Genomics Education Programme

Health Education England

The Genomics Game

Print and play

v1.0

Contents

Using this print and play

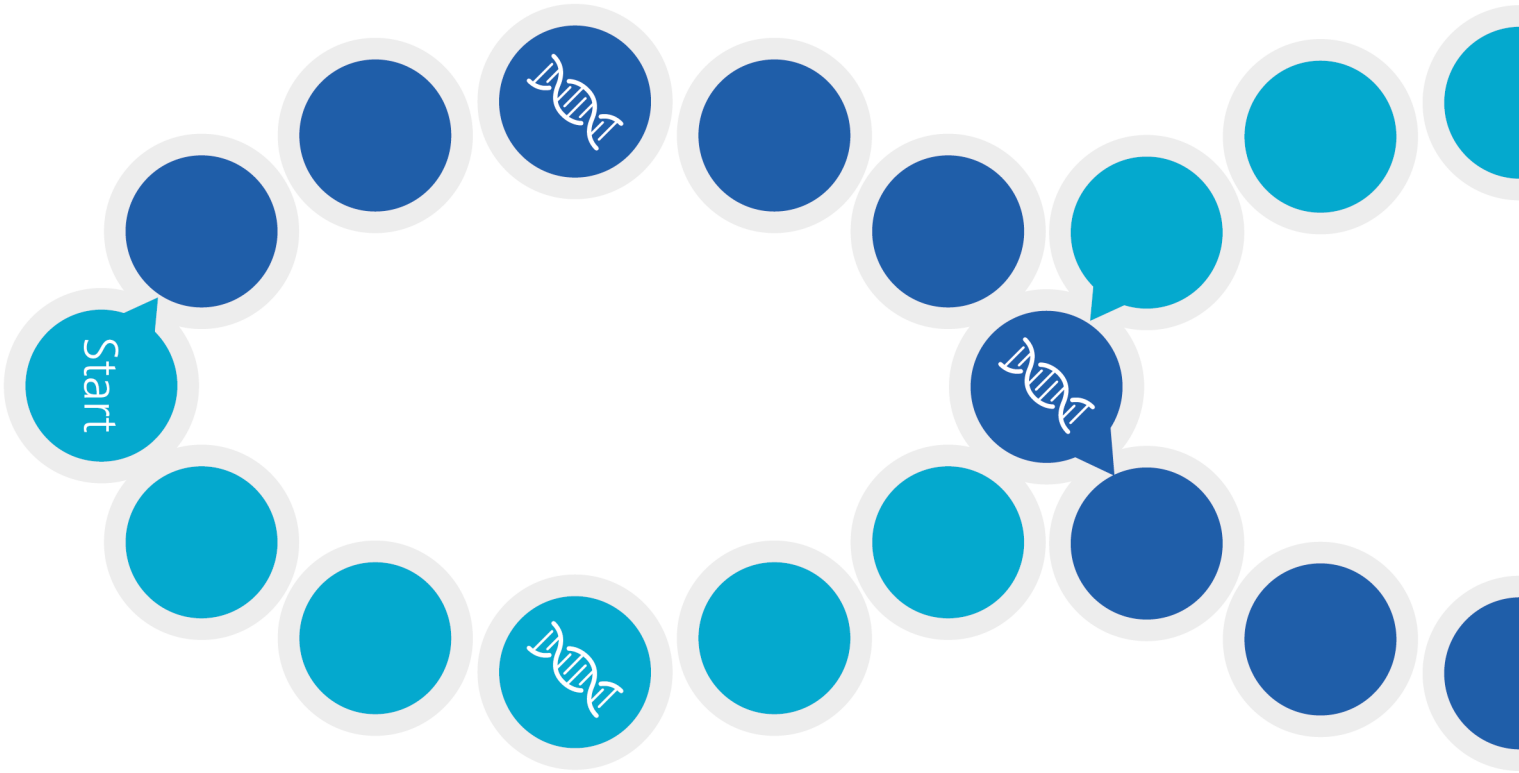
To play the Genomics Game, simply print out this document (A4 size, single-sided), and cut out all components along the dotted lines. Then follow the instructions for set up as outlined in the relevant section.

Note: We recommend laminating the board, instruction sheet, cards and tokens to make your copy of the game more durable. A six-sided die is recommended, but not provided.

For more information about the Genomics Game, email us:
genomicseducation@hee.nhs.uk

For more genomics teaching and learning resources, visit our website:
www.genomicseducation.hee.nhs.uk

GENES



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Game rules

Aim of the game

Answer questions to earn GENES tokens and cover up all five letters on your team's side of the gameboard. The first team to cover up all five letters wins!

Before you play

If this is the first time using this print-and-play document

Carefully cut out the components. These will include **two team tokens** (one for each team: A-T (purple) and C-G (orange)), **ten GENES tokens** (five for each team) and the numbered **question cards**. Cut out the six numbered squares and shuffle them to use instead of a six-sided die if you don't have one.

A timer is recommended, but not essential. Many devices, including smartphones, have built-in timers that you can use.

Setting up

1. Sort the question cards into a pile in numberical order (with the highest number on the top). The card number is indicated at the bottom right-hand corner of each card (e.g. GG-038). Do not shuffle the question cards! Place the pile face-down on the table next to the board (the card on top of the facedown deck should be GG-001).

2. Each team selects a team token (Team A-T or Team C-G) and places it on the 'START' space on the gameboard.

3. Each team takes the five GENES tokens of their team's colour, and places them next to the gameboard.

4. Each team then rolls the die (or flips over one of the numbered squares). The team with the highest number goes first. In the event of a tie, keep going until one of the teams has a higher number.

Game rules (continued)

Take a turn

Roll the die and move your **team token** forward by that number of spaces. Pieces always move in the direction of the arrows on the gameboard.

Now, look at the space you landed on.

1. If it is blank, then:

The other team draws a card from the top of the question card deck and reads the question out loud. Then, start the timer.

If your team gets the question right before the timer runs out, well done! You get another turn and roll the die again. Remember to read out the answer on the card out loud so everyone can learn a little more about genomics.

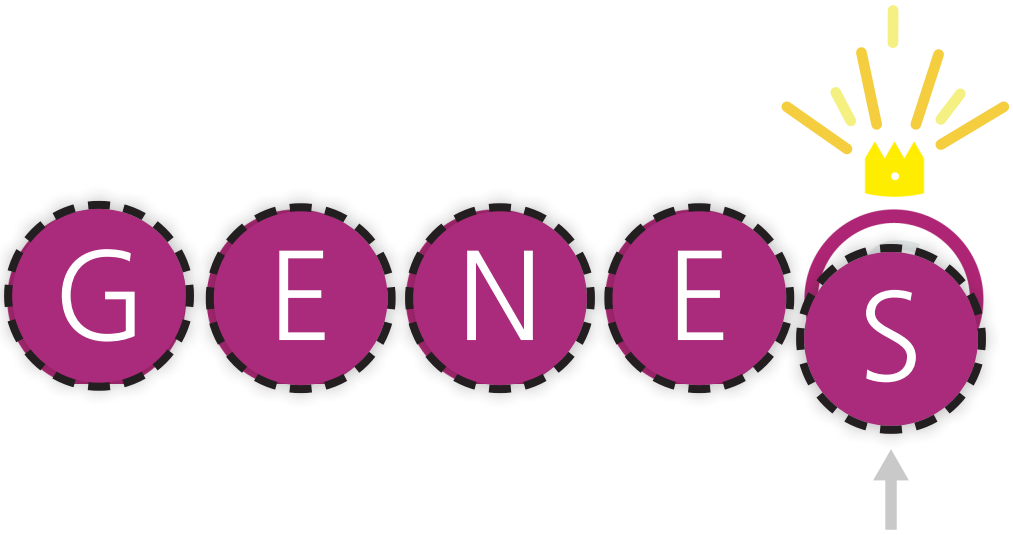
If your team gets the question wrong, or the timer runs out, then read out the answer, and the next team take their turn. Remember to put the question card at the bottom of the pile.

2. If it shows a DNA helix symbol, then:

The same thing happens (as in 1.), but if your team gets the question right, you get to place one of your **GENES tokens** onto one of the GENES spaces on your side of the gameboard, starting with 'G'.

End of the game

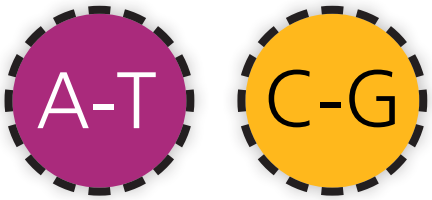
The first team to place all five of their GENES tokens onto the gameboard wins the game!



Tokens

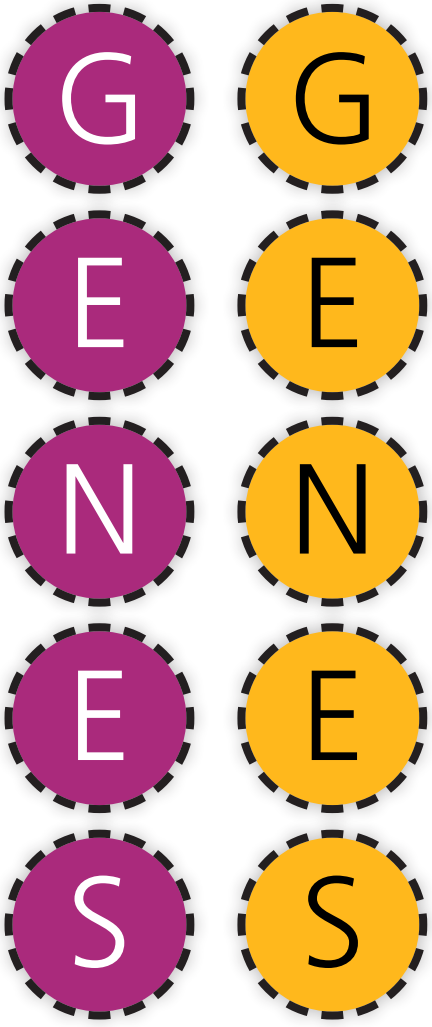
Team tokens (one per team)

For moving around the board



GENES tokens (five per team)

Place onto the ‘GENES’ spaces on your side of the board to win!



1

2

3

4

5

6

What is DNA?
A. A cleaning product
B. A molecule that contains genetic information
C. A molecule that carries oxygen

B is the correct answer.
DNA is how our genetic information is stored. It is made up of four chemical letters: A, T, C and G.

GG-001

In biology, what does DNA stand for?
A. Did not attend
B. Dominant nucleotide acid
C. Deoxyribonucleic acid

C is the right answer.
DNA stands for deoxyribonucleic acid. It is sometimes called 'the molecule of life' because it carries our genetic information.

GG-002

Where would you find your DNA?
A. In all of the cells in your body
B. In most of the cells in your body
C. In none of the cells in your body

B is correct.
DNA is found in nearly every cell in your body. There are exceptions, such as red blood cells (which do not have a nucleus).

GG-003

What are genes?
A. Specific sections of DNA
B. All the DNA in your cells
C. Energy providers for the cell

A is correct.
Genes are specific sections of DNA.

Genes contain the instructions to make molecules such as proteins, which are vital for our cells and bodies to function.

GG-004

What is a chromosome?
A. A tightly bundled molecule of DNA
B. A type of brightly coloured enzyme
C. Where proteins are made
D. The centre of a cell

A is the right answer.
A chromosome is a tightly bundled single molecule of DNA and associated proteins. It is how the DNA is organised in the nucleus of our cells.

GG-005

How many chromosomes do most human cells contain?
A. 23
B. 46
C. 92

B is correct.
Most human cells contain 46 chromosomes. They are arranged in 23 pairs and we get these equally from our parents: one half of each pair from our mother and one half of each pair from our father.

GG-006

True or false?
Genetics is the study of all an individual's DNA.

It's false.
Genetics is the study of individual genes. The study of all an individual's DNA is called genomics.

Sometimes genetics and genomics are used interchangeably but they have different meanings.

GG-007

What is a genome (gee-nome)?
A. A garden ornament
B. An organism's complete genetic material
C. A group of genes

B is the correct answer.
A genome describes an organism's complete genetic material. In humans, this is made of DNA. The human genome contains 3 billion letters of DNA. Each genome contains all the information needed to build that organism and allow it to grow and develop. Genomics is the study of genomes.

GG-008

Approximately how many protein-coding genes does the human genome have?
A. 20,000
B. 200,000
C. 2,000,000

A is correct.
The human genome contains around 20,000 protein-coding genes. These genes carry the instructions to make the thousands of proteins our bodies need.

GG-009

How much of your genome contains the instructions to produce proteins?
A. 2%
B. 32%
C. 82%

A is the right answer.
Less than 2% of the DNA in our genome contains the instructions to produce proteins. Our understanding of the other 98% is increasing. Once called 'junk DNA', we now know this is not the case, with parts of it being crucial to cell function.

GG-010

How much of your genome is the same as everyone else's genome?

A. 1%
B. 50%
C. 99.9%

C is the correct answer.
99.9% of our genomes are identical – only 0.1% is different. This may seem like a small amount, but this equates to 3 million changes in the 3 billion letters of our genome. Most of these variations cause no health problems but some can have serious consequences.

GG-011

True or false?
Some people have a perfect genome.

It's false.
There's no such thing as a perfect genome.

We all have variations in our genomes, but not all variation is bad. Most variations are linked to things like curly hair and blue eyes, not diseases. Variation is what makes each of us unique.

GG-012

Why do people want to study the genome?

A. Scientific research
B. Specific health reasons
C. Trace ancestry
D. All of the above

They are all correct.
The genome interests people for different reasons. In healthcare, we want to improve prediction, prevention, diagnosis and treatment of disease. For example, variations in our genome can indicate the likelihood of developing certain health conditions.

GG-013

In healthcare, the 0.1% variation in our genome can tell us whether someone:

A. Will develop a condition
B. Is more susceptible to a condition
C. Will react differently to a drug

All are correct.
The 0.1% variation in our genomes can tell us whether someone might develop or is more susceptible to a condition, or affect their reaction to different drugs. Research is ongoing to provide more effective, personalised treatments.

GG-014

To investigate an individual's genome, we need a sample of their DNA.

Name at least two types of material that we can obtain DNA from.

We have a copy of our genome in almost every cell in our body. So, in theory, DNA can be extracted from any material containing cells.

For example, hair roots, skin cells, bone marrow, blood, a tumour, faeces and saliva.

GG-015

What is genomic sequencing?

A. Creating new DNA in a lab
B. Reading an individual's genome
C. Putting DNA in alphabetical order

B is the right answer.
Genomic sequencing is used to read or map an individual's genome. It can be used to look at a small part of a genome or all 3 billion letters in a whole genome. Advances in technology mean we can now sequence a human genome in days for under £1,000.

GG-016

True or false?
Now that we've read the human genome, we know everything about it.

It's false.
We don't know everything about the human genome.

Our genomes are huge, very complex and each genome is different, so we don't understand everything about them. But we're learning more all the time.

GG-017

What term is used to describe the passing down of genetic information?

A. Inherited
B. Trait
C. Identity
D. Transmission

A is correct.
Inherited is the term used to describe a physical characteristic or condition shared between biologically related individuals.

GG-018

Which of these are genetically inherited conditions?
A. Cystic fibrosis
B. Tuberculosis
C. Huntington disease
D. Measles

A and C are correct.
Both these conditions are caused by genetic changes that are passed on from one or both parents.

GG-019

True or false?
Cancer is a disease of the genome.

It's true.
All cancers are a result of changes to our genome. In the majority of cases, these changes occur within a person's life but in some rare cases can be inherited.

GG-020

True or false?
Only humans have a genome.

It's false.
Every living organism has a genome, from bacteria to human beings – and even plants!

GG-021

Antibiotic resistance is linked to genomics.
Yes or no?

Yes, antibiotic resistance is due to changes in bacterial DNA.
These changes allow bacteria to adapt so they can survive the antibiotics designed to treat them. As a result, some antibiotics can no longer be used to treat certain infections.

GG-022

True or false?
Genomics is used in infectious disease outbreaks.

It's true.
Pathogens such as bacteria or viruses have a genome too. Genomics played an integral part in the Covid-19 pandemic. DNA sequencing allowed scientists to understand the virus causing the disease, provided information used to develop vaccines and allowed us to track new variants.

GG-023

The size of a change in our genome is directly linked to the potential impact it has on health.
Yes or no?

No, the size of a variation isn't linked to its potential effects or impact on health.
Changes to our genome that affect health can be very small (single DNA 'letter' changes) to very large (changes in chromosome structure).

GG-024

True or false?
Two patients have the same genetic changes that are known to be disease-causing. It is inevitable that they will present with the same symptoms.

It's false.
Individuals may have the same genetic changes, but this doesn't mean they will present with the same symptoms, or any symptoms at all. For some conditions, the same specific genetic changes are always responsible for the condition, for example, Down syndrome.

GG-025

True or false?
A patient's genomic information is the only factor considered for personalised medicine.

It's false.
Personalised (or precision) medicine describes treatment or care specifically tailored to the individual. Information such as current health, lifestyle and genomic factors are used to make sure the individual is receiving the right treatment, at the right time, at the right dose.

GG-026

What is pharmacogenomics?
A. A type of gene therapy
B. A genome-changing treatment
C. Tailored drug treatment using genomics

C is the right answer.
Genomic information can be used to tailor pharmaceutical therapies to suit each individual. The way our bodies respond to some drugs depends on our unique genome. By reading an individual's genome, we can give them the most effective drug and dose combination.

GG-027

In a clinical context, what is a family history?
A. Health information of an individual and their closest relatives
B. A doctor's photo album
C. Record of a family's hospital visits

A is correct.
It documents an individual and their close relatives' health information.
A family history is usually presented in a pictorial diagram known as a genetic family tree, or pedigree.

GG-028

A patient is worried their family has an inherited condition. What could be an appropriate first action?
A. Draw a genetic pedigree
B. Access the family's medical records
C. Meet with the patient's family

A is the right answer.
By drawing a genetic pedigree of an individual and their close family members, it may be possible to identify patterns that could indicate an inherited condition.

GG-029

The following four things can be recorded on a genetic pedigree. Which, though, is the least clinically important?
A. Biological relationships
B. Medical conditions
C. Names of family members
D. Deceased family members and age at death

C is correct.
Genetic family histories can be used to identify whether an inherited condition exists. For this reason, biological relationships, medical conditions and the age of family members that have died are important pieces of clinical information. Names of family members are less so.

GG-030

Which of the below are clinical clues that could suggest a genetic condition? (answer up to four)
A. An unusual presentation, for instance multiple symptoms
B. Young person with a condition that usually presents later in life
C. A step-parent who had the condition
D. A condition that 'runs' in families

All four are correct.
Many signs or symptoms are referred to as clinical clues (sometimes called 'red flags') that can indicate an inherited condition. As genetic information is shared between blood relatives, a step-parent with the condition would not be classed as a clinical clue.

GG-031

Why would the genome of an MRSA bacteria be sequenced during an outbreak?
Select all that are correct.
A. To identify how many people have been infected
B. To identify the source of the outbreak
C. To identify which antibiotic to use
D. To identify the type of bacteria

B, C and D are correct.
Genomics can reveal lots of information that can be used to control the spread and treat people affected. Sequencing the genome of a bacteria can not tell you how many people have been infected during an outbreak.

GG-032

True or false?
Angelina Jolie chose to have a double mastectomy based on a genetic diagnosis.

It's true.
Angelina Jolie's choice to undergo preventative surgery was based on a genetic test that revealed a variation in a gene that increased her chance of developing breast cancer.

GG-033

If you compared the genome from a cancer cell with the genome from a healthy cell, would they look the same?
Yes or no?

No, they wouldn't look the same.
Cancer occurs due to specific changes in the genome, which cause the cell to behave differently to a healthy cell. Therefore, if you looked at the genome in a cancer cell, it would look different to the genome from a healthy cell.

GG-034

What does the word 'familial' in 'familial breast cancer' mean?

A. The condition is related to diet
B. The condition occurs within a family
C. The condition is familiar in healthcare

B is correct.
The word familial means a condition that occurs within families or its members. Around 5-10% of breast cancers are thought to be due to an inherited variant. For instance, specific changes in a gene called *BRCA1* can increase the risk of developing breast cancer.

GG-035

An individual has bowel cancer. What would sequencing the tumour genome tell us?

A. If the cancer was inherited
B. The type of bowel cancer
C. Suitable treatment options
D. The stage the cancer is at

B, C and D are correct.
Sequencing the tumour genome can tell us a lot about the cancer, including its type, stage and potential treatments. Genomic sequencing of the person's 'healthy' DNA could help determine if the cancer is a result of an inherited gene variant.

GG-036

A patient's genomic information should always be handled sensitively.
Can you think of two ways in which sensitive data can be protected?

Practical methods of safeguarding information include:

- Firewalls and encryption.
- Storing data away from personal identifiers.
- Restricting and monitoring access to data.
- A robust consent process.

GG-037

True or false?
Results from a genetic or genomic test will only have clinical implications for the patient.

It's false.
As genomic information is shared between blood relatives, a result from a test may reveal a condition that could affect the patient's family or future offspring. Therefore, a genetic or genomic test can have a greater clinical impact than that of other tests.

GG-038

True or false?
Genomic tests are only available through the NHS.

It's false. Direct-to-consumer (DTC) testing kits can be bought by anyone. The results offer information about ancestry or the presence of variants linked to a number of conditions. They usually look for specific variants in some genes and interpretation of results is often not conclusive. You should always consult a healthcare professional to find out what the results really mean.

GG-039

GG-000

GG-000

GG-000