“Nutrigenomics and Gastrointestinal Disorders: Unlocking the Future of Personalized Nutrition”

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Introduction to Nutrigenomics

> "Did you know your genes might influence how your body reacts to a high-fiber diet or gluten?"

🔬 What is Nutrigenomics?

> Nutrigenomics is the scientific study of how nutrients and bioactive compounds in food influence gene expression and how an individual's genetic makeup affects their response to nutrients.

- **Nutrigenomics = Nutrition + Genomics**
- Studies how **dietary components** influence **gene expression** and how **genetic variations** affect response to nutrients.
- Core idea: **"Food talks to our genes."**

🔁 Interaction Between Nutrients and Genes

- Nutrients can **activate or silence genes** involved in metabolism, immunity, and disease development.
- Diet influences **epigenetic mechanisms** like:
  - DNA methylation
  - Histone modification
  - microRNA expression
- Example: Omega-3 fatty acids modulating inflammatory gene pathways.

🎯 Aims of Nutrigenomics

- **Disease Prevention:** By identifying dietary patterns that reduce the risk of chronic diseases (e.g., IBD, diabetes).
- **Personalized Nutrition:** Tailoring diets based on an individual's genetic profile for optimal health outcomes.
- **Optimizing Nutrient Intake**: Enhancing absorption, metabolism, and utilization based on genetic predispositions.

Overview of the Digestive System

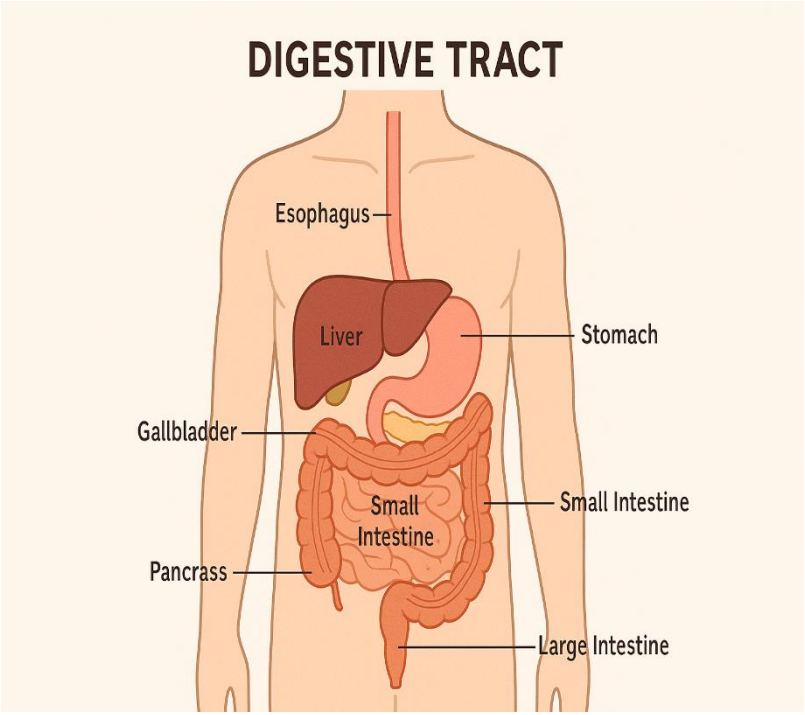
🧠 Purpose of the Digestive System

> The digestive system breaks down food into nutrients, which are absorbed into the bloodstream and used by the body for energy, growth, and repair.

🧬 Link to Nutrigenomics

> The **small intestine and colon** are critical sites where **nutrients interact with gut cells and microbiota**, influencing gene expression and health outcomes.

> "Every bite of food begins a complex journey through organs that not only digest, but also send signals to our genes—especially in the gut."



Basics of Nutrigenomics

How Genes Influence Nutrient Metabolism

🧬 Genes and Nutrient Metabolism

> Our **genes determine how efficiently we digest, absorb, transport, and utilize nutrients.** Variations in genes (called **SNPs – Single Nucleotide Polymorphisms**) explain why people respond differently to the same diet.

🔍 Key Examples:

- **Lactose Intolerance**

  → Mutation in the *LCT* gene affects **lactase** enzyme production

  → Impaired ability to digest lactose in dairy

- **Folate Metabolism – MTHFR Gene**

  → *MTHFR* gene variants reduce conversion of folate to its active form

  → Increases risk of neural tube defects, cardiovascular issues if folate is low

- **Caffeine Sensitivity – CYP1A2 Gene**

  → Fast vs. slow metabolizers of caffeine

  → Affects heart disease risk from coffee intake

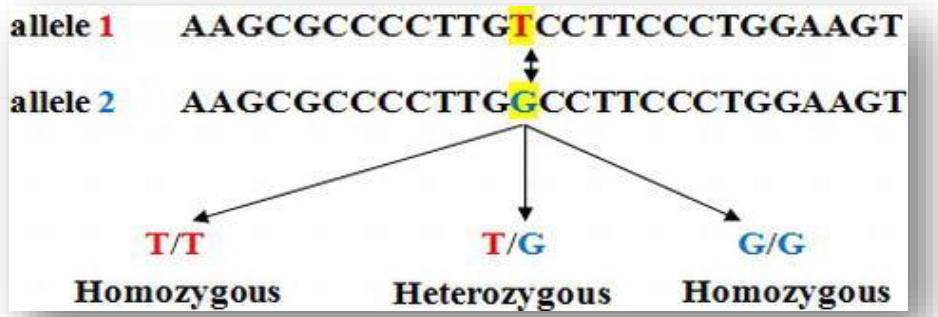
- **FTO Gene and Obesity**

  → Influences fat storage and hunger regulation

  → People with certain variants may gain weight more easily on high-fat diets

Gene-Diet Interactions

Gene-diet interactions refer to the way an individual's genetic makeup influences their response to certain nutrients, and how those nutrients can, in turn, affect gene activity.



How It Works:

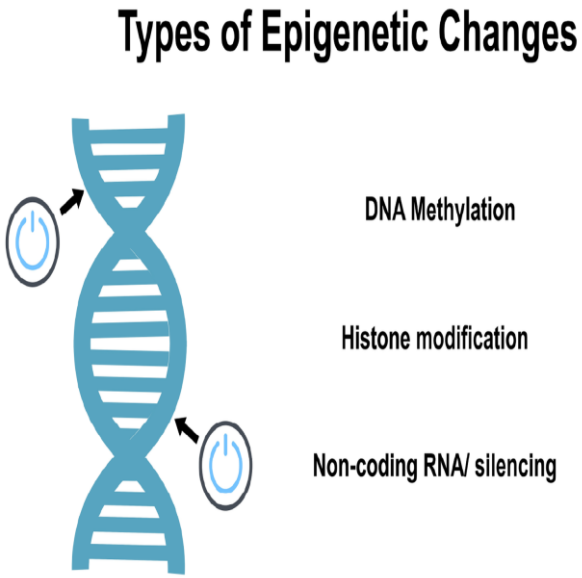
- **Genetic Variations (Polymorphisms):**

  Differences in DNA sequences among people can change how the body processes and responds to nutrients. For example, a single nucleotide polymorphism (SNP) in a gene might reduce or enhance enzyme activity involved in digestion or metabolism.

- **Nutrient Influence on Gene Expression:**

  Nutrients can affect how genes are turned on or off. This can happen through:

  - **Direct effects** on transcription factors (proteins that regulate gene expression)
  - **Epigenetic modifications** such as DNA methylation or histone modification, which don't change the DNA sequence but alter gene activity.



Examples:

Gene	Nutrient/Food	Effect
LCT	Lactose (milk sugar)	Variants cause lactose intolerance; inability to digest lactose properly
MTHFR	Folate (Vitamin B9)	Variants reduce enzyme efficiency, affecting folate metabolism and risk of birth defects
APOE	Dietary fat	Different APOE variants influence cholesterol levels and heart disease risk
NOD2	Dietary fiber & microbiome	Variants linked to Crohn's disease susceptibility, affecting gut inflammation response

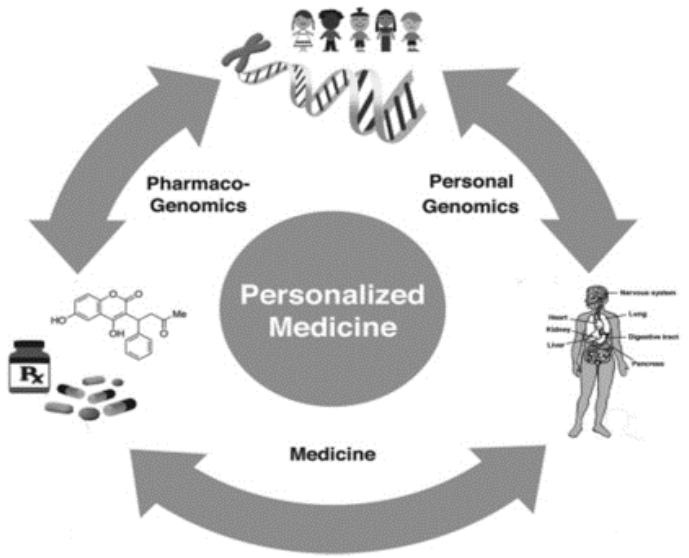
Why It Matters:

- **Personalized Nutrition:**

  Understanding gene-diet interactions allows for customized diets that optimize health based on genetic makeup.

- **Disease Prevention:**

  Tailoring diet according to genetic risk can help prevent or manage diseases, especially in complex disorders like gastrointestinal diseases.



The Gut Microbiome and Gene-Nutrient Interaction

1. Overview of the Gut Microbiota — Deeper Look

- The gut microbiome is dominated by two major bacterial phyla: **Firmicutes** and **Bacteroidetes**, but also includes Actinobacteria, Proteobacteria, and others.
- **Diversity matters**: Higher microbial diversity is generally associated with better health outcomes.
- Some bacteria are specialized in digesting complex carbohydrates, while others help regulate immune functions or produce neurotransmitters like serotonin.

2. How Diet Shapes the Microbiome — Examples

Diet Type	Effect on Microbiome	Key Bacteria Impacted	Health Implications
High-fiber	Increases fiber-degrading, SCFA-producing bacteria	*Bifidobacterium*, *Faecalibacterium*	Improved gut health, reduced inflammation
High-fat (saturated)	Increases pro-inflammatory bacteria, lowers diversity	*Bilophila wadsworthia*	Gut inflammation, metabolic issues
Western (high sugar)	Dysbiosis, increased Firmicutes:Bacteroidetes ratio	Increased opportunistic pathogens	Obesity, metabolic syndrome
Mediterranean	Increased diversity, SCFA producers	*Roseburia*, *Prevotella*	Anti-inflammatory, cardiometabolic benefits
High animal protein	Increase bacteria producing harmful metabolites	*Bacteroides*, *Alistipes*	Potentially increased inflammation

3. Gut Microbiota's Impact on Nutrient Metabolism and Inflammation — Detailed Examples

Mechanism	Microbial Role	Impact on Host	Example Organisms
SCFA production	Fermentation of fibers	Energy source, anti-inflammatory	*Faecalibacterium prausnitzii*
Vitamin synthesis	Produce vitamins	Supplement host vitamins	*Bifidobacterium, Lactobacillus*
Bile acid transformation	Convert primary to secondary bile acids	Regulate fat absorption & metabolism	*Clostridium* spp.
LPS release	Endotoxin production	Induce systemic inflammation	*Escherichia coli, Salmonella*
Dysbiosis promoting inflammation	Shift towards pro-inflammatory bacteria	Chronic inflammation, gut disorders	*Enterobacteriaceae*

4. Interaction Between Microbiota, Host Genes, and Diet — Specific Insights

Interaction Type	Mechanism	Example	Outcome
Host gene → Microbiota	Genetic variants shape immune/mucosal environment	NOD2 variants affect gut bacteria	Altered microbiota, risk of Crohn's disease
Microbiota → Host gene	Microbial metabolites epigenetically regulate host genes	Butyrate inhibits HDACs	Anti-inflammatory gene expression
Nutrients → Microbiota + Host	Diet influences microbial metabolites and host receptor signaling	Fiber → SCFA production → FXR activation	Metabolic and immune regulation
Integrated example	LCT gene + microbiota ferment lactose	Lactose intolerance symptoms modulated by microbiota	Variable symptom severity

Nutrigenomics in GI Disorders:

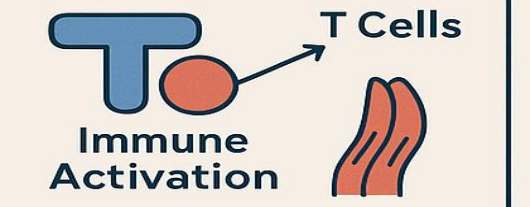


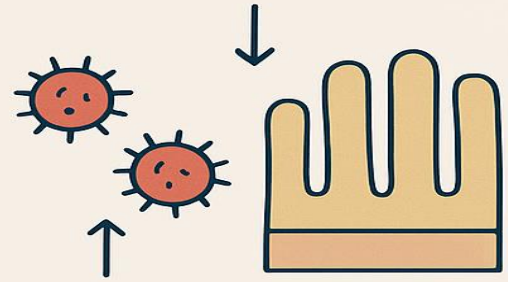
NUTRIGENOMICS IN CELIAC DISEASE



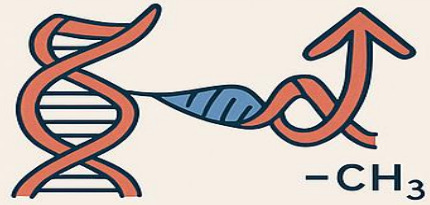
HLA–DQ2/DQ8

GENE–DIET INTERACTION





GENE EXPRESSION CHANGES



EPIGENETICS



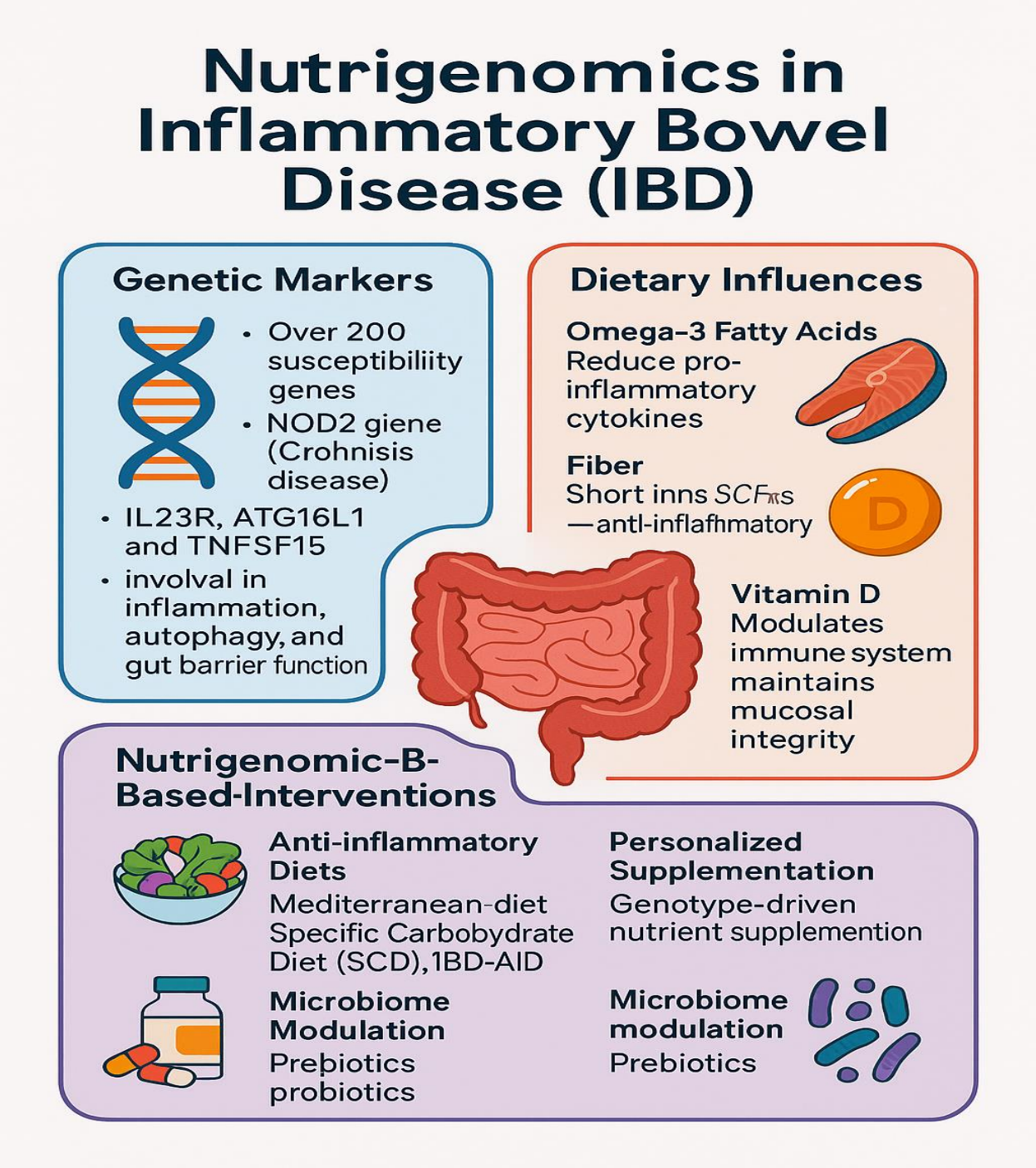
NUTRIGENOMIC APPLICATIONS



Genetic Screening



Gluten Free Diet


Nutrigenomics in Inflammatory Bowel Disease (IBD)
Genetic Markers
• Over 200 susceptibiliity genes
• NOD2 giene (Crohnisis disease)
• IL23R, ATG16L1 and TNFSF15
• involval in inflammation, autophagy, and gut barrier function
Dietary Influences
Omega-3 Fatty Acids
Reduce pro-inflammatory cytokines
Fiber
Short inns SCFπs
—antl-inflafhmatory
Vitamin D
Modulates immune system maintains mucosal integrity
Nutrigenomic-B-Based-Interventions
Anti-inflammatory Diets
Mediterranean-diet Specific Carbobydrate Diet (SCD),1BD-AID
Personalized Supplementation
Genotype-driven nutrient supplemention
Microbiome Modulation
Prebiotics probiotics
Microbiome modulation
Prebiotics

Nutrigenomics in Irritable Bowel Syndrome (IBS)

Interaction of FODMAP with Genetic Factors

- Poor FODMAP digestion raises symptoms in some individuals
- Constellation of susceptibility genes

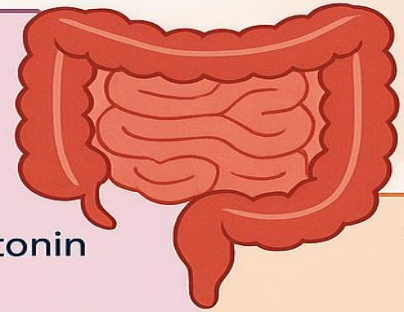


Tailored Dietary Approaches

- Low-FODMAP diet reduces intake of fermentable carbohydrates
- Links to IBS and diet



5-HT



Serotonin Metabolism Genes and Diet

- Variants in serotonin transporter and receptor genes
- Links to IBS and diet



5-HT

Tailored Dietary Approaches

- Low-FODMAP diet reduces intake of fermentable carbohydrates
- Exploration of specific fiber types



Nutrigenomics in GI Disorders: Lactose Intolerance

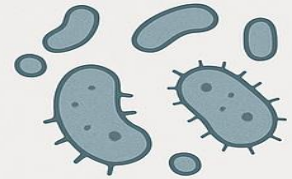


GENE–DIET INTERACTION



Lactose consumption in dairy products

MICROBIOTA–NUTRIENT INTERACTION



Fermentation of undigested lactose by gut bacteria

PERSONALIZED NUTRITION



Genetic test



Probiotics



Enzyme supplements

PERSONALIZED NUTRITION

🧬 MCM6/LCT Gene and Lactose Intolerance

(Slide with Visual Enhancements)

📜 Comparison Table: MCM6 Genotypes and Lactose Tolerance

Genotype	Lactase Production	Tolerance to Dairy	Common Populations	Clinical Guidance
TT	High	Tolerates lactose well	Northern Europeans	Dairy allowed
CT	Moderate	Partial tolerance	Mixed ancestry populations	Small amounts may be tolerated
CC	Low	Lactose intolerant	East Asians, West Africans	Limit lactose; consider alternatives

📘 Case Study: Genetic Testing and Personalized Nutrition

Patient: 28-year-old female, East Asian background

Symptoms: Bloating, abdominal cramps, and diarrhea after consuming milk or ice cream

Genetic Test Result: *MCM6 -13910 CC genotype*

Diagnosis: Primary adult-onset lactose intolerance

Nutritional Intervention:

- Eliminate high-lactose foods
- Recommend lactose-free dairy or fortified plant-based alternatives
- Consider calcium and vitamin D supplementation

Outcome: Symptom resolution within 1 week of dietary adjustment

Case Example: GERD and Gene–Diet Interactions



Patient Profile

- 42-yeold male, office worker, BMI 29
- Irregular eating schedule
- Frequent heartbum, espe cially at night, bloating, regurgitation after fatty meals a coffee

Clinical Assessment

- Diagnosis of GERD
- Lifestyle risk factors
  - Late, Ihigh-fat dnners
  - High coffee and chocolate intake
- Nutrigenomic test results
  - GNB3 C825T polymorphism: inkncreased LES dysfunction
  - TNF-d: 308G>A variant: linked circadian pattern of gastric acid secretion

Nutrigenomics–Informed Dietary Intervention

- Reduce dietary fat intake: eat smaller, more frequent meals
- Avoid spicy, acidic foods: increase intake of anti-inflammatory foods (e.g., omega-3s, turmeric)
- Circadian rhythm (CLOCK): s;hdugd meals earler
- Lifestyle advice

Outcome (After 6 Weeks)

- Heartburn episodes reduced by 70%

🧪 Recent Advances and Case Studies: Multi-Omics in GI Health

🔬 1. Integrating Multi-Omics in Personalized Nutrition

- **Genomics:** Identifies predispositions to food intolerances, inflammatory responses, enzyme deficiencies (e.g., LCT, GNB3).
- **Metabolomics**: Profiles real-time biochemical responses to diet (e.g., bile acids, short-chain fatty acids).
- **Microbiomics:** Reveals gut flora composition affecting nutrient metabolism, inflammation, and barrier function.

> **Visual suggestion**: Venn diagram or layered omics model:
> `Genomics → Microbiome → Metabolome → Personalized Diet`

🏥 2. Examples in Clinical Settings

Condition	Omics Used	Personalized Intervention	Outcome
IBS	Genomics + Microbiome	Low FODMAP + tailored probiotics	Reduced bloating, better motility
GERD	Genomics + Metabolomics	Anti-inflammatory & circadian-based meal timing	Fewer reflux episodes
IBD	Genomics + Microbiomics	SCFA-enhancing prebiotic diet	Reduced flare-ups, improved CRP
NAFLD	Genomics + Metabolomics + Microbiome	Lipid metabolism-guided macronutrient plan	Lower ALT/AST, better liver health

🟦 3. Case Study: Multi-Omics-Based Diet for IBS

Patient: 35-year-old female, recurrent IBS-D

Tests:

- **Genomics:** SNPs in *FUT2*, *IL-10* (linked to impaired mucosal immunity)
- **Microbiome:** Low Bifidobacteria, high methane-producing archaea
- **Metabolomics**: Low SCFA (butyrate), high histamine

Dietary Plan:

- Low-histamine + partially hydrolyzed guar gum (PHGG)
- Probiotic strain *B. infantis 35624*
- Polyphenol-rich foods (green tea, berries)

Outcome:

- 60% reduction in abdominal pain in 4 weeks
- Fewer episodes of diarrhea
- Increased microbial diversity on follow-up

پنل‌های ژنتیکی تجاری تغذیه و سلامت گوارشی

عدم تحمل‌ها و حساسیت‌های شما

بیماری سلیاک
حساسیت به نمک
حساسیت به لاکتوز
حساسیت به کافئین
حساسیت به الکل

عدم تحمل‌ها و حساسیت‌های شما

پاسخ بدن به کربوهیدرات
پاسخ بدن به چربی‌های اشباع
پاسخ بدن به چربی‌های غیراشباع
نیاز بدن به امگا-3 و امگا-6

نیاز بدن شما به ویتامین‌ها

پاسخ بدن به کربوهیدرات
نیاز به ویتامین B2 و فولیک اسید
نیاز به ویتامین A
نیاز به ویتامین B12
نیاز به ویتامین D
نیاز به ویتامین B6
نیاز به ویتامین C
پاسخ بدن به چربی‌های غیراشباع
نیاز به ویتامین E
نیاز بدن به امگا-3 و امگا-6

ریسک بیماری‌های مزمن

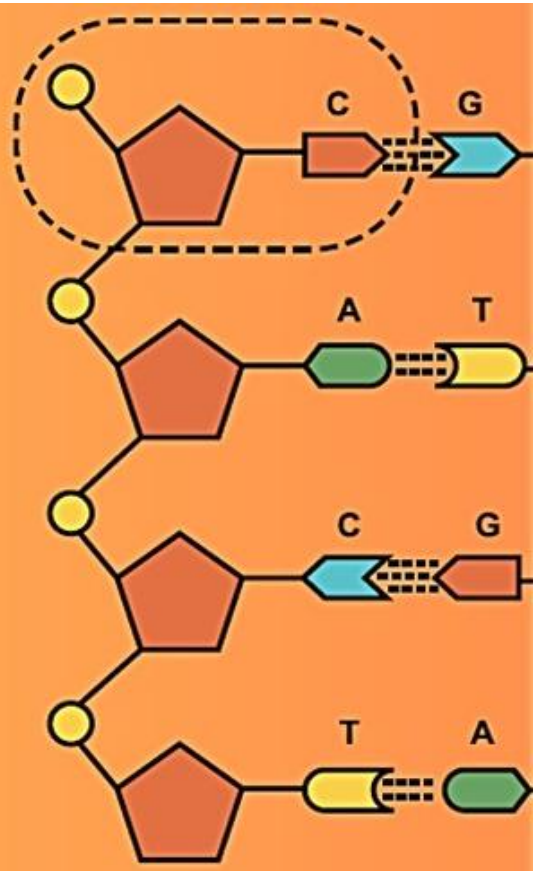
ریسک چاقی
ریسک ابتلا به دیابت نوع 2

رفتارهای اعتیادگونه در تغذیه

پرخوری عصبی و ریزه‌خواری
اشتها

پاسخ بدن شما به ورزش

تاثیر ورزش در کاهش وزن
تاثیر ورزش بر فشار خون
تاثیر ورزش بر سوخت و ساز بدن



🧪 پنل‌های تجاری معروف نوتریژنومیکس:

نام پنل ژنتیکی	شرکت ارائه‌دهنده	کشور	ویژگی‌ها
Nutrigenomix	.Nutrigenomix Inc	کانادا	70+ ژن مرتبط با تغذیه و ورزش
DNAfit	DNAfit	انگلستان	شامل رژیم، ورزش و پاسخ به استرس
23andMe + Health	23andMe	آمریکا	اطلاعات ژنتیکی عمومی + تغذیه‌ای
MyDNA	MyDNA Life	استرالیا	توصیه‌های غذایی، مکمل‌ها، سبک زندگی
GenoPalate	GenoPalate	آمریکا	تحلیل دقیق رژیم غذایی با تفسیر ژنتیکی
Mapmygenome (Genomepatri)	هند	هند	تحلیل رژیم، ورزش، بیماری‌ها بر اساس ژن‌ها

⚖️ Challenges and Ethical Considerations in Nutrigenomics

🚧 Key Challenges

1. Accessibility and Cost

- Genetic and microbiome testing can be expensive
- Limited access in low-resource settings
- Health insurance coverage often lacking

2. Privacy and Data Security

- Genetic data is sensitive and permanent
- Risk of misuse or unauthorized sharing
- Ethical handling of patient consent and storage

3. Scientific Limitations

- Many gene-diet interactions still poorly understood
- Complex traits often influenced by multiple genes + environment
- Lack of long-term, large-scale clinical trials

4. Pseudoscience and Misinformation

- Rise in unregulated "nutrigenomic diets" sold online
- Companies overstate benefits based on weak science
- Risk of eroding public trust and causing harm

🔮 Future Directions in Nutrigenomics and GI Health

1. Personalized Dietary Recommendations

- Integration of gut microbiome profiling and genetic data
- Tailored nutrition plans for individual metabolic and immune responses
- Enhanced efficacy in managing GI disorders like IBS, IBD, and celiac disease

2. AI and Bioinformatics

- Advanced algorithms to analyze multi-omics data (genomics, metabolomics, microbiome)
- Predictive models for nutrient-gene interactions and health outcomes
- Decision-support tools for clinicians and dietitians

3. From Treatment to Prevention

- Early risk identification for GI disorders using nutrigenomic biomarkers
- Lifestyle and diet modifications before disease onset
- Shift towards proactive, rather than reactive, healthcare


ANY QUESTION?


THANK YOU
FOR YOUR
ATTENTION