Personalized Medicine, Epigenetics and Health

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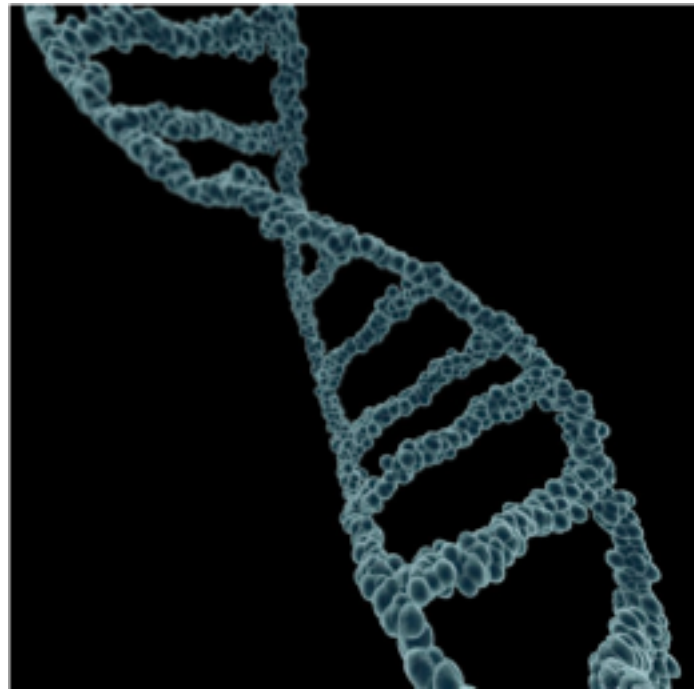


a place of mind
THE UNIVERSITY OF BRITISH COLUMBIA

Faculty of Medicine
Department of Medical Genetics

Personalized Medicine, Epigenetics and Health

- **Genetics**
  - Introduction to Basic Genetics Concepts
- **Epigenetics**
  - What is it and What do We Know About It?
  - How can You Influence your DNA and Genes for better Health?
  - How can exercise, what we eat, and meditation affect our genes?
- **Direct to Consumer Genetics Tests**
  - What are they?
  - 23andMe and other Direct to Consumer Genetic Tests
  - Are they safe to do? Legally? Personally?
- **Personalized Medicine**
  - What Role Does Genetics Play?
  - Is this happening now?

- **OBJECTIVES TODAY**

By the end of today you will be able to:

- Define some genetics terms and concepts
- Discuss epigenetics
- Integrate your new understanding of genetics and epigenetics to help improve your health
- Implement some strategies into your life to improve genetic health
- Discuss various direct to consumer genetic tests available and some things to keep in mind before taking one
- Define personalized medicine

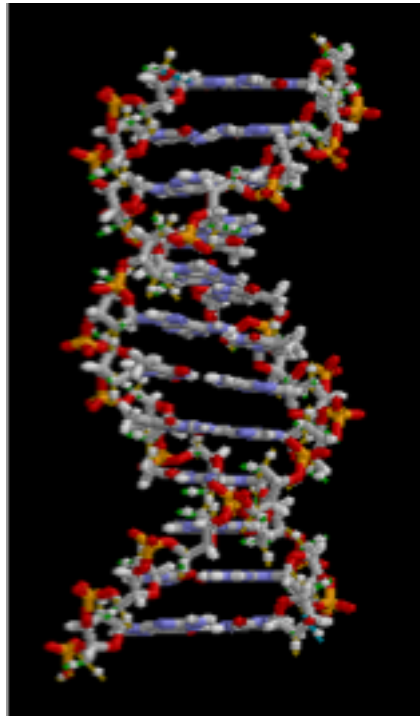
GENETIC TERMINOLOGY

An Introduction to Genetics- Video

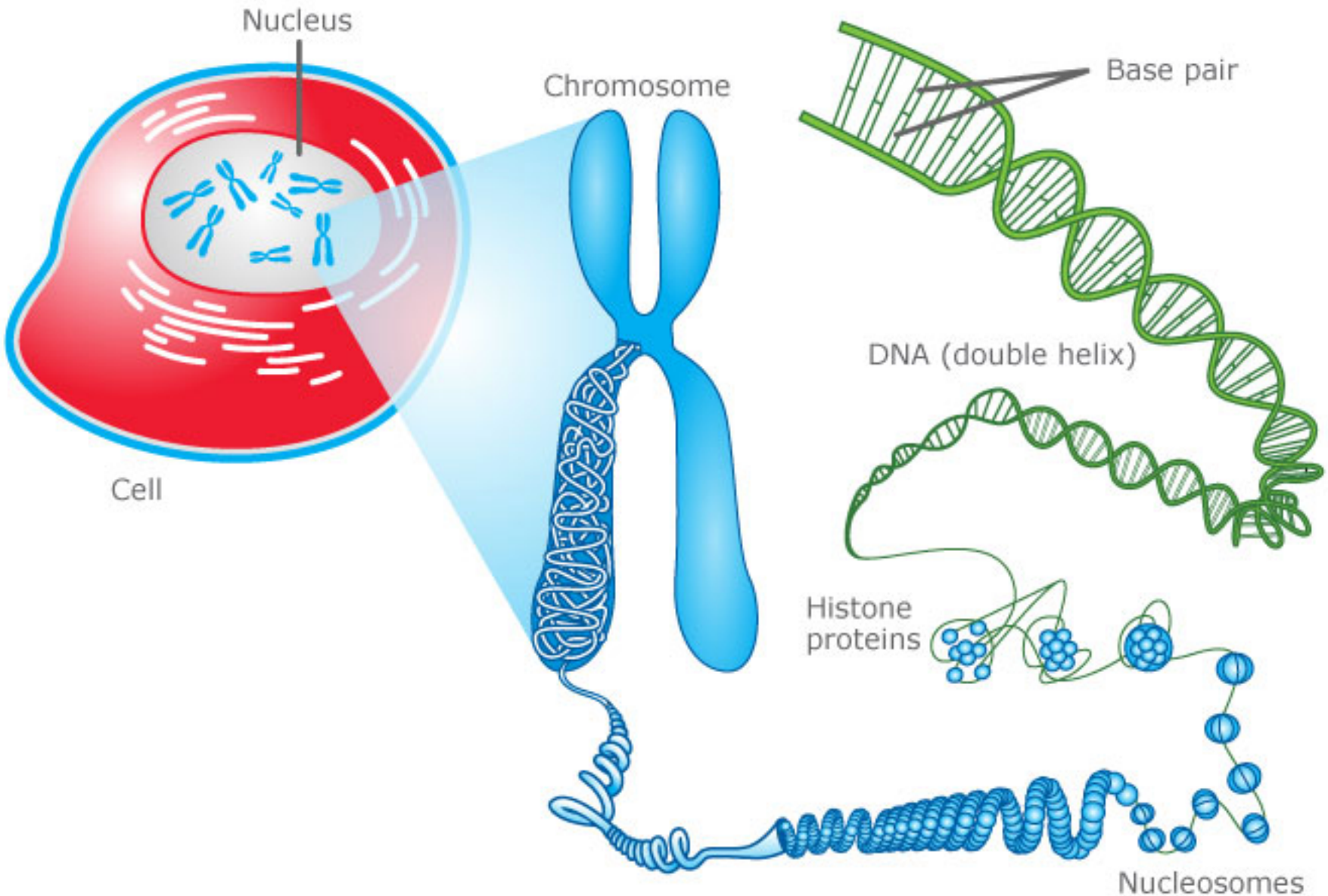
Genome BritishColumbia

- **GENETICS**
  - The study of inheritance in all of its manifestations
  - From expression, transmission, & evolution of genes, to distribution of traits in families & population
  - At the DNA, cellular, biochemical, organism, & population levels

- **Deoxyribonucleic acid (DNA)**
  - Molecule that carries most of the genetic instructions
  - Used to facilitate growth, development, functioning and reproduction
  - Passed from parents to offspring, DNA contains instructions that make every living creature unique
  - Made of bases (~3000 Mb in humans) – 3 billion!
  - Bases are cytosine, guanine, thymine and adenine
    - **C G T A**
    - **G C A T**



- **CHROMOSOME**
  - Thread-like structures located inside the nucleus of animal and plant cells
  - Each is made of protein and a single DNA molecule



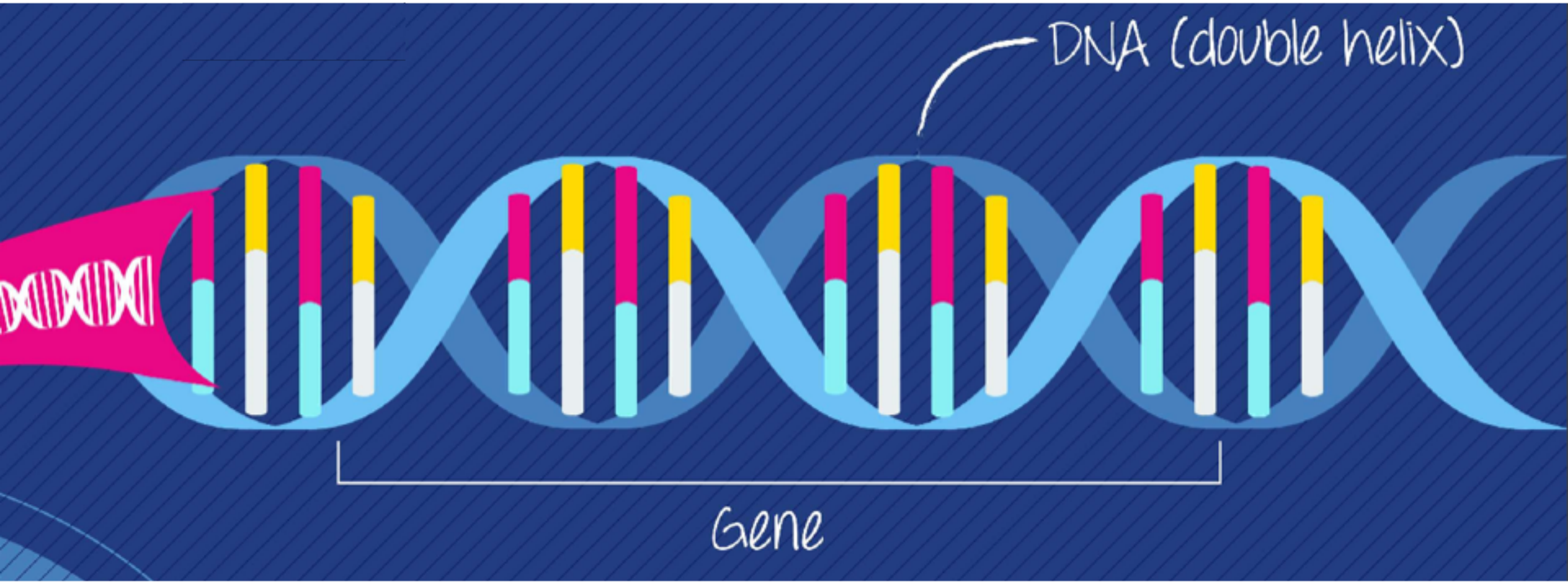
What is DNA?

DNA is a long, ladder-shaped molecule, the famous 'double-helix'. Inside our cells, DNA contains all the information needed to make us grow and live. This information is organised into packages called chromosomes.

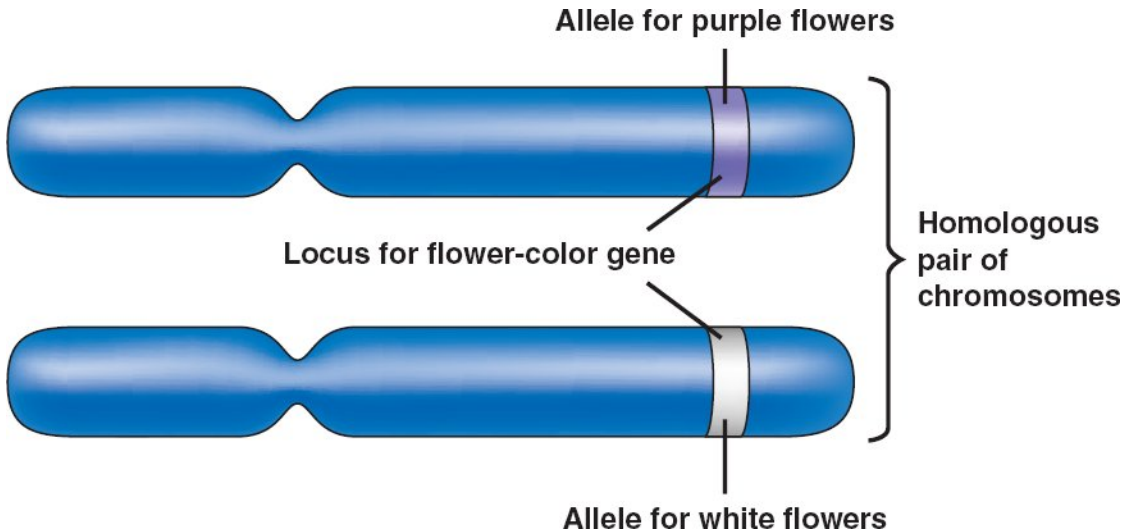
Humans have 46 chromosomes, organised into pairs. One member of the pair comes from our mother and the other from our father.

23
pairs of chromosomes

- **GENES**
  - Fundamental units of genetic material/ information
  - DNA represents the sequence coding a polypeptide
  - ~20,000-25,000 human protein-coding genes
  - Genes make proteins

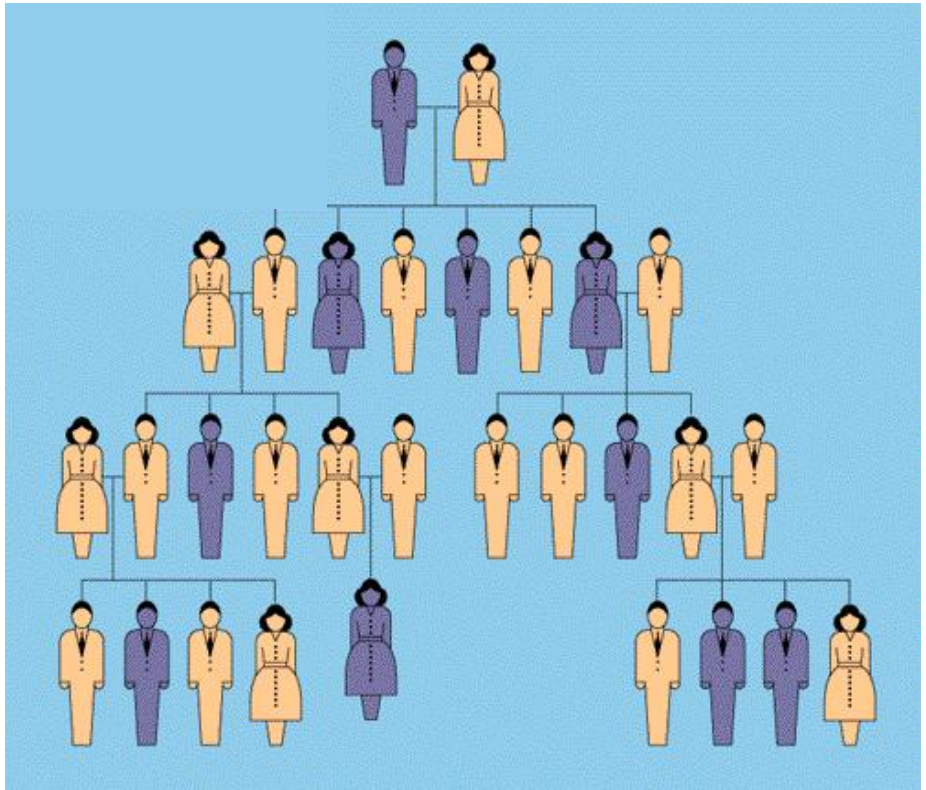

DNA (double helix)
Gene

- **ALLELES**
  - Variant form of a gene
- **LOCUS (pl. LOCI)**
  - Specific site, i.e. address, occupied by genes
  - “Loci”= location

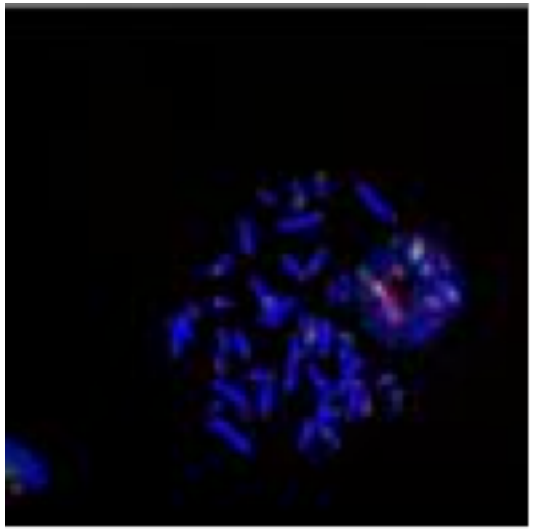


- **DOMINANT**
  - Relationship between alleles of a particular gene which effect the phenotype
  - Dominant alleles mask the contributions of the second recessive allele
- **RECESSIVE**
  - An individual must inherit both recessive alleles from the parents in order to present the phenotype

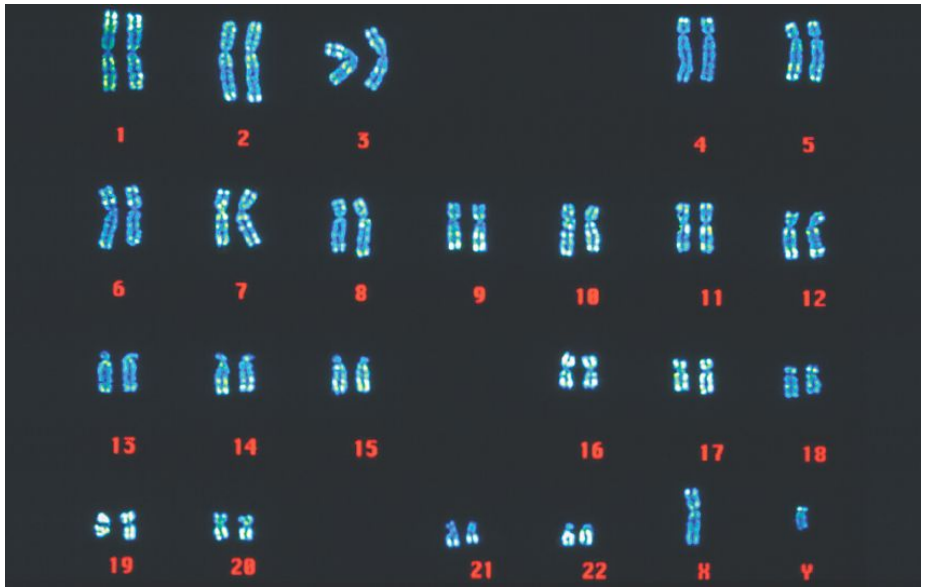
- **HEREDITY**
  - How traits pass from parents to offspring



- **TRAIT**
  - Passed from generation to generation
  - Inherit traits from our parents, and pass them on to our children
  - Examples include physical traits, behavioural traits and medical predispositions



- **KARYOTYPE**
  - Number and appearance of chromosomes in the nucleus
  - Complete set of chromosomes in a species
  - **Male:** XY **Female:** XX



EXERCISE – What Traits do you Have?

Trait	Yes/ No	Dominant/ Recessive
Free ear lobes		
Tongue rolling		
Dimples		
Right-handedness		
Freckles		
Curly Hair		
Left over Right Hand Clasping		
Widow's Peak Hairline		
Chin Fissure		
Pigmented Iris		
No hitchhiker's Thumb		
Can't smell asparagus odour in urine		
Bent little finger		
Mid-digital hair		

Trait	Yes/ No	Dominant/ Recessive
Free ear lobes	**YES**	**D**
Tongue rolling	**YES**	**D**
Dimples	**NO**	**R**
Right-handedness	**YES**	**D**
Freckles	**YES**	**D**
Curly Hair	**YES**	**D**
Left over Right Hand Clasping	**YES**	**D**
Widow's Peak Hairline	**NO**	**R**
Chin Fissure	**NO**	**R**
Pigmented Iris	**NO**	**R**
No hitchhiker's Thumb	**NO**	**R**
Can't smell asparagus odour in urine	**NO**	**R**
Bent little finger	**NO**	**R**
Mid-digital hair	**YES**	**D**

EPIGENETICS

Epigenetics

Epigenetics, as a simplified definition, is the study of biological mechanisms that will switch genes on and off. **What does that mean?**

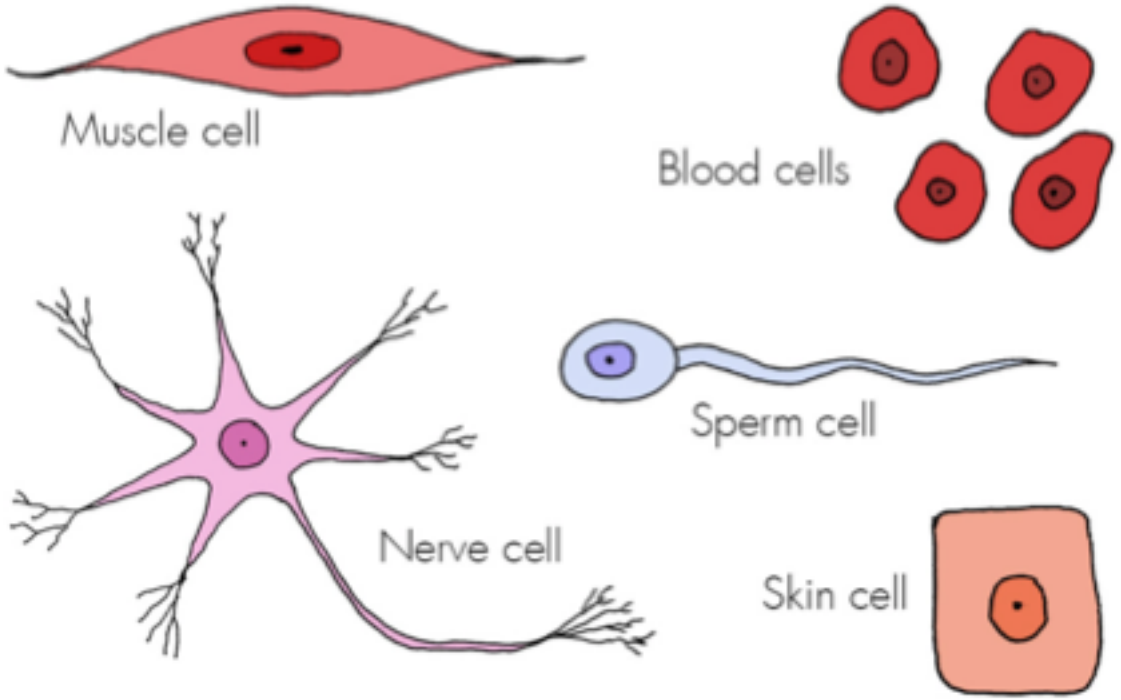
Epigenetics, essentially, affects how genes are read by cells, and subsequently how they produce proteins.

Something that affects a cell, organ or individual without directly affecting its DNA. An epigenetic change may indirectly influence the expression of the genome.

A few important points about epigenetics:

- **Epigenetics Controls Genes.**
- **Epigenetics Is Everywhere.**
- **Epigenetics Makes Us Unique.**
- **Epigenetics Is Reversible.**

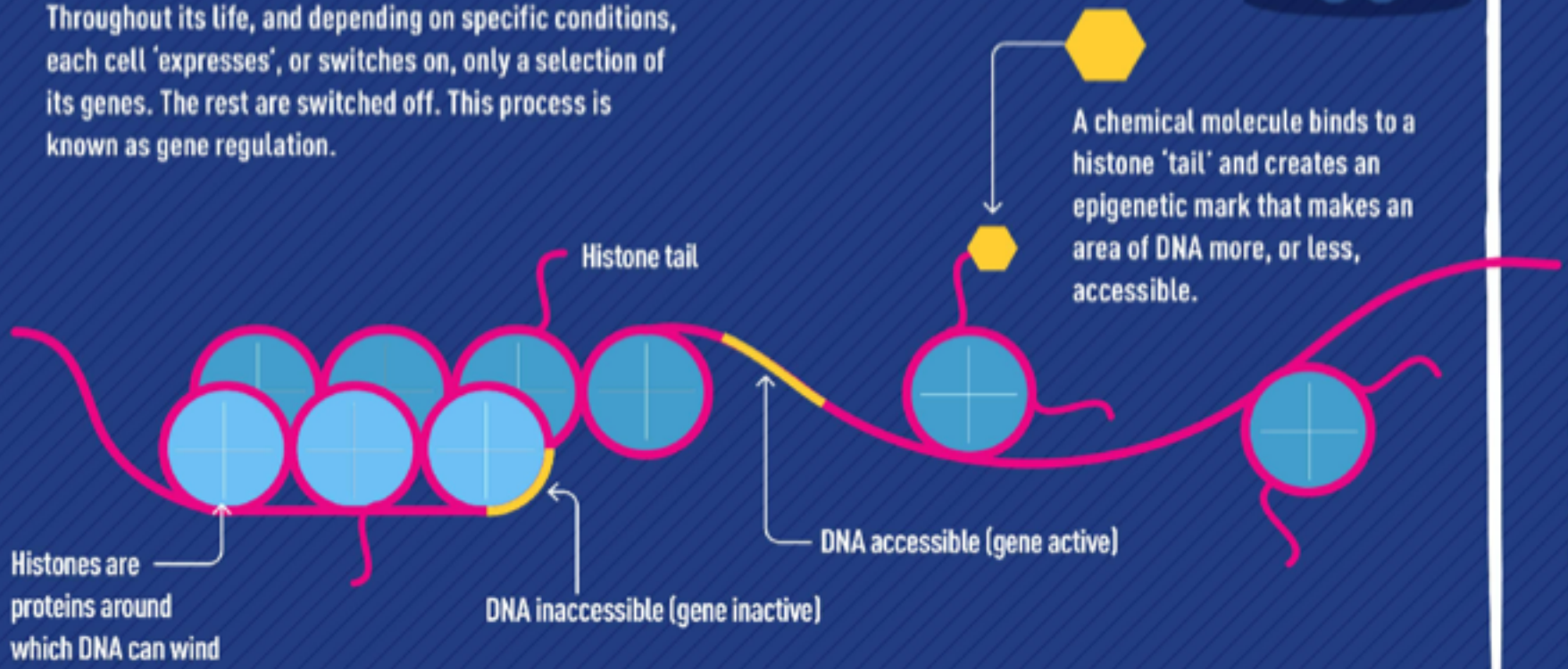
- Have you ever wondered how your kidney cell could have the exact same DNA content as a cell in your eye?



How do genes work?

Although all our cells need the same DNA to function, over time, they don't use it all.

Throughout its life, and depending on specific conditions, each cell 'expresses', or switches on, only a selection of its genes. The rest are switched off. This process is known as gene regulation.

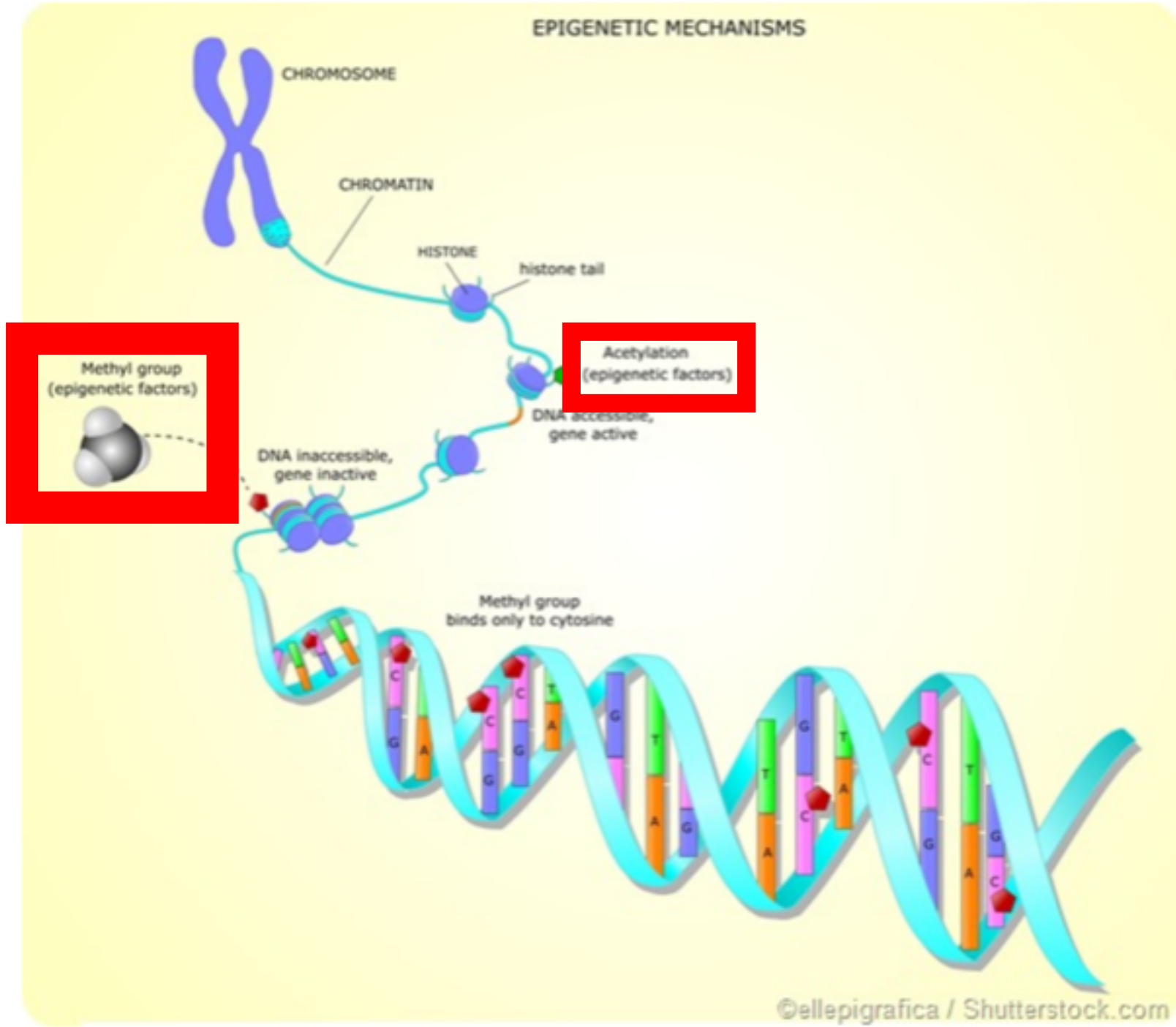


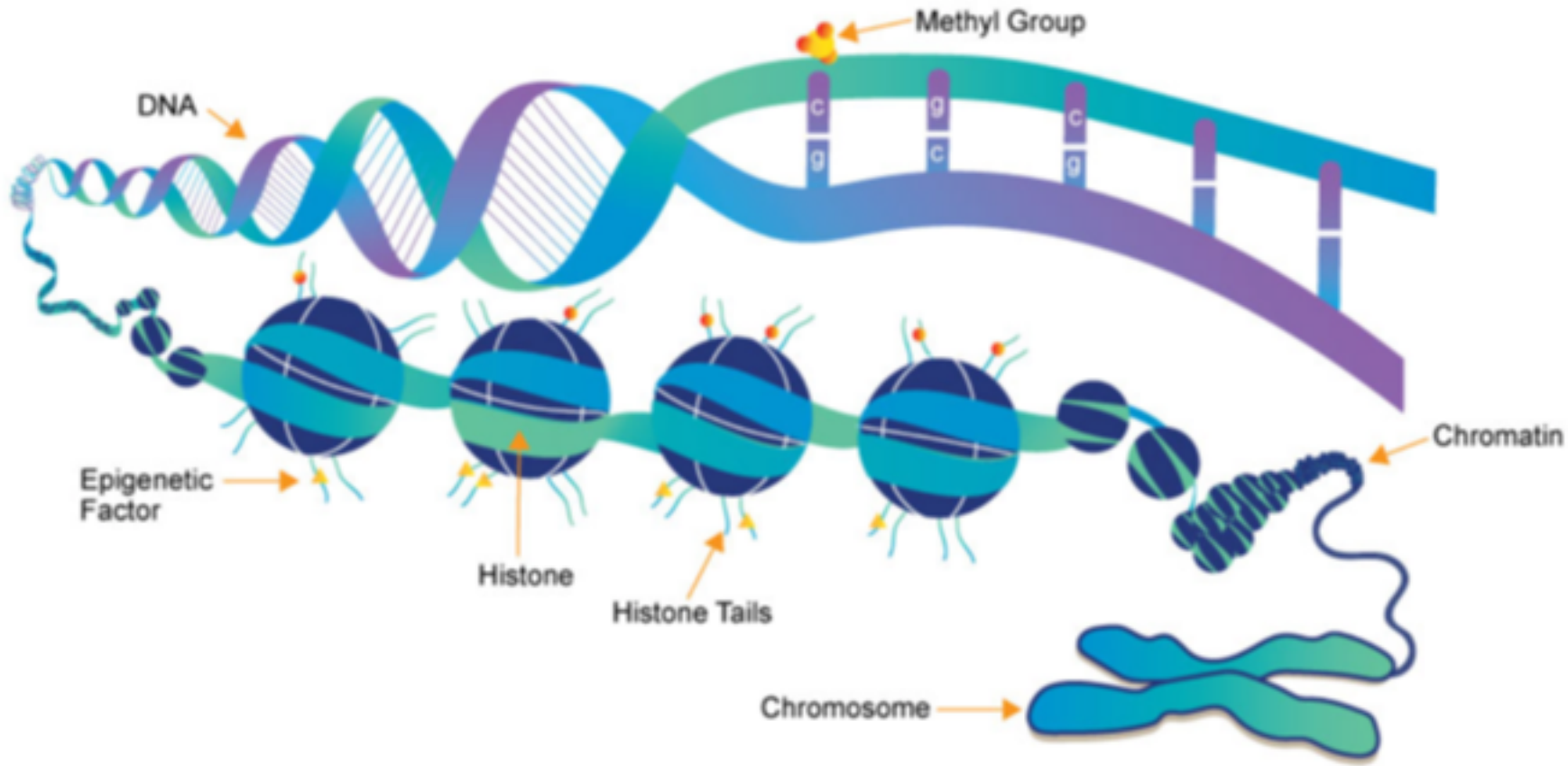
What affects gene regulation?

There are many ways genes can be switched on or off. Sometimes long-term effects in gene regulation happen as a result of age, environment, lifestyle, or disease.

Some of these changes in gene regulation can be inherited, without altering the information contained in the genes. These changes are known as 'epigenetic markers'.

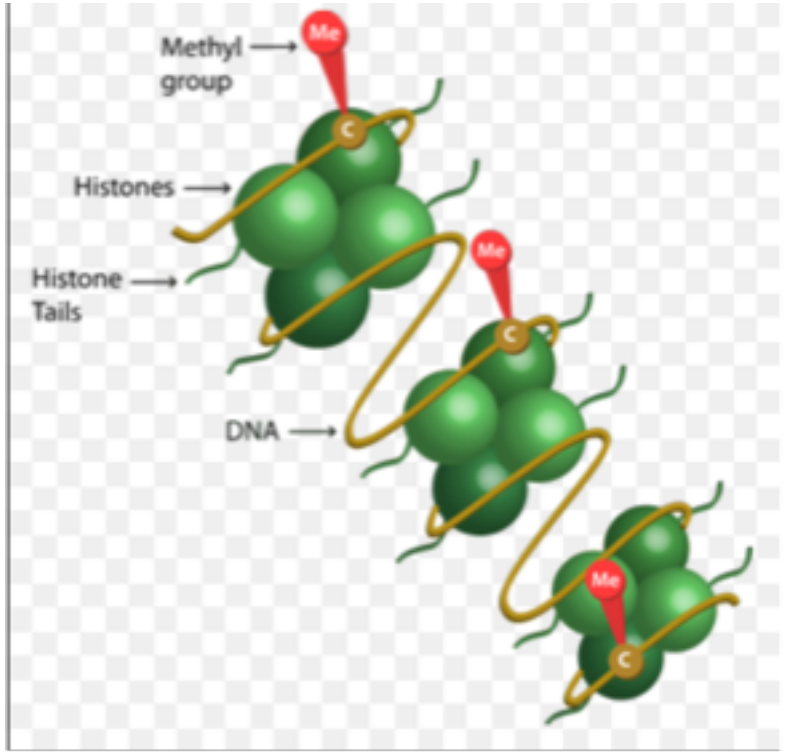
We used to think that these changes were erased from our DNA before being passed on to the next generation. It now seems that they remain and can be inherited by our children.


EPIGENETIC MECHANISMS
CHROMOSOME
CHROMATIN
HISTONE
histone tail
Methyl group
(epigenetic factors)
Acetylation
(epigenetic factors)
DNA accessible,
gene active
DNA inaccessible,
gene inactive
Methyl group
binds only to cytosine
©ellepigrafica / Shutterstock.com



Representation of the chromatin structure, including histones and DNA, which become available to epigenetic marks.

- Methylation is the main OFF switch for genes



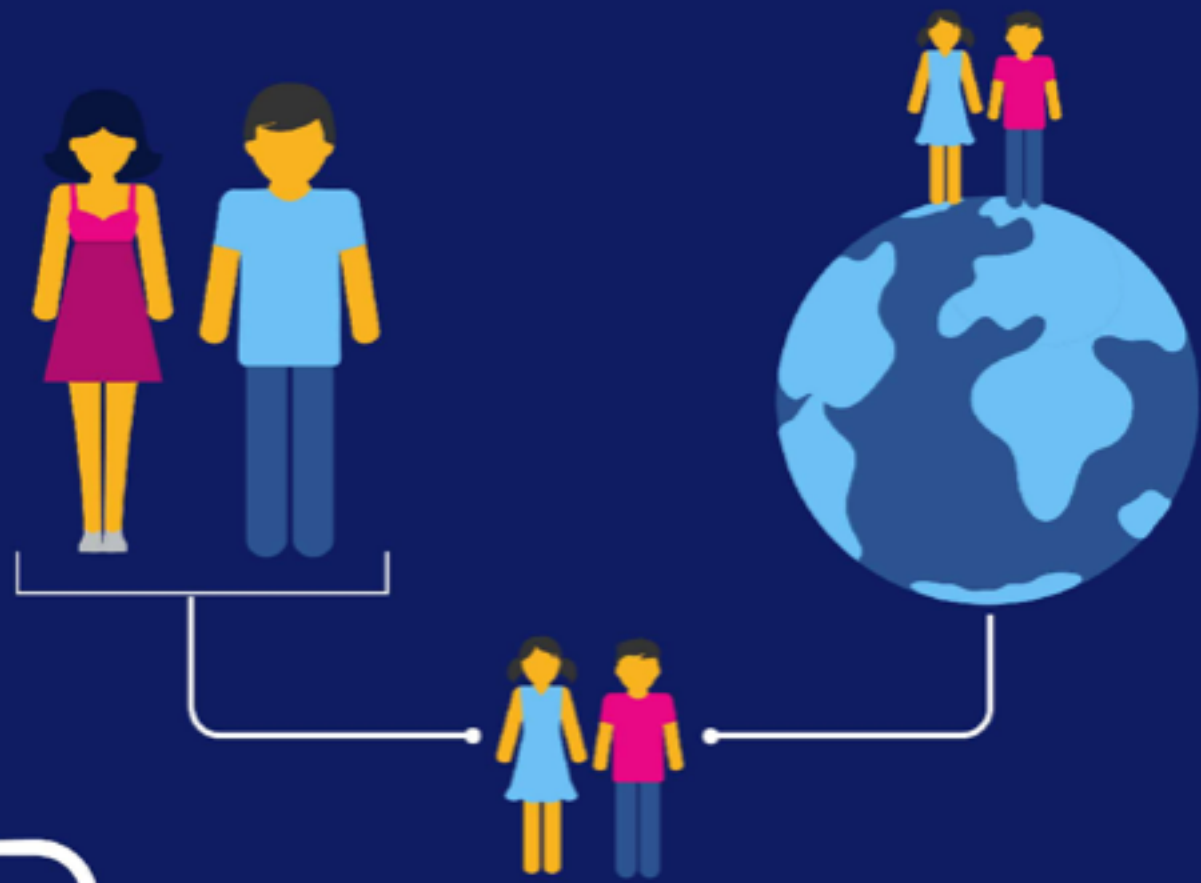
Until recently, all our characteristics were thought to be shaped by two different factors

1 Nature

The genetic information that we inherit from our mother and father

2 Nurture

The influence of our environment



Epigenetics suggests a combination of these

The life experiences of our parents and grandparents may be passed down.

In other words...

what our parents and grandparents ate, how much exercise they did, and what chemicals they were exposed to, are all factors that could affect how our bodies look and work.

AN EXAMPLE...

A joint US/European study found that prenatal exposure to famine can lead to epigenetic changes that may affect a person's health later in life.

The research suggests that children conceived during the Dutch Hunger Winter in 1944-45 suffered from persistent bad health six decades later, such as susceptibilities to heart and lung disease, glucose intolerance and other conditions.

3 Epigenetic Reasons to Meditate Your Stress Away

THE EPIGENETICS OF MINDFULNESS

May 19, 2015 Bailey Kirkpatrick Educationally Entertaining

3 minutes read

The phrase 'a moment on the lips, a lifetime on the hips' is already a rather onerous reminder to eat a healthy diet. But imagine how you might feel if the consequence lasted for several lifetimes instead?

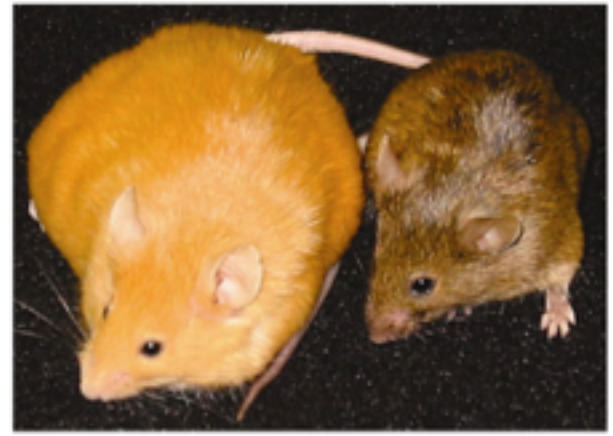
DNA Is Not Destiny: The New Science of Epigenetics

Discoveries in epigenetics are rewriting the rules of disease, heredity, and identity.

By Ethan Watters | Wednesday, November 22, 2006

RELATED TAGS: GENETICS, EPIGENETICS

2.6K



With no more than a change in diet, laboratory agouti mice (left) were prompted to give birth to young (right) that differed markedly in appearance and disease susceptibility.

Binge Drinking as a Teen May Epigenetically Harm the Health of Future Generations

December 6, 2016 Bailey Kirkpatrick News & Reviews

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Binge drinking as a teenager not only harms your brain and body, but may also epigenetically impact your future children, a new study reports. Excessive drinking in adolescents could turn genes on or off in their offspring's brain, setting them up for susceptibility to certain diseases.

Parents Who Exercise Could Epigenetically Pass on Heightened Learning Ability to Their Children

MICE STUDY SHOWS THAT OFFSPRING MAY INHERIT GREATER LEARNING CAPACITY VIA MICRORNAS FROM PARENTS EXPOSED TO MENTAL AND PHYSICAL EXERCISE

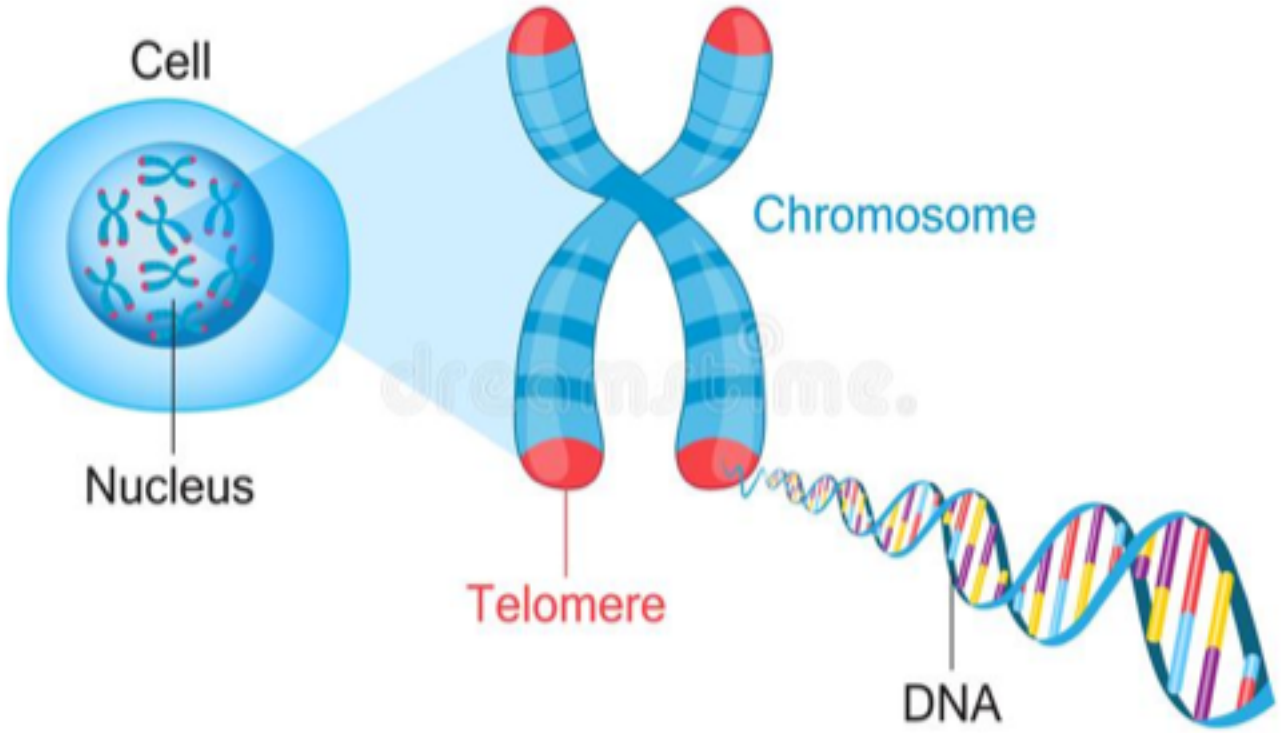
May 29, 2018 Bailey Kirkpatrick Exercise, News & Reviews, Parenting

Meditation and Epigenetics

- 3 ways meditation may epigenetically alleviate stress and improve your health

1. Lower harmful inflammation – chronic inflammation is connected to depression, Alzheimer's disease, cancer and obesity and many more
2. Maintain telomere length
3. Reduce cancer risk

Telomerase



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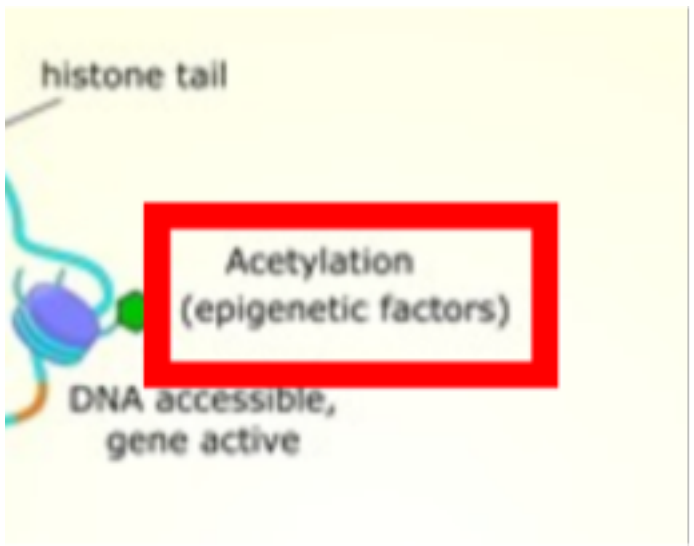
NIHMSID: NIHMS542085
PMID: 24485481

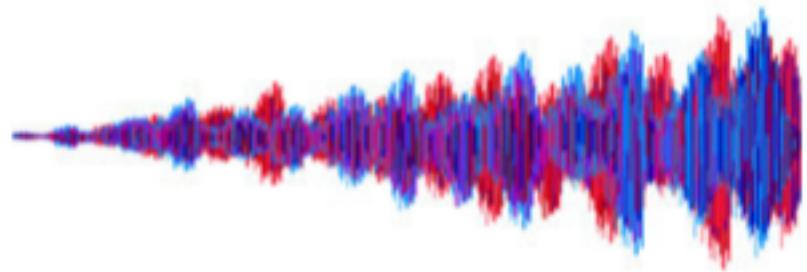
Rapid changes in histone deacetylases and inflammatory gene expression in expert meditators

Perla Kaliman,[a,1] María Jesús Álvarez-López,[a,b] Marta Cosín-Tomás,[a,b] Melissa A. Rosenkranz,[c,d] Antoine Lutz,[c,d,e] and Richard J. Davidson[c,d,f,1]



> "To the best of our knowledge, this is the first paper that shows rapid alterations in gene expression within subjects associated with mindfulness meditation practice."
>
> — Richard J. Davidson

Altered Traits



Science Reveals How Meditation Changes Your Mind, Brain, and Body

NEW YORK TIMES BESTSELLING AUTHORS
Daniel Goleman & Richard J. Davidson

Meditation, mindfulness may affect way your genes behave

Ben Locwin | January 26, 2016 | Genetic Literacy Project

PRINTER FRIENDLY

519 15 4

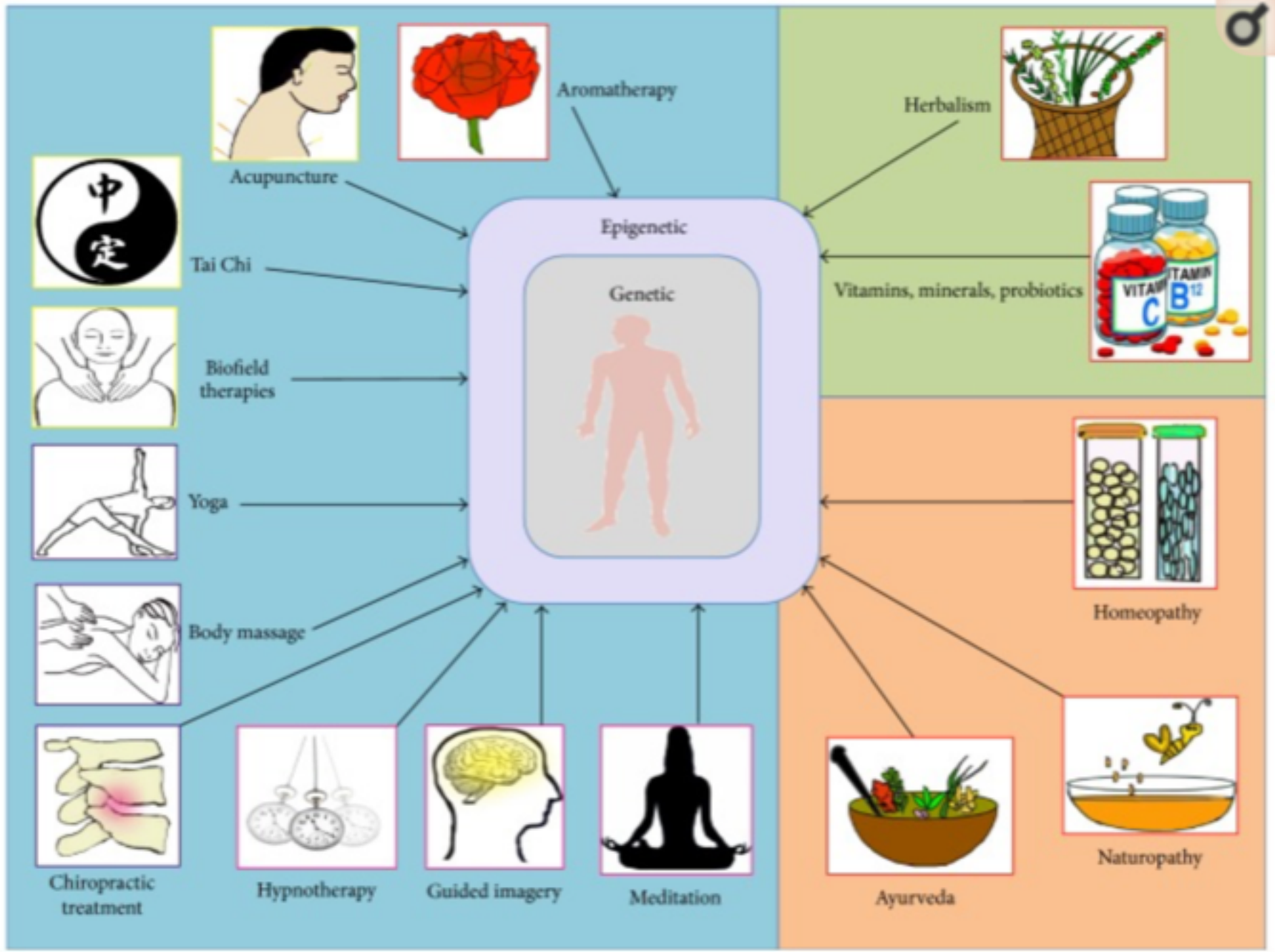
In the world of psychotherapy and biopsychology, mindfulness has experienced a tremendous amount of attention recently — mostly because in many of the challenges of the mind it is put up against, mindfulness has fared very well — performing as well as (or better than) drug therapies in some cases.

Mindfulness is endorsed by the American Heart Association (AHA) as a preventive therapy for cardiovascular disease and they also recommend mindfulness as a strategy for overeating.

However, for physicians and patients to fully unlock the potential power for mindfulness as a way to improve health, a biological mechanism for its efficacy is needed. One possible theory that researchers are exploring is that mindfulness affects a person's epigenetics.

WHAT CAN WE DO ABOUT ALL OF THIS?

If the life that just happens to us exerts epigenetic effects, can activities we choose also exert such effects?


Acupuncture
Aromatherapy
Herbalism
Tai Chi
Epigenetic
Genetic
Vitamins, minerals, probiotics
Biofield therapies
Yoga
Homeopathy
Body massage
Naturopathy
Chiropractic treatment
Hypnotherapy
Guided imagery
Meditation
Ayurveda

Methyl Diet

- Methyl-related nutrients – folate, methionine, Vitamin B12 and Vitamin B6
- **FOLATE** (synthetic form is folic acid): Strawberries, citrus fruits, and leafy green vegetables (400 mg/ day)
- **B12**: fish, meat, milk and eggs
- **SAM-e** (S-adenosyl methionine): supplement OTC
- Without methylation – build up homocysteine – leads to coronary artery disease
- If you don't exercise 3 times/ week – increased levels of homocysteine

Nutrigenomics is a fascinating and important field of study on the effects of nutrition on genetic expression. From a 2012 article in Nutrition Research Reviews: “nutrition makes an impact on the genome to such a degree that it is paramount to understand this interaction in detail to prevent health disorders and help the treatment of diseases.” In fact, “diets and foods can have an effect on breast cancer risk that is shown many years after their consumption, and even in the offspring.”

Nutrients. 2015 Feb; 7(2): 922–947.
Published online 2015 Jan 30. doi: 10.3390/nu7020922

PMCID: PMC4344568
PMID: 25647662

The Interaction between Epigenetics, Nutrition and the Development of Cancer

Karen S. Bishop[1,*] and Lynnette R. Ferguson[1,2]

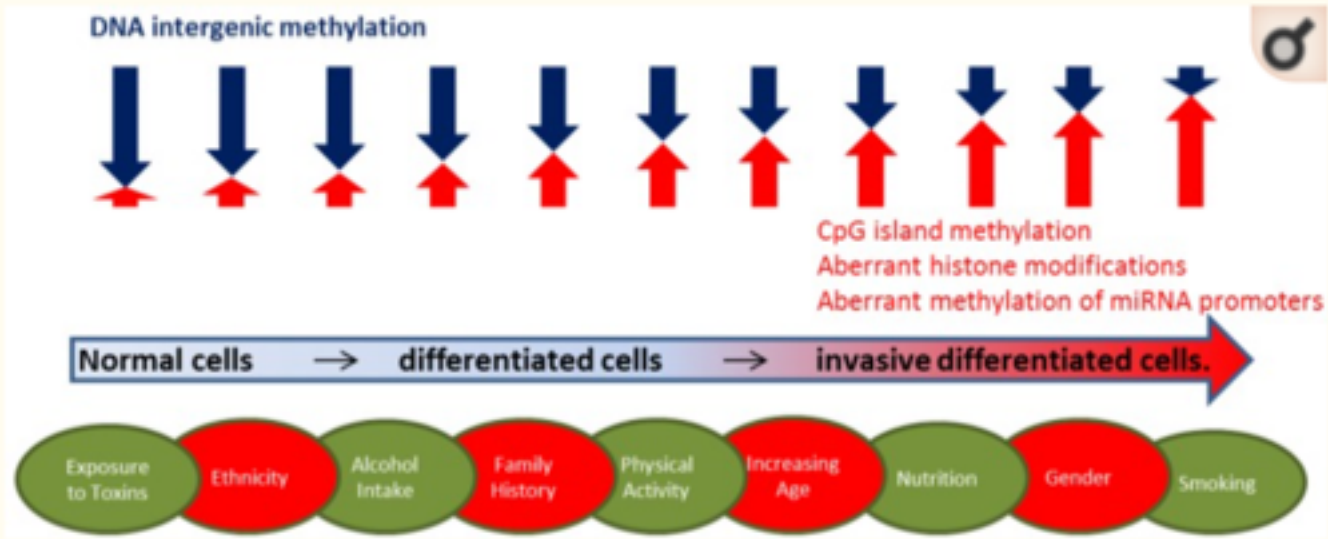


Figure 1

A diagrammatic representation of the extent and type of epigenetic modifications that promote cancer risk and/or progression, and the modifiable (in green ovals) and non-modifiable (in red ovals) factors that may influence these epigenetic modifications.

Could We Reverse Alzheimer's Symptoms by Restoring Epigenetic Balance?

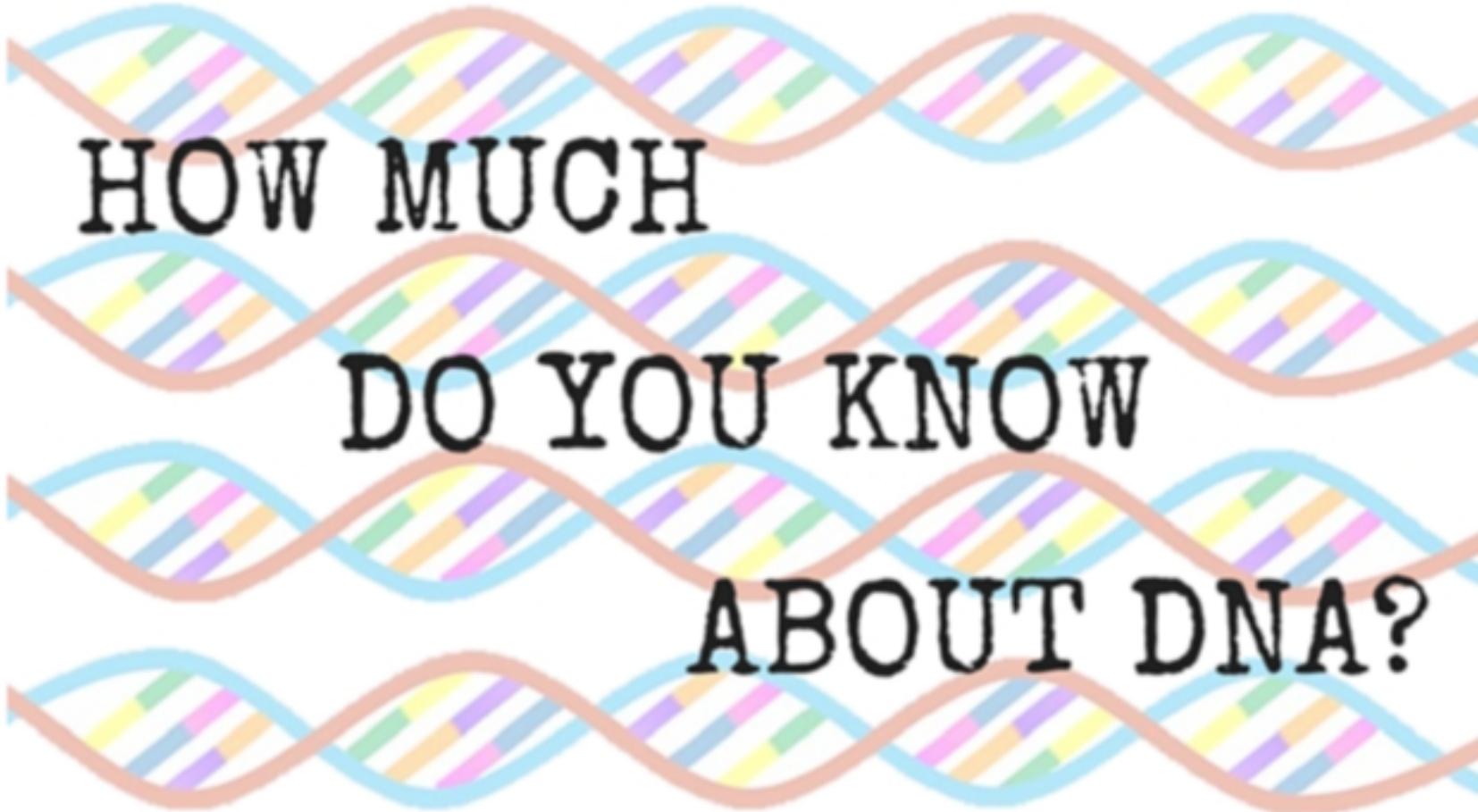
June 12, 2018 Bailey Kirkpatrick Aging, Diseases & Disorders, News & Reviews

The future of epigenetic drugs

In the light of increasing knowledge on the role epigenetic factors play in disease, it is now becoming apparent that epigenetics could be ideal therapeutic targets - particularly taking into consideration that many of these epigenetic factors are reversible. Epigenetic drugs are incredibly potent and can help reverse abnormal gene expression that can result in various diseases.

Sarah Dowie 8 Sep 2016

BREAK – 30 minutes


HOW MUCH
DO YOU KNOW
ABOUT DNA?

1) Should you necessarily be scared if you find out you are 10 times more likely to get a rare cancer?

2) If you look like your mom, are you more likely to get the diseases that run in her family or your dad's family?

3) If you have the recessive disease sickle cell anemia, should your kids be tested to see if they are carriers?

4) If you look like your dad, did you get more of his DNA?

5) If you flip a coin and get heads ten times in a row, what are the chances that the next flip will be a head?

6) True or false: Each cell in your body has the same DNA.

Direct to Consumer Genetic Tests

Personalized Medicine, Epigenetics and Health

- 23andMe
- AncestryDNA
- My Heritage
- National Genographic
- Illumina
- Karmagenes
- Sunrise Genetics, Inc. (Marigene and Hempgene)
- LivingDNA
- Vitagene
- CRI Genetics
- Family Tree DNA
- uBiome
- Helix

'I feel like I found my people': Consumer DNA test unlocks family secret for this Canadian father and daughter

Saskatchewan adoptee makes surprise find of birth father in B.C.

Laura Lynch · CBC News · Posted: Jun 11, 2018 1:00 AM PT | Last Updated: 10 hours ago

The tears and laughter began to flow as they embraced Saturday morning, marking yet another happy connection made courtesy of consumer DNA testing.

DNA testing a 'game changer'

Vancouver-based genealogist M. Diane Rogers called the advent of DNA testing and digital collection a "game changer" because of the relative speed and ease of gaining information.

But she said she warns clients of the risks that can include unwelcome surprises.

"Definitely there is the possibility of coming up with family you've never heard of before that you may be hesitant to accept," said Rogers.

Why a DNA data breach is much worse than a credit card leak

You can't change your DNA

By Angela Chen | @chengela | Jun 6, 2018, 3:54pm EDT

This week, DNA testing service MyHeritage revealed that hackers had breached 92 million of its accounts. Though the hackers only accessed encrypted emails and passwords — so they never reached the actual genetic data — there's no question that this type of hack will happen more frequently as consumer genetic testing becomes more and more popular. So why would hackers want DNA information specifically? And what are the implications of a big DNA breach?

One simple reason is that hackers might want to sell DNA data back for ransom, says Giovanni Vigna, a professor of computer science at UC Santa Barbara and co-founder of cybersecurity company Lastline. Hackers could threaten to revoke access or post the sensitive information online if not given money; one Indiana hospital paid $55,000 to hackers for this very reason. But there are reasons genetic data specifically could be lucrative. "This data could be sold on the down-low or monetized to insurance companies," Vigna adds. "You can imagine the consequences: One day, I might apply for a long-term loan and get rejected because deep in the corporate system, there is data that I am very likely to get Alzheimer's and die before I would repay the loan."

D.I.Y. DNA: Genetic testing at home is risky business

What harm could come from sending off a sample of your DNA to find out your genetic history and potential health problems?

Mar 23, 2015

Photograph by Vicky Lam

"You may learn information about yourself that you did not anticipate," warns 23andMe, a testing company. "This information may evoke strong emotions and has the potential to alter your life and worldview."

But not everyone considers the implications of DNA testing, Fraser said, even though "this is some of the most sensitive information that exists."

"It has become one of those things that is almost as casual, or potentially as casual, as other things we do on the internet," Fraser said. "A huge number of people just kind of click 'I Agree' and they continue."

For instance, 23andMe says if you use a third-party site like Facebook or Twitter to sign into your DNA account, it will collect information such as your profile picture, age range, and friends or followers, depending the privacy settings.

Fraser said when it comes to companies like 23andMe that test for health risks like Parkinson's disease and whether you're a carrier for certain genetic conditions like cystic fibrosis, people should be especially careful.

He pointed out that it's not just your personal information, it's information about your parents and your offspring, so there are other people implicated.

23andMe, like other DNA testing companies, warns potential users that genetic information you share with others could be used against your interests. For instance, if you share your genetic information with a doctor, it may become part of your medical record and then be accessible by insurance companies.

The privacy implications of DNA testing kits that can 'alter your life'

'This is some of the most sensitive information that exists,' says Halifax privacy expert

Yvonne Colbert · CBC News · Posted: Jan 31, 2018 6:00 AM AT | Last Updated: January 31

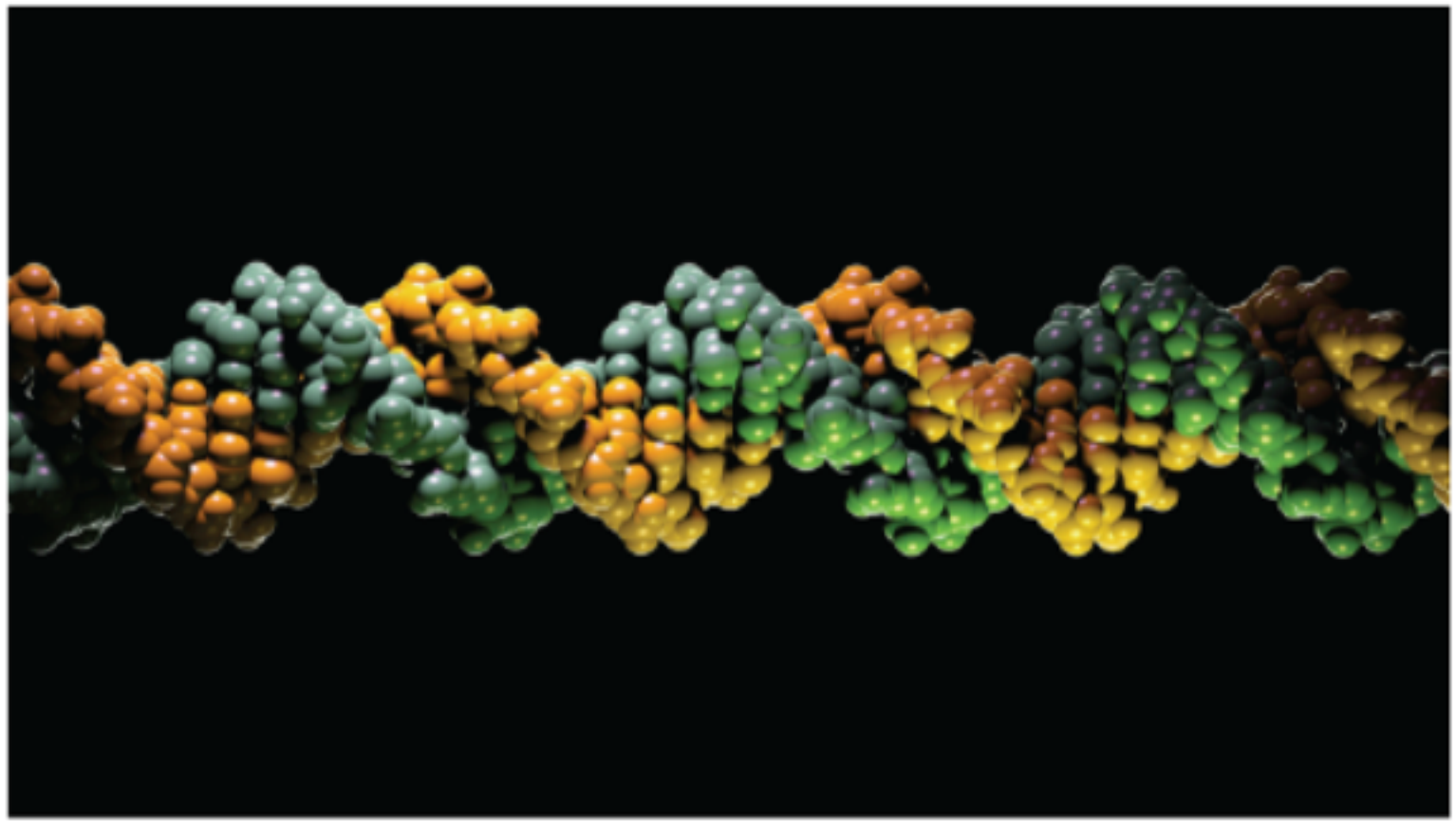
She was shocked to learn she had a half-sister living in Nova Scotia.

"I never in a million years expected to find a sibling," she said. "I even commented to my husband that I didn't expect to have any long-lost relatives coming out of the woodwork."

Finding half siblings can be just one of the surprises that comes from DNA testing, an increasingly popular way for people to learn about their ethnic backgrounds.

Canada's new genetic privacy law is causing huge headaches for Justin Trudeau

By Wayne KondroMar. 10, 2017 , 6:00 PM



The Genetic Non-Discrimination Act, originally introduced in 2013 by now-retired Liberal Senator James Cowan, is aimed at preventing the use of information generated by genetic tests to deny health insurance, employment, and housing, or to influence child custody and adoption decisions. It calls for fines of up to $740,000 and prison terms of up to 5 years for anyone who requires any Canadian to undergo a genetic test, or to disclose test results, in order to obtain insurance or enter into legal or business relationships. The bill bars discrimination on the grounds of genetics, and the sharing of genetic test results without written consent (with exemptions for researchers and doctors).

To delay and potentially kill the legislation, Trudeau's government is considering not sending the bill to the governor-general (a tactic that doesn't appear to have been used since the 1920s), and instead asking Canada's Supreme Court to rule on the bill's constitutionality. That process could take up to 2 years.

We can't say we weren't warned. Long before the Human Genome Project charted almost all of the three billion base pairs of human DNA, ethicists and futurists sounded alarms about the potential misuse of genetic information, as testing became cheaper and more widely available. The term "genoism"—unethical discrimination based on genetics—was coined by Andrew Niccol, director of *Gattaca*, a 1997 movie that portrayed a society driven by eugenics rather than merit. The film's foresight, alas, proved greater than its cultural impact. Canada, for one, has been drifting for years toward the world it depicted.

Maybe. But that hasn't stopped critics from citing the insurers' position as proof that Canada is hurtling toward a *Gattaca*-like society, where the genetically flawed live diminished lives, cut off from important opportunities or benefits. In 2009, researchers at the University of British Columbia published a survey in which 40 per cent of 233 people with family histories of Huntington's disease reported they'd experienced some sort of discrimination based on their risk of developing the devastating hereditary brain disorder—especially when it came to getting insurance. Fully 29 per cent said insurers had rejected them, increased premiums or asked them to take genetic tests. (The highly predictive Huntington's mutation, it should be noted, is not part

---

of 23andMe's health results package.)

SCIENCE \ HEALTH

23andMe's new genetic test for cancer could create a false illusion of safety

It tests for three mutations, but many more could predispose you to cancer

By Angela Chen | @chengela | Mar 6, 2018, 2:41pm EST

23andMe can now sell genetic tests for cancer risk directly to consumers, after being cleared by the US Food and Drug Administration. Their kit will test for three mutations known to predispose people to developing cancer — but there are hundreds more that it won't take into account.

This is the first time the FDA has approved a direct-to-consumer genetic test for these three particular mutations on the BRCA1 and BRCA2 genes. (In the past, the FDA approved DTC genetic kits for conditions such as late-onset Alzheimer's and celiac disease.) Mutations on the BRCA1 and BRCA2 genes are known to be associated with higher risk for prostate cancer, ovarian cancer, and breast cancer. The three mutations 23andMe will test are the most common for those of Ashkenazi Jewish descent — but not the most common mutations in the general population.

Because the test *only* tests for three mutations, "those tested can get the false illusion that they are not carriers, when in fact they may have other of the hundreds of known functional mutations," according to Eric Topol, a geneticist at the Scripps Research Institute, in an email to *The Verge*.

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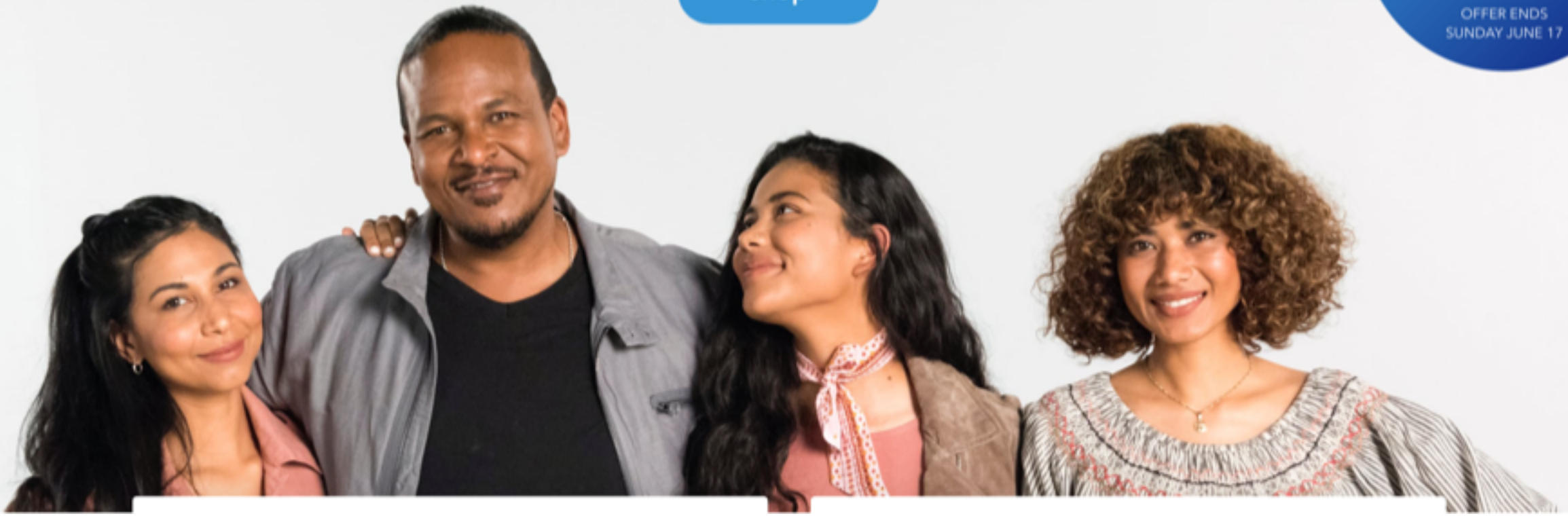


Traits Reports

Explore the genetics behind your appearance and senses.

View Traits Tutorial

Asparagus Odor Detection	Likely can smell >
Bitter Taste	Likely can't taste >
Cheek Dimples	Likely no dimples >
Cleft Chin	Likely no cleft chin >
Earlobe Type	Likely detached earlobes >
Earwax Type	Likely wet earwax >
Eye Color	Likely brown or hazel eyes >
Finger Length Ratio	Likely ring finger longer >

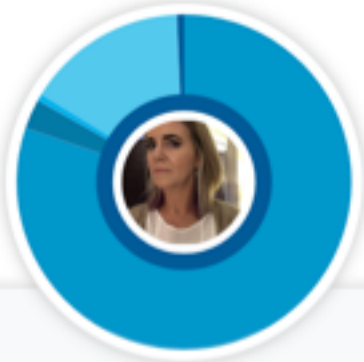
Freckles	Likely a lot of freckles >
Hair Texture	Likely straight or wavy >
Light or Dark Hair	Likely light >
Newborn Hair	Likely little baby hair >
Photic Sneeze Reflex	Likely no photic sneeze reflex >
Red Hair	Likely no red hair >
Skin Pigmentation	Likely lighter skin >
Sweet vs. Salty	Likely prefers salty >
Toe Length Ratio	Likely second toe longer >
Unibrow	Likely no unibrow >
Widow's Peak	Likely no widow's peak >

Wellness Reports

Find out how your DNA may affect your body's response to diet, exercise, and sleep.

View Wellness Tutorial

Alcohol Flush Reaction	Unlikely to flush ›
Caffeine Consumption	Likely to consume less ›
Deep Sleep	Less likely to be a deep sleeper ›
Genetic Weight	Predisposed to weigh about average ›
Lactose Intolerance	Likely tolerant ›
Muscle Composition	Common in elite power athletes ›
Saturated Fat and Weight	Likely similar weight ›
Sleep Movement	Likely more than average movement ›



Jane Gair 100%

European	100%
British & Irish	80.3%
Ireland	
Scandinavian	2.8%
French & German	0.7%
Broadly Northwestern European	15.5%
Broadly European	0.7%

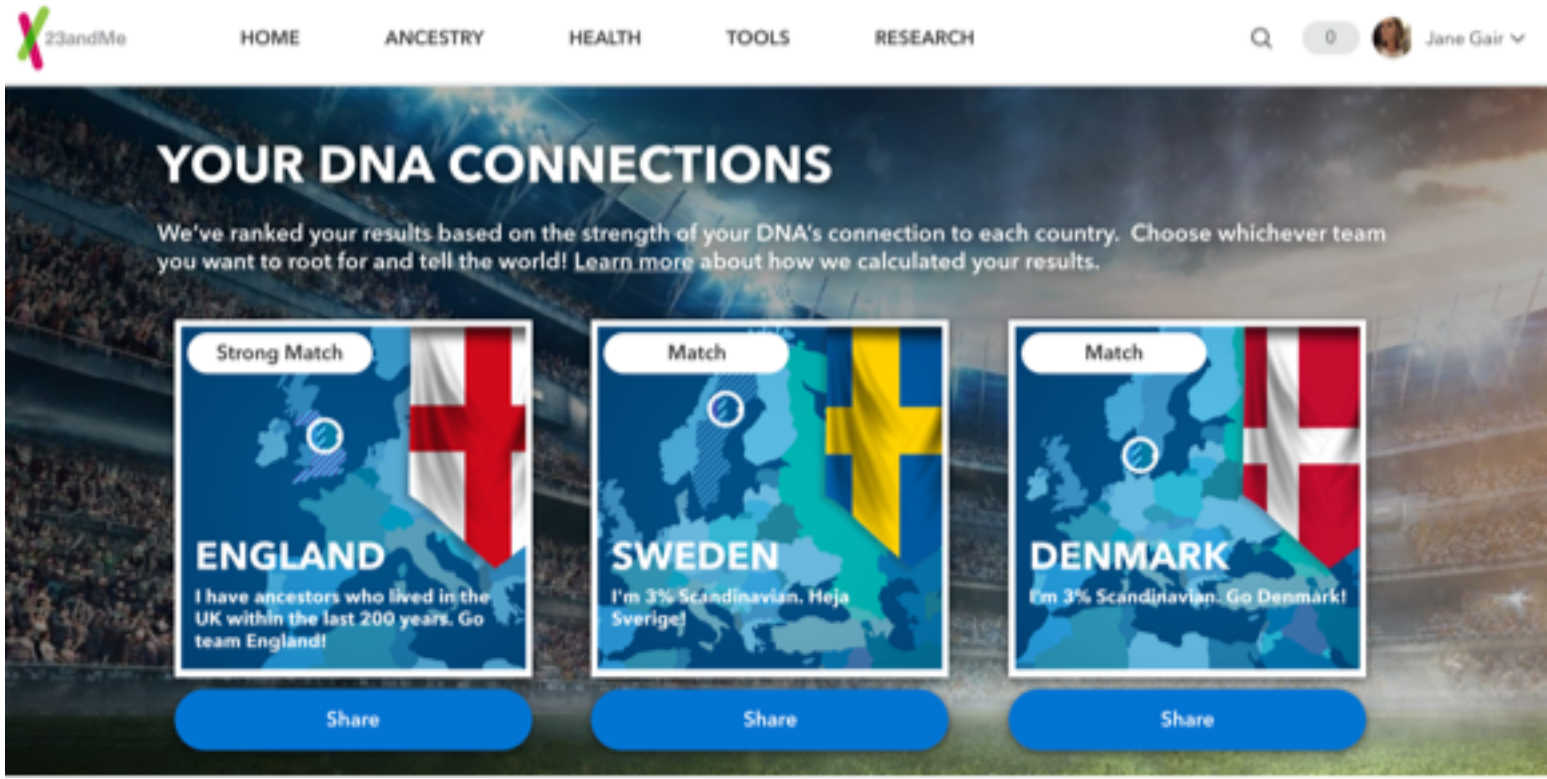
See all tested populations

23andMe

ROOT FOR YOUR ROOTS℠

It's not too late to find out which countries are linked to your DNA.

view your results



Wake-Up Time

Jane, people with your genetics in their 40s wake up on average around **7:55 am** on their days off.

When does your internal alarm clock ring?

Our biological sleep rhythms affect when we naturally prefer to fall asleep and wake up. We looked at data from 23andMe research participants and discovered genetic associations with being a morning person or a night person. Fittingly, self-described morning people tend to wake up earlier than self-described night people.

Alzheimer’s Disease

Jane's Genetic Risk

Jane Gair

4.3 out of 100

women of European ethnicity who share Jane Gair's genotype are estimated to develop Alzheimer's Disease between the ages of 50 and 79.

Typical or Decreased Risk

Average

7.1 out of 100

women of European ethnicity are estimated to develop Alzheimer's Disease between the ages of 50 and 79.

Factors Used to Estimate Genetic Risk

Age	Ancestry	Sex	SNP
50-79	European	Female	APOE ε2/ε3/ε4 (APOE)

Lumbar disc disease

Lumbar disc disease (LDD) is one of the most common musculoskeletal diseases, and disc degeneration resulting from LDD is a primary cause of low back pain. The genetic contribution to disc degeneration has been estimated to be about 74%. This study of 467 Japanese people with LDD and 654 healthy controls found that the SNP rs2073711 was associated with risk of LDD. Each A at rs2073711 was found to decrease subjects' odds of LDD by 1.6 times. However, a subsequent study in Finns and Chinese could not replicate this association in either group.

Journal: *J Med Genet*
Replications: None
Contrary Studies: 1
Applicable Ethnicities: Asian
Marker: rs2073711

Who	Genotype	Genetic Result
	GG	Typical odds of LDD.
Jane Gair	**AG**	**Moderately lower odds of LDD.**
	AA	Substantially lower odds of LDD.

Citations

Virtanen IM et al. (2007) . “Phenotypic and population differences in the association between CILP and lumbar disc disease.” *J Med Genet* 44(4):285-8.

Celiac Disease

Jane's Genetic Risk

Jane Gair

0.62 out of 100

women of European ethnicity who share Jane Gair's genotype are estimated to develop Celiac Disease between the ages of 0 and 79.

Average

0.24 out of 100

women of European ethnicity are estimated to develop Celiac Disease between the ages of 0 and 79.

Factors Used to Estimate Genetic Risk

Age	Ancestry	Sex	SNP
0-79	European	Female	rs2187668 (HLA-DQA1), rs6822844 (4q27 region), rs6441961 (3p21 near CCR3), rs9851967 (3q28 near LPP)

Amyotrophic lateral sclerosis (ALS)

This study examined 1,767 Europeans with ALS and 1,916 healthy controls. The authors found that each C at rs10260404 increased a person's risk for the sporadic form of ALS by about 1.3 times compared to those with the TT genotype. Subsequent studies have failed to confirm this association, however.

Journal: *Nat Genet*
Replications: None
Contrary Studies: 4
Applicable Ethnicities: European
Marker: rs10260404

Who	Genotype	Genetic Result
Jane Gair	**CC**	**Slightly higher odds of ALS.**
	CT	Typical odds of ALS.
	TT	Slightly lower odds of ALS.

Citations

van Es MA et al. (2009) . "Genome-wide association study identifies 19p13.3 (UNC13A) and 9p21.2 as susceptibility loci for sporadic amyotrophic lateral sclerosis." *Nat Genet*.

Fogh I et al. (2009) . "No association of DPP6 with amyotrophic lateral sclerosis in an Italian population." *Neurobiol Aging*.

Chiò A et al. (2009) . "A two-stage genome-wide association study of sporadic amyotrophic lateral sclerosis." *Hum Mol Genet* 18(8):1524-32.

Cronin S et al. (2009) . "Screening for replication of genome-wide SNP associations in sporadic ALS." *Eur J Hum Genet* 17(2):213-8.

van Es MA et al. (2008) . "Genetic variation in DPP6 is associated with susceptibility to amyotrophic lateral sclerosis." *Nat Genet* 40(1):29-31.

Malignant Melanoma

Jane's Genetic Risk

Jane Gair

2.4 out of 100

women of European ethnicity who share Jane Gair's genotype are estimated to develop Melanoma between the ages of 0 and 79.

Average

1.7 out of 100

women of European ethnicity are estimated to develop Melanoma between the ages of 0 and 79.

Factors Used to Estimate Genetic Risk

Age	Ancestry	Sex	SNP
0-79	European	Female	MC1R R151C/R160W (MC1R), rs16891982 (SLC45A2)

Breast and Ovarian Cancer

Jane Gair	No copies of the three early-onset breast and ovarian cancer mutations identifiable by 23andMe. May still have a different mutation in BRCA1 or BRCA2.

Cilantro (coriander) aversion

A study of roughly 76,000 individuals of European ancestry who participated in 23andMe research surveys identified a genetic marker associated with disliking the taste of fresh (not dried) cilantro. The marker rs2741762 is located near olfactory receptor genes that are involved in odor detection. Individuals with the AA genotype at rs2741762 had about 1.1 times higher odds of disliking cilantro compared to individuals with the AG genotype, while those with the GG genotype had about 1.1 times lower odds of disliking cilantro.

Journal: *23andMe White Paper*
Replications: None
Contrary Studies: None
Applicable Ethnicities: European
Marker: rs2741762

Who	Genotype	Genetic Result
Jane Gair	**AA**	**Slightly higher odds of disliking the taste of cilantro.**
	AG	Typical odds of disliking the taste of cilantro.
	GG	Slightly lower odds of disliking the taste of cilantro.

Citations

Fayzullina S et al. (2014) . “Genetic associations with traits in 23andMe customers.” *23andMe White Paper*.

Eriksson N et al. (2012) . “A genetic variant near olfactory receptor genes influences cilantro preference.” *Flavour* 1(1):22.

Longevity

This study compared 213 Ashkenazi Jewish subjects ranging in age from 95 to 107 to a group of counterparts about 30 years their junior. Members of the longer-lived group were more likely to have a C in both copies of the SNP rs2542052. People with this genetic signature tended to be more sensitive to insulin and were less likely to have high blood pressure, which suggests it may promote longevity by protecting against cardiovascular disease.

Journal: *Biogerontology*
Replications: None
Contrary Studies: 1
Applicable Ethnicities: European
Marker: rs2542052

Who	Genotype	Genetic Result
Jane Gair	**CC**	**Higher odds of living to 100.**
	AC	Typical odds of living to 100.
	AA	Typical odds of living to 100.

Citations

Novelli V et al. (2008) . "Lack of replication of genetic associations with human longevity." *Biogerontology* 9(2):85-92.

Atzmon G et al. (2006) . "Lipoprotein genotype and conserved pathway for exceptional longevity in humans." *PLoS Biol* 4(4):e113.

Photic sneeze reflex

A study of 5388 individuals of European ancestry who participated in 23andMe research surveys identified a genetic variant associated with the photic sneeze reflex. Each copy of the C version at rs10427255 increased one's odds of ACHOO by about 1.3 times.

Journal: *PLoS Genetics*
Replications: None
Contrary Studies: None
Applicable Ethnicities: European
Marker: rs10427255

Who	Genotype	Genetic Result
Jane Gair	**CC**	**Slightly higher odds of having the photic sneeze reflex**
	CT	Typical odds of having the photic sneeze reflex
	TT	Slightly lower odds of having the photic sneeze reflex

Citations

Eriksson N et al. (2010) . "Web-based, Participant-driven Studies Yield Novel Genetic Associations for Common Traits" *PLoS Genetics* 6(6): e1000993.

Sensitivity to the sound of chewing (misophonia)

A study of roughly 80,000 individuals with European ancestry who participated in 23andMe research surveys identified a genetic marker associated with sensitivity to the sound of other people chewing food. The marker rs2937573 is located near a gene (TENM2) that may play a role in the brain. Individuals with the GG genotype at rs2937573 had about 1.2 times higher odds of being sensitive to the sound of chewing, compared to individuals with the AG genotype. Individuals with the AA genotype had about 1.2 times lower odds of being sensitive.

Journal: *23andMe White Paper*
Replications: None
Contrary Studies: None
Applicable Ethnicities: European
Marker: rs2937573

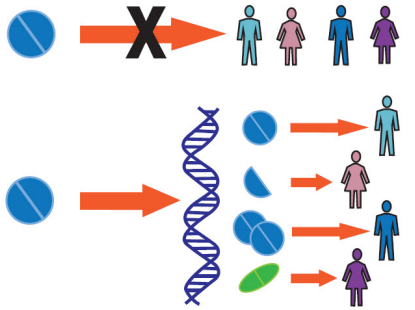
Who	Genotype	Genetic Result
Jane Gair	**GG**	**Slightly higher odds of being sensitive to the sound of chewing.**
	AG	Typical odds of being sensitive to the sound of chewing.
	AA	Slightly lower odds of being sensitive to the sound of chewing.

Direct to Consumer Genetic Testing: Think Before You Spit, 2017 Edition!

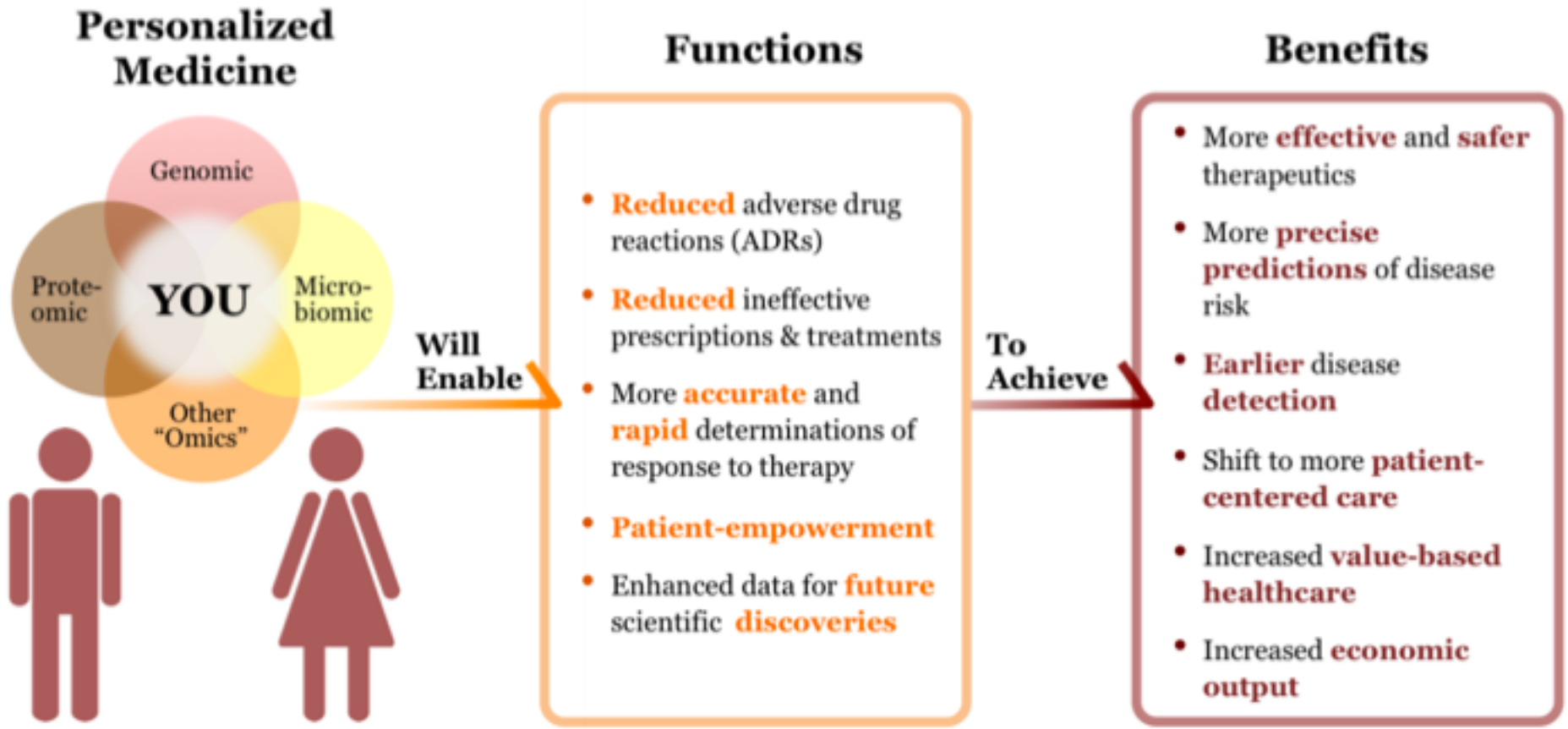
With improved technology and plummeting prices in the coming decade, we could see an expansion of DTC testing for personal genomic information. The content of information obtained from such testing will evolve. Nevertheless, both the general public and the health care provider community need to be aware of the potential utility and limitations of such tests. In a 2016 study, a survey of people who underwent personal genomic tests found that most of those tested who shared results with their health care providers were not satisfied by the reaction of their providers. Many providers questioned medical actionability of the test results and showed lack of engagement or interest. In a recent commentary in *Nature*, Dr Zak Kohane from Harvard University stated that when it comes to personal genomic tests, "we really have a perfect storm of insufficient data and insufficient competence." Physicians aren't yet prepared to handle genetic test results of this type and neither is the general public.

PERSONALIZED MEDICINE

- **Personalized Medicine**
  - Separates patients into different groups
  - Medical practices are tailored to accommodate for the unique needs of the individual
  - Based on their predicted response or risk of disease
  - Dates back as far as Hippocrates, where the professional was expected to treat the patient rather than the disease (create a remedy suitable for the person)



Personalized Medicine, Epigenetics and Health



- **The Human Genome Project**
  - International research effort
    - Goal to sequence and map all the genes that comprise the complete genome of humans
  - Completed in April 2003
  - Allows comprehension of the human “blueprint”
    - Personalized medicine utilizes the data to highlight trends that occur throughout the species
    - Diagnosis and treatment of genetic diseases occurs more quickly and efficiently due to availability of information

- **Pharmacogenomics**
  - Study of inherited genetic differences in drug metabolites and pathways affect patient's responses to drugs
  - Combines pharmacology (science of drugs) and genomics (study of genes and their function)
  - **Therapeutic effect:** Consequence of the medical treatment, where the results are thought to be desirable
  - **Adverse effect:** Harmful or undesirable effect (Also known as side effect)

nature medicine

Altmetric: 21 More detail »

News & Views | Published: 07 May 2018

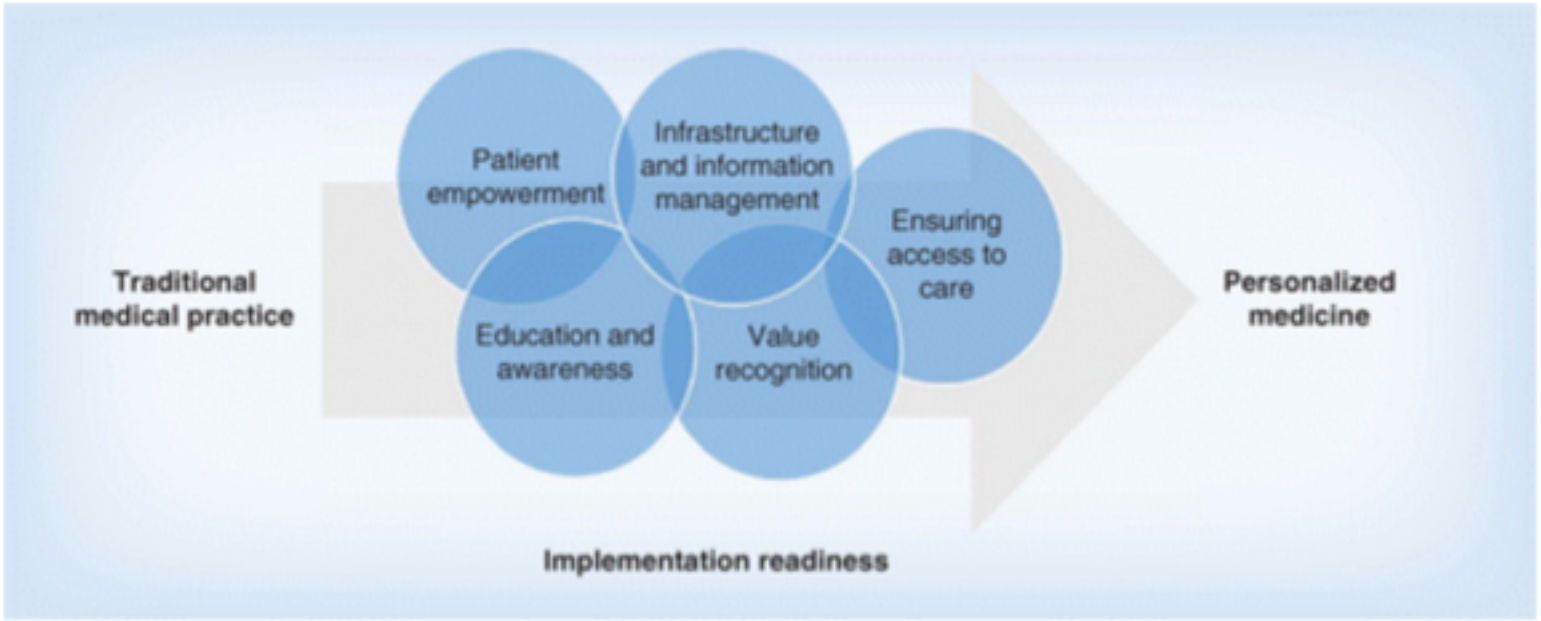
PERSONALIZED MEDICINE

Predicting breast cancer therapeutic response

Ana C. Garrido-Castro & Eric P. Winer

Nature Medicine **24**, 535–537 (2018) | Download Citation

In triple-negative breast cancer, therapeutic response to carboplatin and docetaxel is similar. However, carboplatin therapy is superior to docetaxel in patients with germline BRCA1 or BRCA2 mutations, but 'BRCAness' does not predict sensitivity to carboplatin.



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PERSONALIZED MEDICINE, AHEAD OF PRINT | EDITORIAL

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Personalized medicine in brain metastases: a plea for more translational studies

Franziska M Ippen, Megan D'Andrea & Priscilla K Brastianos

Published Online: 25 May 2018 | https://doi.org/10.2217/pme-2017-0087

nature REVIEWS GASTROENTEROLOGY & HEPATOLOGY

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News & Views | Published: 30 April 2018

COLORECTAL CANCER

Personalized screening for colorectal cancer

Ernst J. Kuipers & Manon C. Spaander

Nature Reviews Gastroenterology & Hepatology (2018) | Download Citation

Colorectal cancer screening can save lives but there is a need for targeted, personalized screening. A new study examines an individual risk assessment based on family history, lifestyle, environmental and genetic factors, but faecal haemoglobin levels and their change over time can also help to further identify patients at high risk.

However, despite the steady increase in the number of clinically useful molecular diagnostics and targeted therapies, the healthcare system has been slow to integrate personalized medicine into clinical practice [8–10]. Indeed, evidence suggests that in most cases, personalized medicine is not even discussed at the point of care. A recent public survey has shown that only four out of ten consumers are aware of personalized medicine, and only 11% of patients say their doctor has discussed or recommended personalized medicine treatment options to them [11]. Behind this lag in clinical adoption are novel challenges that healthcare delivery systems are encountering as they adapt to the new requirements, practices and standards associated with the field [12].

POG – Personalized Onco-genomics (Vancouver at BCCA)

- BC Cancer Agency scientists are looking at certain mutations that are driving the cancer to grow – can search for a drug that might stop the growth
- POG is about trying to customize a treatment for each individual person's cancer – this is "personalized medicine"
- started in 2012 – 30 patients
- 2016 – 750
- Aim is for 5000
- All incurable cancers
- Currently only people in BC but expanding soon


THE
NATURE
OF
THINGS


CRACKING
CANCER

The Facts About Cancer

- Cancer is responsible for 30% of all deaths in Canada.
- 2 out of 5 Canadians will develop cancer in their lifetimes.
- 1 in 4 will die from cancer.
- New Canadian cancer cases are expected to increase 40% over the next 15 years.

Zuri Scrivens

- Breast cancer at 33
- Mastectomy, radiation, chemotherapy, and hormone therapy
- Within 9 months – cancer back to her lymph nodes and liver
- Cancer was considered incurable at this point
- 7 years ago
- NO signs of cancer - not a miraculous drug, but a common treatment for diabetes
- Zuri's mutation caused high amounts of growth factor
- The diabetes drug blocks the growth factor
- within 5 months her cancer was undetectable

Personalized Medicine

Matching Treatments to Your Genes

“If doctors know your genes, they can predict drug response and incorporate this information into the medical decisions they make,” says Dr. Rochelle Long, a pharmacogenomics expert at NIH.

It’s becoming more common for doctors to test for gene variants before prescribing certain drugs. For example, children with leukemia might get the *TPMT* gene test to help doctors choose the right dosage of medicine to prevent toxic side effects. Some HIV-infected patients are severely allergic to treatment drugs, and genetic tests can help identify who can safely take the medicines.

“By screening to know who shouldn’t get certain drugs, we can prevent life-threatening side effects,” Long says.

Pharmacogenomics is also being used for cancer treatment. Some breast cancer drugs only work in women with particular genetic variations. If testing shows patients with advanced melanoma (skin cancer) have certain variants, 2 new approved drugs can treat them.

Even one of the oldest and most common drugs, aspirin, can have varying effects based on your genes. Millions of people take a daily aspirin to lower their risk for heart attack and stroke. Aspirin helps by preventing blood clots that could clog arteries. But aspirin doesn't reduce heart disease risk in everyone.

The Promise of Personalized Medicine

Personalized medicine could provide solutions to one of the biggest challenges facing our country – the rising cost of health care. Canada currently spends around $200 billion on health care each year, which is roughly one-tenth of GDP. As a 2011 Frasier Institute study indicates, Ontario is spending more than half of its total revenue on health care and "total provincial health spending has grown at an average annual rate of 7.5 percent over the last 10 years."

Personalized medicine will dramatically change the medical care landscape by improving upon current knowledge of such things as disease progression and drug efficacy.

RECAP

- Define some genetics terms and concepts
- Discuss epigenetics
- Integrate your new understanding of genetics and epigenetics to help improve your health
- Implement some strategies into your life to improve genetic health
- Discuss various direct to consumer genetic tests available and some things to keep in mind before taking one
- Define personalized medicine

QUIZ

QUIZ: Are you a gene genius?

Test your DNA knowledge with this quiz.

- How many chromosomes do most of us have? *

A. 2
B. 46
C. 23
D. 64

- DNA stands for ... *

A. Digenetic Natured Antibody
B. Deoxyribonucleic Acid
C. Di-Nutritive Apparatus
D. Do Not even Ask

- Humans have: *

A. About 300,000 DNA base pairs
B. About 3,000,000 DNA base pairs
C. About 3,000,000,000 DNA base pairs

- A genome is: *

A. Genetic information that is identical to every member of the same species
B. All of the information from an organism's DNA
C. A method of testing DNA

- A genetic mutation can be: *

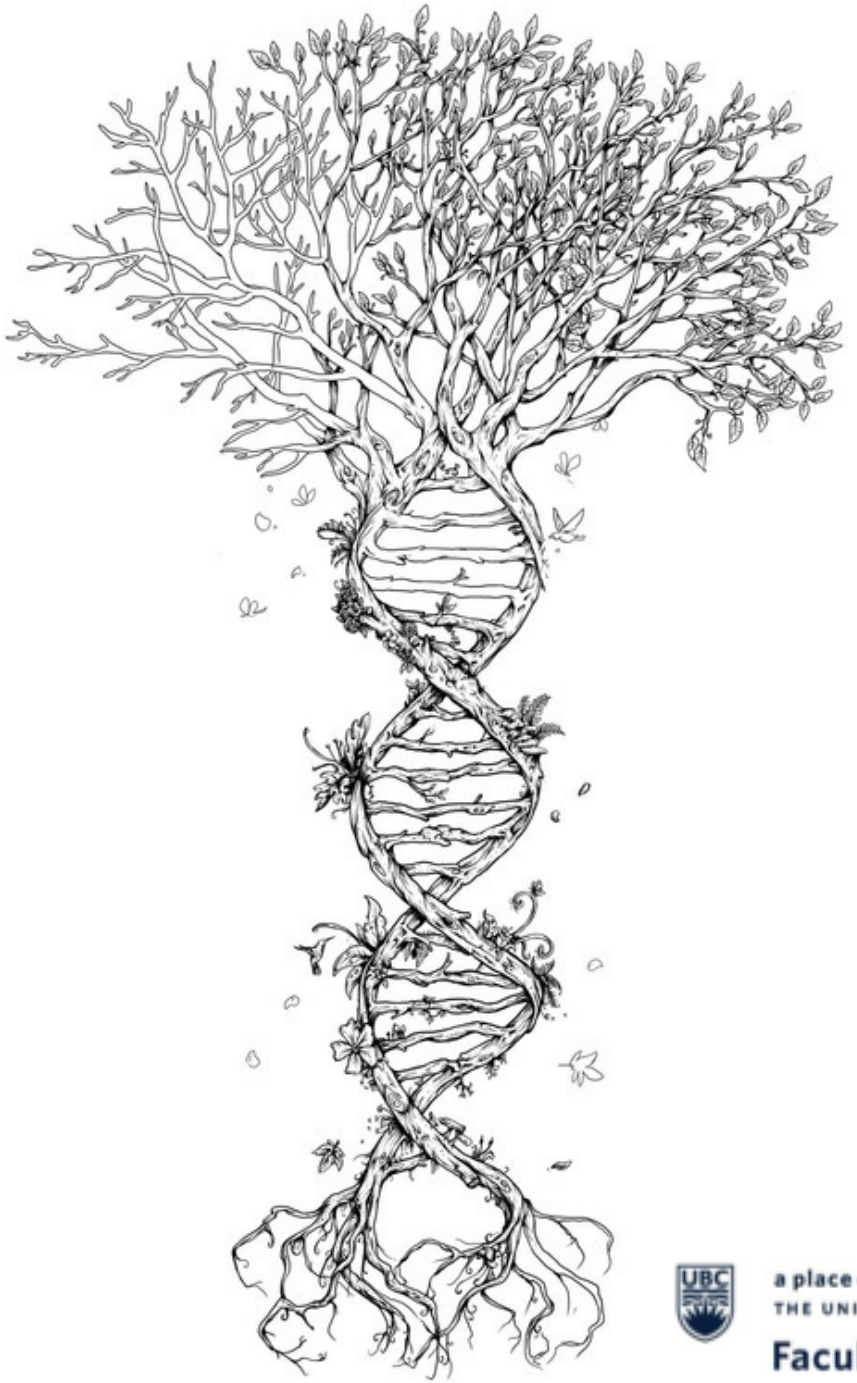
A. Bad
B. Good
C. Have no effect
D. All of the above

- All home DNA testing kits look at the same gene markers to determine your risk of getting a disease. *
- True
- False

- If a genetic test shows you have a low risk of developing a disease, you could still get that disease. *
- True
- False

- If you take a home DNA test, your right to keep that information private from employers and insurance companies is protected by law in Canada. *
- True
- False

QUESTIONS?



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