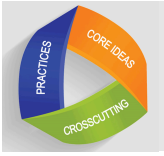
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Unit: 5
Lesson: 2

Time Length: 45–50 min

What Does Science Tell Us About Free Will and Determinism?

Are We Programmed or Do We have Free Will?



NGSS Instructional Outcomes

Next Generation Science Standards

Science and Engineering Practices

Asking Questions and Defining Problems: Students explore the scientific perspective on genetic determinism and its relation to free will.

Engaging in Argument from Evidence: Debating the extent to which genetics determine human behavior based on scientific evidence.

Crosscutting Concepts

Cause and Effect: Understanding the relationship between genetic makeup and human behavior.

Systems and System Models: Analyzing the human body as a complex system affected by genetic and environmental factors.

LS3: Heredity: Inheritance and Variation of Traits: Exploring the role of genes in determining physical and behavioral traits.

LS4: Biological Evolution: Examining the concept of genetic determinism in the context of human evolution and behavior.



CCSS Instructional Outcomes

Common Core State Standards

English Language Arts Standards

CCSS.ELA-LITERACY.RST.11–12.1: Citing specific textual evidence to support analysis of science and technical texts, focusing on how genes influence behavior.

CCSS.ELA-LITERACY.SL.11–12.1: Engaging in collaborative discussions on complex topics like genetic determinism and free will, building on others' ideas, and expressing their own clearly.

Mathematics Standards

Statistics and Probability: Understanding and interpreting statistical information related to genetics and behavior.

History/Social Studies Standards

CCSS.ELA-LITERACY.RH.11–12.7: Integrating and evaluating multiple sources of information presented in diverse formats and media in order to address questions of free will and determinism.

CCSS.ELA-LITERACY.RH.11–12.9: Comparing and contrasting treatments of the same topic in several primary and secondary sources.

Content Learning Outcomes:

- Describe gene interactions with human behavior.
- Describe the types of genetic determinism and their relation to human behavior.

Materials

- Instruction/Teacher Facilitation: Slides 5.23–5.41
- Triple-Entry Vocabulary Journal (Student responsibility)
- Resource: YouTube Videos: Libet's Experiment and Debunking Libet's Conclusions
- YouTube Video: What is Epigenetics?
- YouTube Video: CRISPR Explained
- Article: Chinese Scientist Who Produced Genetically Altered Babies Sentenced to 3 Years in Jail
- Activity: Game of Life
- Resource Materials
- Question Bank
- Lesson 5.2 Assessment

Instruction/Teacher Facilitation: Slides for Lesson 5.2

- **Slide 5.23.** What Does Science Tell Us about Free Will and Determinism?
- **Slide 5.24.** What is Genetic Determinism?
- **Slide 5.25.** What is a Gene?
- **Slide 5.26.** Interesting Facts about Genes
- **Slide 5.27.** Genetic Link to Behavior: Association versus Causal
- **Slide 5.28.** Genes and OCD

- **Slide 5.29.** Our Behavior can Disrupt Our Gene
- **Slide 5.30.** Genetics Study on Behavior
- **Slide 5.31.** Case Studies
- **Slide 5.32.** What is Epigenetics?
- **Slide 5.33.** Types of Genetic Determinism
- **Slide 5.34.** How CRISPR Works
- **Slide 5.35.** CRISPR Explained
- **Slide 5.36.** Anecdote 1
- **Slide 5.37.** Genes and Criminal Behavior
- **Slide 5.38.** Anecdote 2
- **Slide 5.39.** Same-Sex Attraction
- **Slide 5.40.** Summary from a Scientific View
- **Slide 5.41.** Class Activity Time!

Instruction/ Teacher Facilitation

In Lesson 5.1, we learned about free will and determinism from an Islamic theological lens, but is there a way we can examine this concept through a scientific lens?

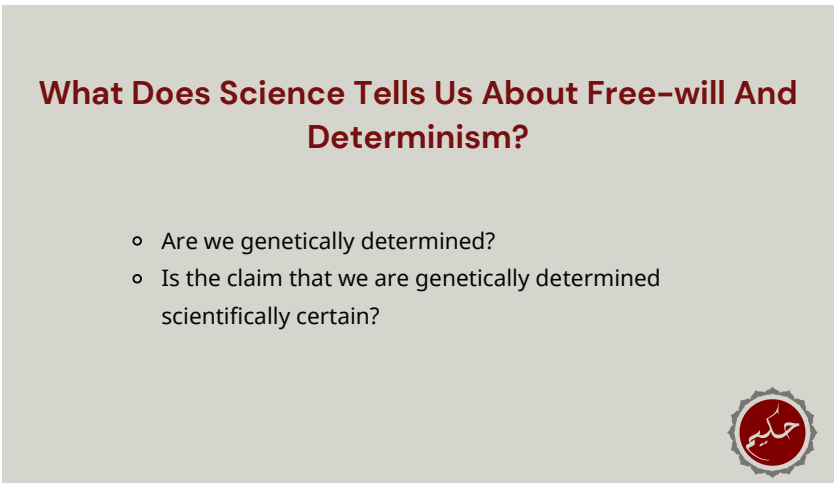
Q&A

Ask students: How do you think science could/would approach the topic of free will and determinism? (Students might have a variety of answers.)

A: Genetics, because genes determine a lot of what happens within our bodies, so is this a type of determinism?

Let us explore this question: "What is the scientific perspective on genetic determinism?"

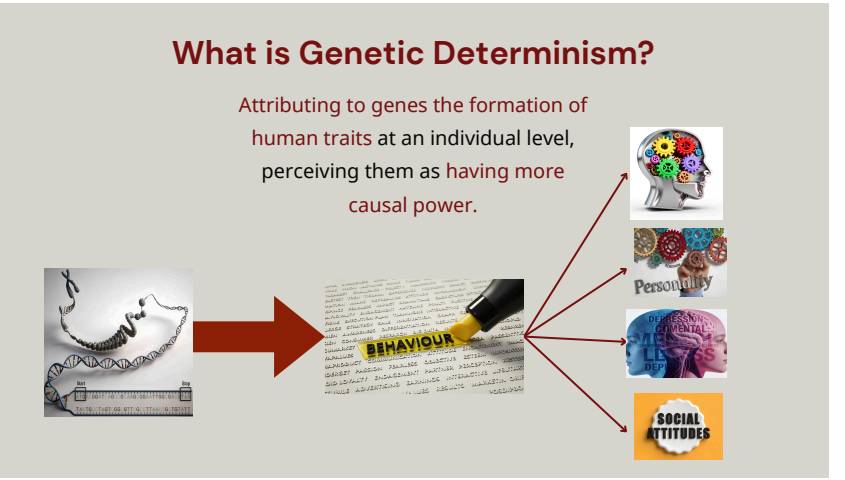
Slide 5.23: What Does Science Tell Us about Free Will and Determinism?



In discussing the topic of this lesson, "What Does Science Tell Us About Free Will And Determinism?" we will look at answering two essential questions:

1. Are we genetically determined?
2. Is the claim that we are genetically determined scientifically certain (*qaṭ'ī*)?

Slide 5.24: What is Genetic Determinism?



First, are we genetically determined?

We have to first define **genetic determinism**.

- At the individual level, it is the belief that our physical, human traits that correspond to behavioral traits, are determined by our genetic makeup.
- For example, the level of intelligence—IQ level is determined on your genes.

Let us start by looking at what science can tell us about free will by examining the Libet Experiment. Conducted by Benjamin Libet (1983), this experiment aimed to explore whether our conscious decisions are made freely or determined by brain activity before we are aware of them.

Key Findings of the Libet Experiment:

- Brain activity (readiness potential) begins before a person consciously decides to act.
- Libet recorded EEG signals showing brain activity 300–500 milliseconds before the person reported making a conscious decision.
- This suggests that the brain "decides" before the person is aware of making a choice.
- However, Libet also found a "veto power." Even if the brain initiates an action, a person can still consciously stop it, implying some level of free will (but more like a "free won't").
- The Libet's data shows ambiguity in denying free will.

Resource Materials:

These videos can be shared with students for a better understanding of the Libet Experiment.

Libet Experiment

1. **The Libet Experiment: Is Free Will Just an Illusion?**

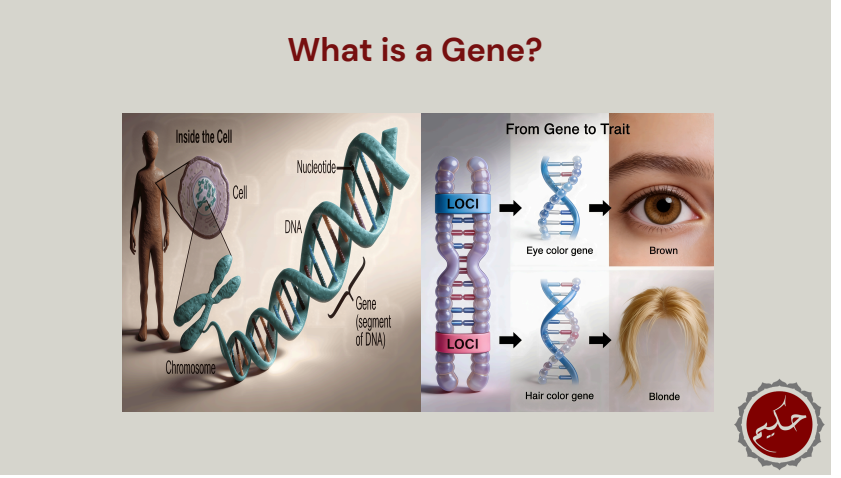
YouTube, BBC Radio 4, 7 Nov. 2014.

Debunking Libet's Conclusions

2. **Debunking Libet's Conclusions**

A Lecture from Peter Ulric Tse's Edx MOOC on the neural bases of free will, 31 Dec. 2019.

Slide 5.25: What is a Gene?



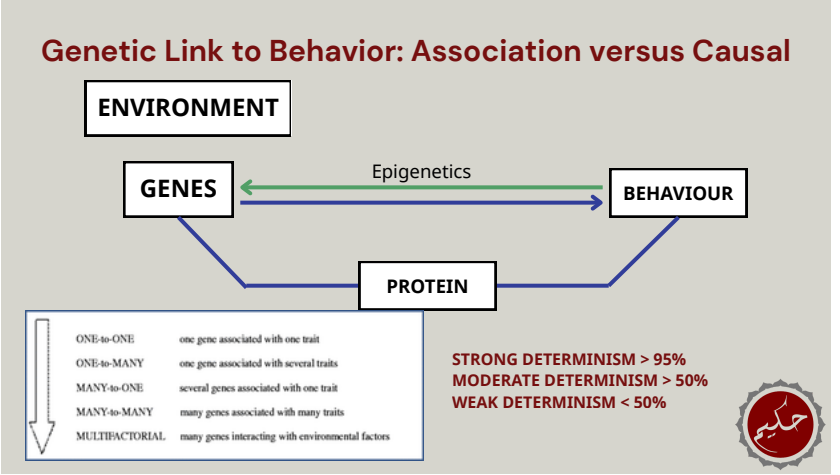
This requires us to go to a more basic level and examine what a **gene** is.

In biology or general science classes, we have seen genes before; they are the building blocks of life; the basic component of our DNA.

For example, like in a recipe book that gives instructions on how to make a dish on each page; similarly certain parts of your genes correspond to specific proteins, and those proteins then correspond to certain functions (like the nervous system) and traits (eye color, hair color, and the like).

The question that arises is whether we have genes that pinpoint our behavioral traits, such as intelligence, temperament, and so forth.

Slide 5.26: Genetic Link to Behavior: Association versus Causal



Coming back to our question of whether or not we are genetically determined, we have to see how and what things are controlled by our genes.

First of all, genes can be linked to effects/behaviors in many ways.

- A **causal relationship** occurs when a change in one variable produces a change in the other variable.
- **Association** or **correlation** between two variables, on the other hand, merely implies that knowing the value of one variable provides information about the value of another variable. For example, variable (A) seems to increase and as (A) increases, variable B also increases. This is an association; we see an effect happening which means that they might be related, BUT this does not mean that increase in A is causing B to increase. The cause can be a 3rd factor or a combination of factors.

There is a spectrum of how genes correlate with traits or behaviors:

- **One → One:** one gene is associated with one trait, for example, in cystic fibrosis or sickle cell anemia, if certain parts of a gene is altered, these diseases can develop.
- **One → Many:** one gene is associated with many traits
- **Many → One:** many genes are associated with one trait.
- **Many → Many:** many genes are associated with many traits.
- **Multifactorial:** many genes interact with environmental factors.

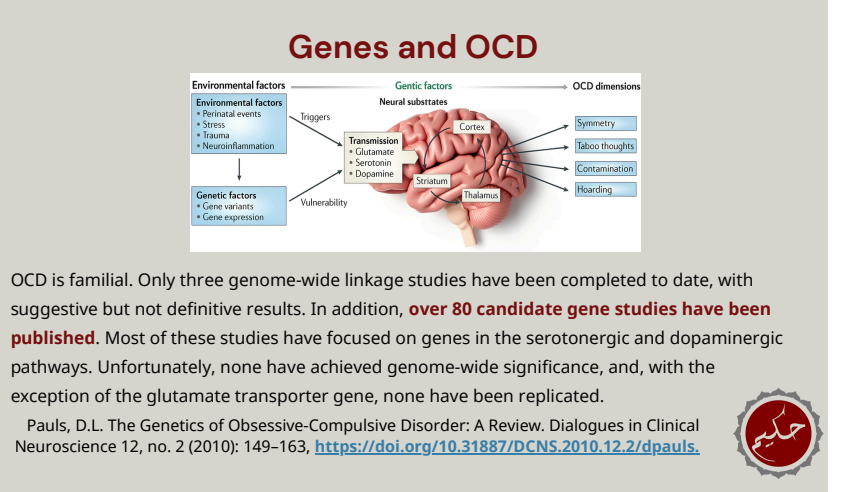
In terms of the strength of the association, there are different levels:

- **Strong association:** higher likelihood that changes in variable A (gene) is linked to changes in variable B (behavior)
- **Moderate association:** moderate likelihood that changes in variable A (gene) is linked to changes in variable B (behavior)
- **Weak association:** low likelihood that changes in variable A (gene) is linked to changes in variable B (behavior)

The correlation between genes and behavior is usually not straightforward or direct. There are often multiple mechanisms/ pathways involved that affect the outcome.

- As we might know from biology, the gene first needs to be transcribed and then translated into proteins. From these associated proteins, the behaviors can then be developed.
- The environment is another factor affecting the link between genes and behavior.
- Therefore, what causes a specific behavior or trait is multifactorial.

Slide 5.27: Genes and OCD

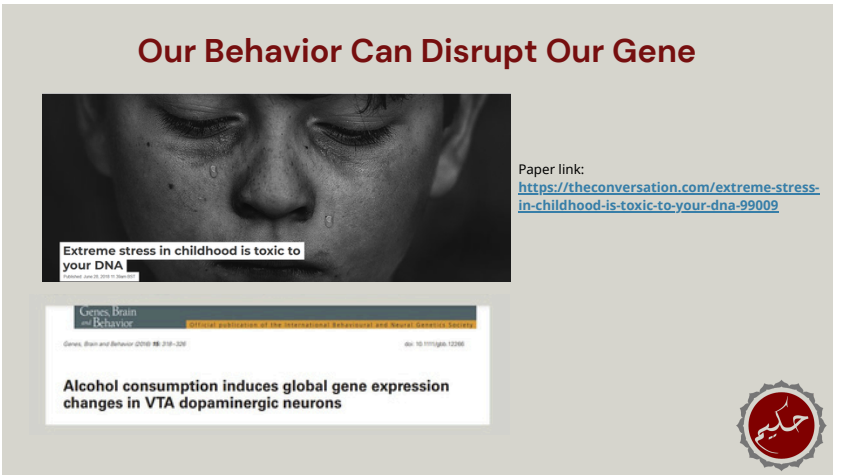


Let us look at this varied correlation and range of degrees of association with the example of OCD (Obsessive-compulsive disorder); we will see how this pathway of genes to behavior is complicated: factors are outlined in the diagram in Slide 5.27.

- There are genetic factors and environmental factors, and the transmission is done by the proteins resulting from transcription and translation earlier, giving rise to the repetitive OCD thoughts and behaviors.

- Some studies suggest that OCD is due to genetics, but thus far, have found associations and not causation.
- From existing surveys and family genetic studies, no specific gene (or part of gene) has been identified as being responsible for OCD behaviors.
- The key takeaway here is that the relationships between genes and behaviors are complex and influenced by multiple factors.

Slide 5.28: Our Behavior can Disrupt Our Gene

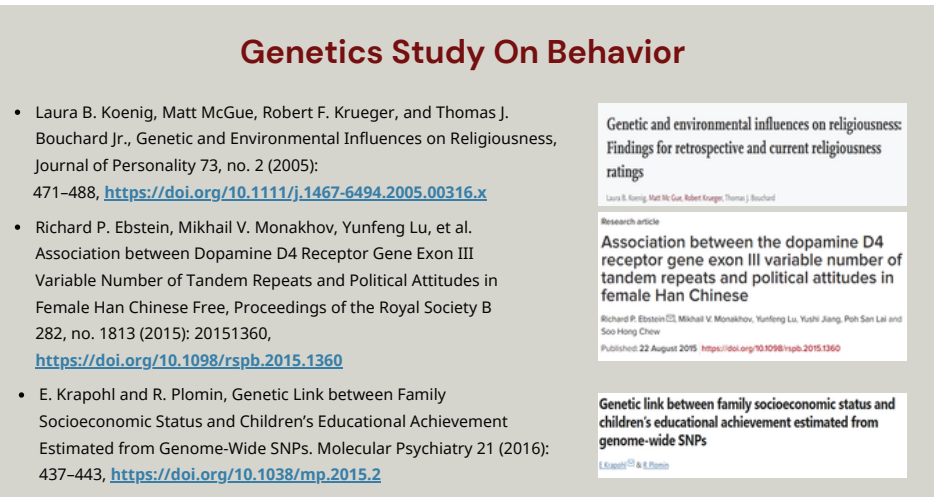


So far, we have been looking at how genes lead to human behavior. What about the other way around; can our behavior affect our genes?

Scientific studies suggest that the things we do can, in fact, affect our genes.

- Smoking, doing drugs, and alcohol consumption, for example, can alter our genes.
- Extreme levels of stress (e.g., traumatic experiences of victims) have been said to alter genes which were then passed on to the next generation.
- Therefore, our actions or the lifestyle we adopt can affect our genes and their function.

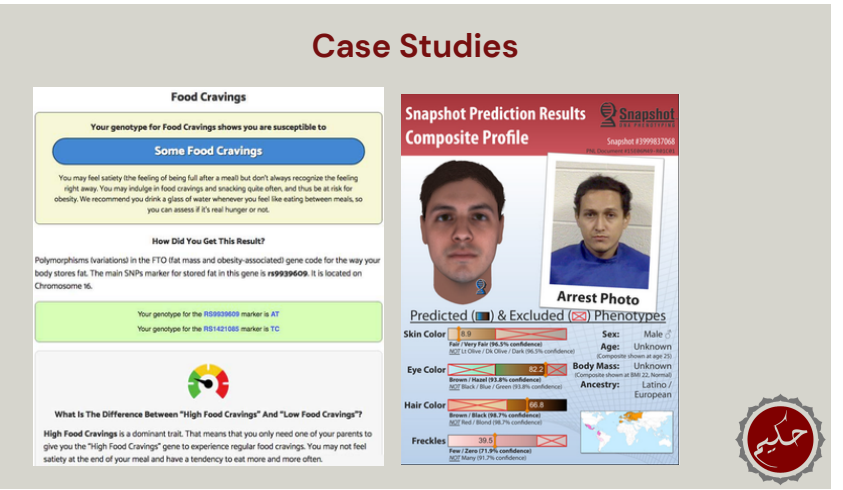
Slide 5.29: Genetics Study on Behavior



Current studies have indicated that:

- Genes can influence your religiousness.
- Gene screening can predict your political affiliation.
- Genes can affect your education and economic status.

Slide 5.30: Case Studies



Case Studies

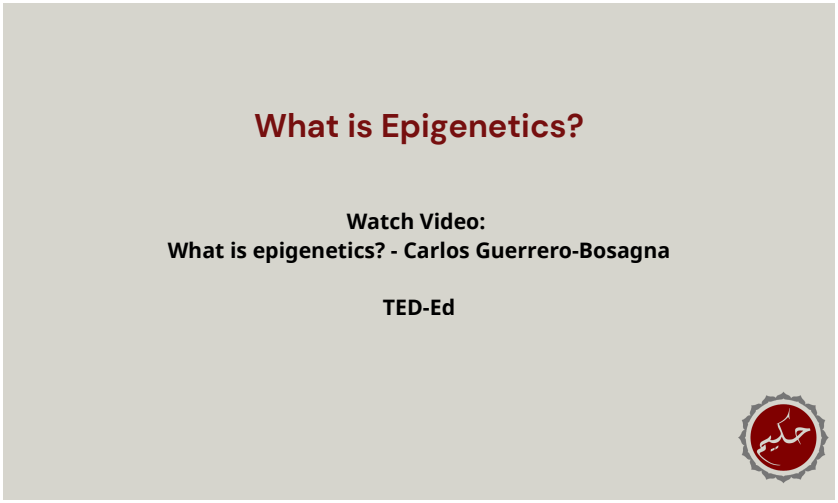
Murder Suspect: In 2017, there was a murder case, where a man attempted to kidnap a girl; a family member who tried to stop him was killed. The blood was found and sent to a lab. This particular forensic lab used the evidence (blood) to construct/identify the physical traits. This picture is the result of their reconstruction. This suggested the brother of the boyfriend of that girl. Subsequently, the evidence was screened again along with traditional DNA testing, and this man was found to be the actual perpetrator.

This is what modern technology can do today. A minute amount of your DNA can be used to reconstruct physical traits.

This leads to the question: What are behavioral traits? There are many companies today that perform DNA testing and analysis for you. You send them a swab of your saliva, and within a few days, they can outline for you in detail, your ancestry and whether you have high/low levels of food cravings! This is the level that the study of genetics has achieved.

Bear in mind that all these tests and measurements are based on probabilities; there are elements of chance and uncertainty within all these associations.

Slide 5.31: What is Epigenetics?



Epigenetics

These associations are part of a more complex pathway than just a gene being transcribed and translated. They are effects of what we call **Epigenetics**.

Here is an introduction to epigenetics and how it plays a role in affecting our behavior. Watch the Video: "**What is Epigenetics?**" by Carlos Guerrero-Bosagna, TED-Ed, 27 June 2016.

What is Epigenetics?

Epigenomes are chemical tags that are attached to the genome that affect its expression.

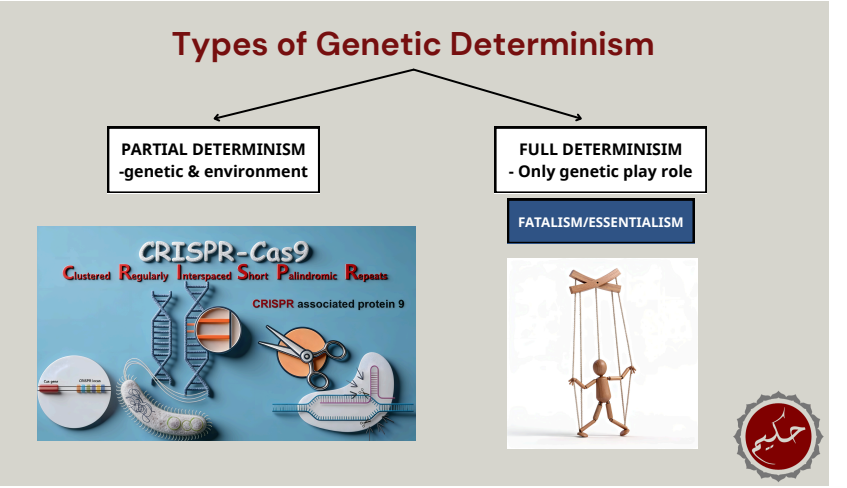
- In the process of gene expression, transcription of genes is either boosted or interfered with.
- Methyl group: causing the DNA to be wrapped more tightly around the histone protein so that it becomes inaccessible, which then limits or inhibits gene expression.

- Epigenetic changes can survive cell division, which means they can continue to have effects on the person throughout their entire lives.
- The epigenome interacts between the genes and the environment, which include diet, chemical exposure, and medications.

For example, although a pair of twins have the exact same DNA, their exposures and lifestyle choices can affect their epigenome, causing differences in their behaviors, the way they age, susceptibility to diseases, and lives in general. Social interactions also cause epigenetic changes that affect epigenetic traits which were then passed on to their offspring.

Epigenetics is not part of the DNA/gene sequencing itself, it is beyond genetics. Studies show that epigenetics has a considerably strong influence on us and has become the focus of today's research.

Slide 5.32: Types of Genetic Determinism



Now, coming back to the concept of genetic determinism.

Classifying Genetic Determinism

Full Determinism

Only genetics plays a role in determining all your behaviors and actions.

- We have no choice whatsoever, everything is in our genes.
- Also known as Fatalism or Essentialism.
- For example, life is like puppetry, fully controlled by external factors and you have no control over your action.

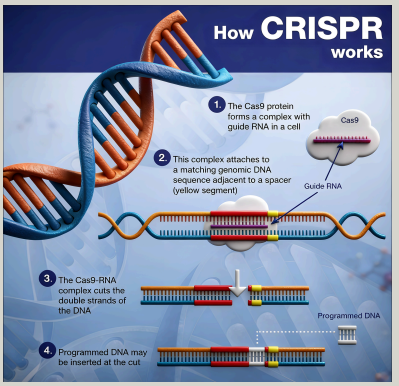
Partial Determinism

Both genetics and the environment play a role in determining all your behaviors and actions.

- This concept of nature versus nurture.
- For example, twins are born genetically identical, but their environment and upbringing result in different abilities and behaviors.
- Most scientists ascribe to this form of genetic determinism.
- A technological advancement made in the realm of genetics is CRISPR-Cas 9.

Slide 5.33: How CRISPR Works

How CRISPR Works



- Gene Editing (A cut and paste tool for genes)
- CRISPR stands for Clustered Regularly Interspaced Short Palindromic Repeats.

Slide 5.34: CRISPR Explained

CRISPR Explained

Watch Video:
CRISPR Explained

Mayo Clinic

CRISPR Explained

Let us see how it works:

- Watch the video: "**CRISPR Explained**," Mayo Clinic, 24 July 2018.

Specific genes are located and targeted, then are replaced with a preferable gene in its place through the use of proteins.

Four Basic Steps

1. A protein called Cas-9 forms a complex with a guide RNA.
2. This complex attaches to a matching gene sequence
3. The Cas-9-RNA complex cuts the gene sequence.
4. The edited gene is inserted at this cut location

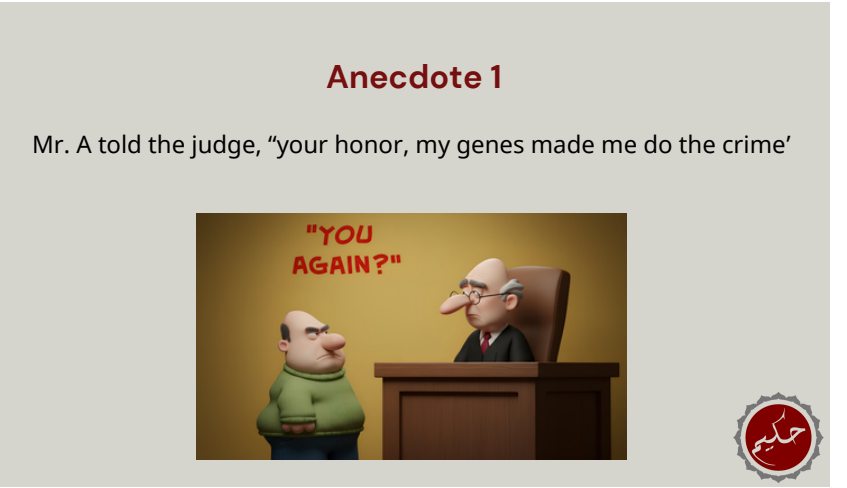
Article: Genetically Altered Embryos

Read Article: Dennis Normile, "**Chinese Scientist Who Produced Genetically Altered Babies Sentenced to 3 Years in Jail**," Science Insider, 30 Dec. 2019.

- Chinese scientist, He Jiankui, genetically altered embryos using CRISPR and was jailed for it; the court considered his action unethical.

Since we have the ability to edit our genes, scientists support the concept of being partially determined, because we have the choice to edit our genes. If we were fully determined, then we would not have that option.

Slide 5.35: Anecdote 1



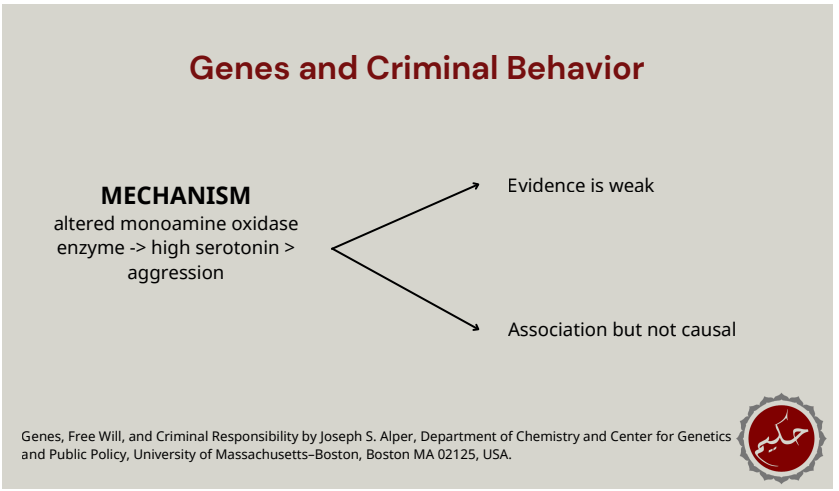
Q&A

How does the concept of *mukallaf* fit into genetic determinism?

Anecdote 1: Mr (A) told the judge, "Your honor, my genes made me do the crime."

- **Ask students:** How many of you agree with this statement?

Slide 5.36: Genes and Criminal Behavior



Let us look at the evidence: **Genes and criminal behavior**

So scientists looked at the reason for aggression in people and noticed that they had high levels of serotonin (a neurotransmitter).

Looking at their genetic screening results suggests that they have an altered monoamine oxidase enzyme.

- The function of monoamine oxidase enzyme is to turn off the mechanism that makes/releases serotonin in the body. Since this enzyme is altered, serotonin production is not capped, resulting in higher levels of serotonin in the body. Higher levels of serotonin leads to higher levels of aggressiveness.
- Mechanism => an altered monoamine oxidase enzyme -> high serotonin (a neurotransmitter) > aggression.

Many scientists/researchers do not agree with this association. They said that those with aggression might have high levels of serotonin, but not the other way around, that everyone with high levels of serotonin will act aggressively.

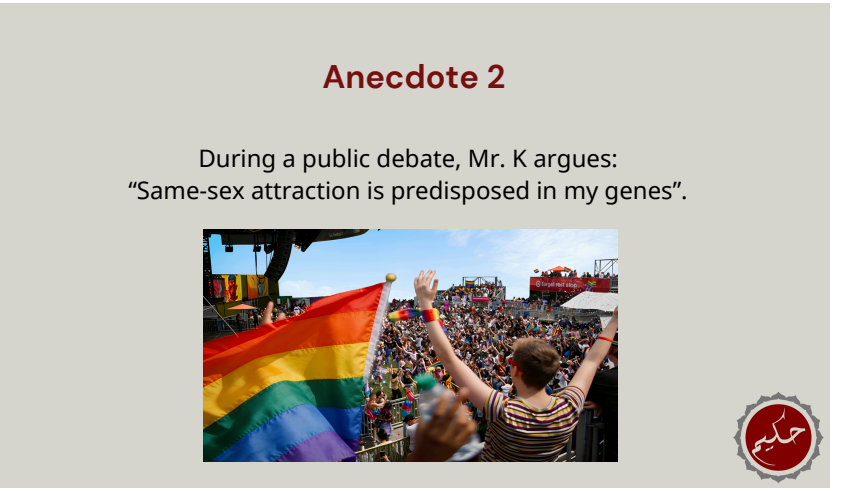
For example, you have a knife. Just because you have a knife does not mean you are a criminal. It depends on what you do with the knife. Criminals who kill may have knives with them, but you having a knife does not mean you will murder someone with it.

So the evidence for high levels of serotonin leading to aggression is weak. This would be classified as an association, but not causation.

Ask students: Based on the evidence, is this association/correlation *qaṭ'ī* or *ẓannī*? [A: *ẓannī*]

Q&A

Slide 5.37: Anecdote 2



Anecdote 2: During a public debate, Mr. K argues: “Same-sex attraction is predisposed in my genes.”

Slide 5.38: Same-Sex Attraction



A study was done among half a million people by the UK Biobank and concluded that there is no single “gay” gene, in other words, there is no specific gene.

They found some associations, about 8–25%, but they were not able to pinpoint to a specific gene or locations of some genes that caused this behavior.

There can be some inclination in a person, in their heart/mind, but there is no consequence for that. The consequences are based on actions; acting upon that inclination results in sin.

Q&A

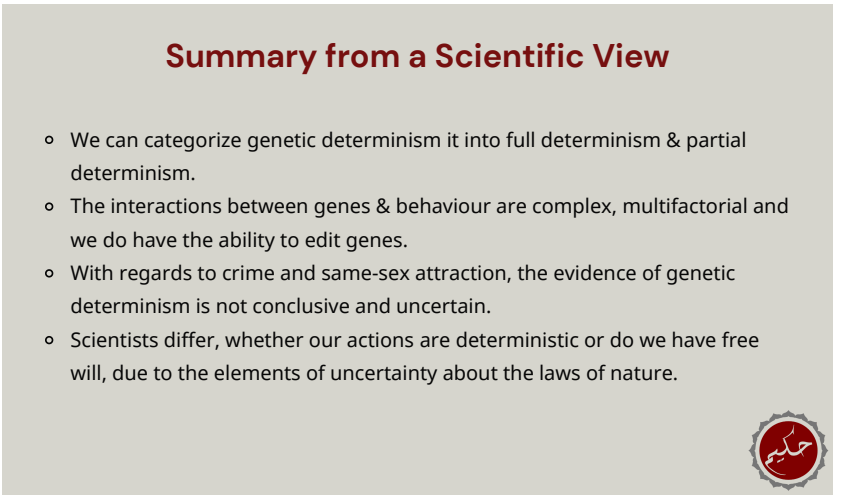
Ask Students: Based on the evidence here, is this association/ correlation *qaṭ̄ī* or *ẓannī*? [A: *ẓannī*]

Free Will and Derterminism 3 Scholars

Watch the video: "**Free Will and Determinism**" 17 Jan. 2013, featuring three scholars:

1. Robert Saploski, a Stanford scholar, a Determinist, who says that free will is a myth; that we are biological creatures, and all of our "choices" actually depend on biological forces.
2. Bill Nye, the Science Guy, who is confused about the topic, says a little bit of both; determinism results from our condition but some levels of choice exist.
3. Michio Kaku, a physicist, who says there is uncertainty with regards to the position of electrons. In terms of free will, he feels that we do have some kind of free will.

Slide 5.39: Summary from a Scientific View



Summary of the scientific view on genetic determinism, based on these three scholars:

- We can categorize genetic determinism into full determinism and partial determinism.
- The interactions between genes and behavior are complex and multifactorial, and we also have the ability to edit genes. (Genetics and Epigenetics)
- With regard to crime and same-sex attraction, the evidence of genetic determinism is not conclusive and is uncertain.
- Scientists differ on whether our actions are deterministic or we have free will, due to the elements of uncertainty in the laws of nature (i.e., we do not know everything).

The scientific and Islamic perspectives on determinism and free will are closely related in some regard. Both state that we do have some free will while some elements might be pre-determined.

Therefore, both determinism and free will happen/exist.

An Islamic theological aspect of determinism and free will is *qaṭī*, whereas the scientific aspects are *ẓannī* and no definitive answer can be concluded.

Group Activity: Conway's Game of Life

The Game of Life is not your typical computer game. It is a cellular automaton and was invented by Cambridge mathematician John Conway. This game became widely known when it was mentioned in an article published by Scientific American in 1970. It consists of a grid of cells that, based on a few mathematical rules, can live, die, or multiply. Depending on the initial conditions, the cells form various patterns throughout the game. [For more information, watch the video: "**John Conway's Game of Life segment**." 22 Sept. 2012.]

John Conway's Game of Life

Instructions

1. Each group has 20 squares to begin with.
2. Place them strategically on the grid paper.
3. Transport those positions to the grid on the website: **https://playgameoflife.com**
4. Then press START to see how many alive squares you end up with.
5. Document the number of squares you have at the end.

Game of Life

Rules

For a space that is populated:

a. Each cell with one or no neighbors dies, as if by solitude.



b. Each cell with four or more neighbors dies, as if by overpopulation.



c. Each cell with two or three neighbors survives.



Game of Life Explanation

For a space that is empty or unpopulated:

Each cell with three neighbors becomes populated.



When all groups have put in their positions on the website, press START to see how many squares are alive.
Document the number of live squares for each group.

Slide 5.40: Class Activity Time!



Learning points from this activity: Discuss the game and its relation to reality.

Significant points to discuss:

This game represents the topic of determinism and free will.

Ask students:

Q&A

- What do we have a choice in?
  A: Where we placed the squares on the grid originally.
- What aspect is determined?
  A: The number of squares given originally (20) and that there is a set of rules. In life, some aspects are determined and in some other aspects, we have free will. Life continues whether we understand the rules or not. In the end, we are at the Mercy of Allah (swt).

Biology Connection

This lesson pairs very closely with sections on genetics in biology courses. (In most Biology textbooks, this would be the Unit on Genetics. There are specific chapters on how genes are controlled and DNA technology intersects with Genomics.)

- Genes and Alleles, genotypic and phenotypic traits, .
- Gene function, gene expression (Transcription and Translation of DNA), and gene editing
- Activation and inhibition of genes
- Proteomics and Epigenetics
- Nature versus Nurture