foods



Folate
Vitamin B12
Choline
Betaine
Methionine

leafy greens, lentils
fish, eggs, meat
liver, eggs, broccoli
beets, quinoa
protein foods

These foods supply the *raw materials* needed to create and place epigenetic tags.

Epi-bioactive Foods



Polyphenols
ECGG
Curcumin
Sulforaphane
Allicin
Flavanols
Omega-3

blueberries, EVOO
green tea
turmeric
broccoli sprouts
garlic
dark chocolate
salmon, oily fish

These foods supply natural compounds that help **regulate the enzymes** that write or erase epigenetic tags.

Methyl Donor Nutrients

Folate (Vitamin B9)

Food Source	Serving Size	Amount	% Daily Value
Spinach (cooked)	1 cup	263 mcg	66%
Lentils (cooked)	1 cup	358 mcg	90%
Asparagus	1 cup	268 mcg	67%
Avocado	1 whole	163 mcg	41%

Choline

Food Source	Serving Size	Amount	% Daily Value
Egg (with yolk)	1 large	147 mg	27%
Beef liver	3 oz	356 mg	65%
Salmon	3 oz	187 mg	34%
Chicken breast (cooked)	3 oz	74 mg	13%
Soybeans	1 cup	214 mg	39%

Betaine

Food Source	Serving Size	Amount	% Daily Value
Beets	1 cup	175 mg	No DV established
Spinach (cooked)	1 cup	160 mg	No DV

Curcumin



Food Source	Serving Size	Amount	% Daily Value
Turmeric powder	1 tsp	~200 mg	No DV
Turmeric root	1 tbsp	Variable	No DV

Resveratrol

Food Source	Serving Size	Amount	% Daily Value
Red grapes	1 cup	Moderate	No DV
Blueberries	1 cup	Low–moderate	No DV
Peanuts	1 oz	Low	No DV

Quercetin

Food Source	Serving Size	Amount	% Daily Value
Red onions	1 medium	High	No DV
Apples (with skin)	1 medium	Moderate	No DV
Berries	1 cup	Moderate	No DV

Anthocyanins

Food Source	Serving Size	Amount	% Daily Value
Blueberries	1 cup	High	No DV
Blackberries	1 cup	High	No DV
Purple cabbage	1 cup	Moderate	No DV

Epi Bioactive Nutrients

Sulforaphane

Food Source	Serving Size	Amount	% Daily Value
Broccoli sprouts	1 oz	Very high	No DV
Broccoli	1 cup	Moderate	No DV
Kale	1 cup	Moderate	No DV

EGCG (Green Tea Catechin)

Food Source	Serving Size	Amount	% Daily Value
Matcha	1 cup	High	No DV
Green tea	1 cup	Moderate	No DV

2

Curcumin

Food Source	Serving Size	Amount	% Daily Value
Turmeric powder	1 tsp	~200 mg	No DV
Turmeric root	1 tbsp	Variable	No DV

Resveratrol



Food Source	Serving Size	Amount	% Daily Value
Red grapes	1 cup	Moderate	No DV
Blueberries	1 cup	Low–moderate	No DV
Peanuts	1 oz	Low	No DV

Quercetin

Food Source	Serving Size	Amount	% Daily Value
Red onions	1 medium	High	No DV
Apples (with skin)	1 medium	Moderate	No DV
Berries	1 cup	Moderate	No DV

Anthocyanins

Food Source	Serving Size	Amount	% Daily Value
Blueberries	1 cup	High	No DV
Blackberries	1 cup	High	No DV
Purple cabbage	1 cup	Moderate	No DV

I'm a superfood!



I'm magic. ✨



Dead Bugs Support Gut Health and Help Train Immune System



Salminen S et al. "The International Scientific Association of Probiotics and Prebiotics (ISAPP) consensus statement on the definition and scope of postbiotics." *Nature Reviews Gastroenterology & Hepatology*. 2021

What Way of Eating Best Supports Your Genes?

Mediterranean-Style Dietary Pattern

Plants • Fiber • Healthy fats • Fish • Minimal processed foods

Ranked Best Overall Diet for 8 Consecutive Years by US News & World Report

Framingham Heart Study - UK Biobank - Baltimore Longitudinal Study on Aging

What Else Influences Gene Expression?

Lifestyle Factors Shape Your Signaling Environment

Sleep - Exercise - Stress & Relaxation – Emotions - Connection

These factors influence hormones, neurotransmitters, inflammation, and metabolic signals that affect gene expression.