

## Unit 5: Are We Programmed or Do We Have Free Will?

### Discussions on Fate and Genetic Determinism

## Lesson 2 - What Does Science Tell Us About Free Will & Determinism

**Time Length:** 45-50 min.

### INSTRUCTIONAL OUTCOMES:

#### Next Generation Science Standards (NGSS)

##### *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.

#### Common Core State Standards (CCSS)

##### *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 & 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:

- **Presentation Slides** (25-46)
- **Triple-Entry Vocabulary Journal** (Student Responsibility)
- Video [What is epigenetics? - Carlos Guerrero-Bosagna](#)
- Video [CRISPR Explained](#)
- Supplemental Material - Article about the scientist who developed CRISPR [Chinese scientist who produced genetically altered babies sentenced to 3 years in jail | Science](#)
- Video [The great free will debate | Bill Nye, Michio Kaku, Robert Sapolsky, Steven Pinker & more](#)
- Videos on the individual scientists/scholars:
  - Robert Sapolsky - [Why You Don't Have Free Will: Your Breakfast Food, Biology, and Culture | Robert Sapolsky](#)
  - Bill Nye - [Hey Bill Nye, Do You Believe In Free Will? | Big Think](#)
  - Michio Kaku - [Michio Kaku: Why Physics Ends the Free Will Debate | Big Think](#)
- **Game of Life Instructions**
- Game of Life website - [Conway's Game of Life](#)

## Instruction/Teacher Facilitation:

- ❖ In the last lesson, 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?
- ❖ Ask students: How do you think science could/would approach the topic of free will and determinism? **(Students might have a variety of answers.)**
  - Answer - 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 25}

- ❖ 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:
  - Are we genetically determined?
  - Is the claim that we are genetically determined scientifically certain (qatti)?

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- ❖ First, are we genetically determined?
  - We have to first define genetic determinism.
    - On an individual level, it is the belief that our physical, human traits that correspond to behavioral traits (like personality, level of intelligence, social attitude, and even mental conditions) are determined by our genetic makeup.
    - For example: the level of intelligence - IQ level - it is determined based on your genes.

### {SLIDE 27}

- ❖ This requires us to go to a more basic level and examine what a gene is. [Not a jinn, a gene.]
  - In biology or general science classes, we have seen genes before; they are the building blocks of life; the basic component of our DNA.

- Example: like in a recipe book that gives instructions on how to make a dish on each page; similarly certain parts of your genes, or certain segments, correspond to specific proteins, and those proteins then correspond to certain functions (like the nervous system etc) and traits (eye color, hair color, etc).
- The question that arises is do we have genes that pinpoint our **behavioral** traits also, like intelligence, temperament, etc?

## {SLIDE 28}

### ❖ Interesting Facts about Genes:

- Humans share around 96% of their DNA with chimpanzees, 90% with mice, and 60% with bananas! - Depending on which location on the chromosomes we are looking at, 96% of our DNA is similar to chimpanzees. [This helps us see that we all, and all the things around us, come from a common Creator who uses similar things to create us.]
- Sequencing one person's genome generates around 200 GB of data, the capacity of a typical computer. - If one was to write out the letters of the genome in a Microsoft Word document, of all 46 chromosomes, one would generate around 200 GB. One full page of writing is on average 12 kilobytes only. That is a lot of information packed in just one cell, which has chromosomes all tightly wrapped storing this info.
- In terms of distance - If all the DNA in your cells were laid out in a line, it would reach the sun and back around 70 times.
- If you spoke one letter of DNA per second, 24 hours a day, it would take about 100 years to recite the entire human genome.
- Your genome is only around 0.1% different from any other person's, but that equates to 3 million differences in your DNA!

## {SLIDE 29}

### ❖ Genetic Link To Behavior - Association Vs 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/causes a change in the other variable.
  - An 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 A's increase is *causing* B to increase. The cause can be a 3rd factor or a combination of factors.
- There is also a spectrum of how genes correlate with traits or behaviors:
  - One → One - one gene associated with one trait
    - For example: cystic fibrosis or sickle cell anemia, if certain parts of a gene is altered, these diseases can develop.
  - One → Many - one gene associated with many traits

- Many → One - many genes associated with one trait
- Many → Many - many genes associated with many traits
- Multifactorial - many genes interacting with environmental factors
- In terms of the strength of the association, there is a range:
  - Strong/High Association/Determinism > 95% chance that the associated result will be present
  - Moderate Determinism is around a 50% chance of the associated trait being developed.
  - Weak Determinism < 50%
- It is not just a straight or direct correlation between genes and behavior. There are many molecular mechanisms in between 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 environmental effects are also another factor in this link of genes to behavior.
  - Therefore, this link from genes to behavior is a multifactorial association, which also varies in degree.

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- Let's 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 outlined in the diagram in the slide]
  - There are genetic factors and environmental factors, and the transmission is done by the proteins that were mentioned as a result of transcription and translation earlier, all resulting in these repetitive OCD thoughts and behaviors.
  - Some studies suggest that it is due to genetics, but they can't find the actual connecting point; they see an association but haven't seen proof of causation.
  - They do surveys and genetic studies of the families, but a specific part of a gene has not been found to be responsible for the OCD behavior.
  - Again, the main point to take note of here is that the association between genes and behavior is complex and multifactorial.

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- ❖ So far, we have been looking at how the genes lead to behavior. What about the other way around; is there a link between our behavior affecting 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.
    - Even effects due to extreme levels of stress, like that suffered at the hands of the Nazis, have been passed on to the next generations.
    - Therefore, the actions that we choose are factors that might affect the functioning of our genes. (We will see in a bit how directly or indirectly they are affected.)

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- Current studies have indicated that:
  - Religiousness is a factor - some studies mention that your genes can even determine your sense of religious affinity.
  - Politics is a factor - screening your genes might predict which political party you would support.
  - Studies have also been done on education level and economic status as factors.

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- Case Studies:
  - Murder Suspect - In 2017, there was a murder case, where a male intruder was attempting to kidnap a girl and the family was trying to stop him and was killed in the process. While fighting off the family members, a little bit of blood of the intruder was spilled before he ran away. This blood was found and sent to a lab. In this particular forensic lab, they tried to reconstruct the evidence found at the crime scene into actual physical traits. This picture is the result of their reconstruction. This suggested the brother of the boyfriend of that girl. After this evidence, the screening of the evidence was done again along with traditional DNA testing, and this man was found to be the actual perpetrator.
  - This is the kind of situation that this modern technology can be used for. Small remembrance of your DNA can be used to reconstruct physical traits.
  - This leads to the question: What about behavioral traits? - There are many companies out there that do DNA testing and analysis for you. You send them a swab of your saliva, and within a few days, they can outline for you multiple elements. They can outline for you, in detail, your ancestry, but also to such a capacity that they can see if you have high/low levels of food cravings! This is the extent of the study of genetics and behavior.
- All of these things are due to probabilities, therefore there is the element of chance and uncertainty with all of these associations.

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- ❖ Epigenetics: These associations that have been analyzed 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 what epigenetics is and how it plays a role in affecting our behavior. Watch [What is epigenetics? - Carlos Guerrero-Bosagna](#)
  - Epigenome - 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.
    - Other chemical groups will loosen the DNA wrapped around the histone protein, making it more accessible and therefore activating the gene expression or increasing 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 can be affected by diet, chemical exposure, and medications.
  - Example: twins, although they 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 the person not only life-long but those epigenetic traits can be 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 now become the focus of many recent studies.

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- ❖ Now, coming back to the concept of genetic determinism: Classifying Genetic Determinism
  - Full Determinism - only genetics plays a role in determining everything for you.
    - We have no choice whatsoever, everything is in our genes.
    - Also known as Fatalism or Essentialism
    - Example: Life is like puppetry, fully controlled by external factors and no control/choice over your own actions.
  - Partial Determinism - both genetics and the environment is playing a part
    - This concept of nature versus nurture.
    - Example: Twins - born genetically identical, but their environment and situations resulted in the development of 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.

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

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- Let's see how it works: Watch [CRISPR Explained](#)
- Specific genes are located and targeted, then are replaced with a preferable gene in its place through the use of proteins.
- 4 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.
- Chinese scientist, He Jiankui, genetically altered embryos using CRISPR and was jailed for it; the court considered his action unethical. [See Article - <https://www.science.org/content/article/chinese-scientist-who-produced-genetically-altered-babies-sentenced-3-years-jail> ]

- 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.)

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- ❖ 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?

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- Let's look at the evidence: Genes and criminal behavior
  - So scientists looked at the reason for the aggression in people and noticed that it seemed they had high levels of serotonin (a neurotransmitter).
  - Looking at their genetic screening results suggests that they have an altered monoamine oxidase enzyme.
    - ◆ The job of monoamine oxidase enzyme is to turn off the mechanism that makes/releases serotonin in the body. Since this enzyme is altered, it is not stopping or capping the serotonin production, which results in higher levels of serotonin in the body. Higher levels of serotonin results in becoming more aggressive.
  - 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.
- Example: You have a knife. Just because you have a knife does not mean that you are a criminal. It depends on what you do with the knife. Will you cut fruit with it, or use it to hurt someone? But just because those who killed had a knife, and you have a knife, doesn't mean that you will kill with it.
- So the evidence for high levels of serotonin leading to aggression is weak. This would be classified as an association, but not causal.
- Ask Students: Based on the evidence, is this association/correlation qat'i or zanni? [Zanni]

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

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- A study was done of half a million people by the UK Biobank and concluded that there is no single “gay” gene, so there is no specific gene.
- They found some associations, about 8-25%, but they were not able to pinpoint a 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 come based on actions; acting on that inclination results in sin.

- Ask Students: Based on the evidence here, is this association/correlation qat'i or zanni? [Zanni]

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- Watch: <https://www.youtube.com/watch?v=VIV7BCjZy8Y>
  - Robert Saploski - Harvard scholar - Determinist, says that free will is a myth; we are biological creatures, and all of our "choices" actually depend on biological forces.
  - Bill Nye - the Science Guy - Confused about the topic, says a little bit of both determinism due to conditions but there is still a level of choice.
  - Michio Kaku - Physicist - says there is uncertainty in regards to the position of electrons. In terms of free will, he feels that we do have some kind of free will.

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- Summary of the scientific view - Based on these 3 scholars
  - We can categorize genetic determinism into full determinism & partial determinism.
  - The interactions between genes & 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 about the laws of nature (i.e. we don't know everything).
- ❖ The scientific conclusion and the Islamic conclusion on determinism and free will are closely related in some regard.
  - Both state that we have a level of free will and some elements that are determined. Therefore, both views say that both determinism and free will happen/exist.
  - The Islamic theology aspect of determinism and free will is qati, whereas the scientific aspects are zanni and no definitive answer can be concluded.

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- ❖ Culminating Group Activity: **The Game of Life**
  - Divide the students into groups. Each group gets 20 square stickers and a sheet of grid poster paper.
  - Place these 20 square stickers strategically on the grid paper following the given rules.
  - Transport the positions of these stickers to the corresponding grid on [Play Game of Life](#).
  - When all the groups are done putting in their positions on the website, then press START to see how many squares are alive.
  - Document the number of live squares for each group.

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- ❖ Learning points from this activity: Discussion about the game and its relation to reality.
  - Watch: [https://www.youtube.com/watch?v=e7otJVE\\_p1Y](https://www.youtube.com/watch?v=e7otJVE_p1Y)
  - Significant points to discuss

- This game represents the topic of determinism and free will.
- What do we have a choice in? - where we placed the squares on the grid originally
- What aspect is determined? - the number of squares given originally (20), there is a set of rules
- In life, some aspects are determined and in some aspects, we have free will.
- The life continues whether we understand the rules or not.
- In the end, we are at the Mercy of ALLAH swt.

**Biology Connections:**

- This lesson pairs very closely with sections on genetics in biology courses. (In most Biology textbooks, this would be Unit 2 on Genetics. There are specific chapters on how genes are controlled and DNA technology intersects with Genomics.)
  - Genes and Alleles, genotypic and phenotypic traits, etc.
  - Gene function, gene expression (Transcription and Translation of DNA), and gene editing → activation and inhibition of genes
  - Proteomics and Epigenetics
- Nature vs Nurture