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Understanding Genetic Disorders: from DNA to disease



BIOS4YOU
AR 2.0

BIO-INSPIRED STEM TOPICS FOR ENGAGING YOUNG GENERATIONS
THANKS TO THE USE OF AUGMENTED REALITY

Project Number: 2023-1-DE03-KA220-SCH-000126516

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General information

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Name of the
exercise:

DNA Detective: From Mutation to Diagnosis” – Delightex AR
Diorama Mission

Description of the
exercises:

DNA Detective: From Mutation to Diagnosis is a mission-based AR learning activity created in Delightex as a static AR diorama with four zones. The activity is designed for students aged 14–18 (English level B1/B2) and is based on the learning unit “*Understanding Genetic Disorders – From DNA to Disease*”.

Students move through four connected AR rooms, explore visual objects, read short information panels, and complete tasks directly related to the content shown in the previous zone. All questions and texts used in the AR environment are fixed and identical to those described in this document

Sources used for scientific accuracy:

Wallis, G. A. (2018). *The genetic basis of disease*. Essays in Biochemistry.

<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6279436/>

National Human Genome Research Institute (NHGRI). (2024). *Genetic disorders (Fact sheets)*.

<https://www.genome.gov/Genetic-Disorders>

Participants:

Individual work on a personal device (smartphone/tablet).
Optional pair discussion after completion.

Participants’ age
range:

14–18 years

STEM subject and
specific topic:

Biology / Life Sciences

Topic: genetic disorders (single-gene, chromosomal, complex),
inheritance, genetic testing, bioethics basics





Gamification process:

Phase 1 – Briefing: Intro panel with mission goal.
Phase 2 – 4-zone investigation: Students complete tasks in each zone.
Phase 3 – Rewards + Exit ticket: Badges + short reflection.

Badges (icons):

- Mutation Spotter (Zone 1)
- Inheritance Solver (Zone 2)
- Chromosome Expert (Zone 3)
- Clinic Consultant (Zone 4)

Written or graphic description of Augmented info:

The augmented information is delivered through a static AR diorama built in Delightex. The diorama consists of four connected rooms (zones). Each zone contains text panels, visual objects, and interactive answer panels. Students interact with the content by tapping panels and selecting answers. Feedback appears directly in the AR scene.

Zone 1 – Mutation Scan (DNA)

Augmented elements:

- 3D DNA double helix model
- Introductory information panel
- Definition panel about mutations

Texts used in the AR scene:

Intro panel (center):

Welcome, DNA Detective!
Explore the genetics lab.
Start with DNA and learn how a mutation can cause disease.
Tap hotspots and answer the questions.

Information panel (left):

What is a mutation?
A mutation is a change in the DNA sequence.
DNA is made of four letters: A, T, C and G.
When one letter changes, the gene may not work correctly.





This can affect how the body functions.

This zone introduces the core concept of mutations and prepares students for the task-based zones that follow.

Zone 2 – Question Room: Mutation Check

Augmented elements:

- Blackboard-style question panel
- Three answer panels
- Feedback panel for incorrect answers

Question text (center board):

What is a mutation?

Answer panels (right side):

- **A:** A change in the DNA sequence
- **B:** A disease
- **C:** A chromosome

Feedback panel (appears if wrong answer is chosen):

Not quite.

Read the definition of mutation again (previous scene).

This zone checks understanding of the definition presented in Zone 1. The question directly depends on the previous information panel.

Zone 3 – Chromosome Check

Augmented elements:

- 3D chromosome models
- Two option panels
- Feedback panel

Question text (center board):

Chromosome check:

Which chromosome set shows a chromosomal disorder?





Option panels:

- **Option A:** 46 chromosomes
- **Option B:** 47 chromosomes

Correct feedback panel:

Correct! This set has an extra chromosome.

Incorrect feedback panel:

Not quite. Look for an extra chromosome.

This zone focuses on recognising chromosomal disorders by comparing chromosome numbers.

Zone 4 – Patient Case & Ethics

Augmented elements:

- Patient case panel with image
- Yes / No ethics question
- Final mission completion panel

Patient case text:

PATIENT CASE: The patient has frequent lung infections and thick mucus. Doctors discovered a change in one gene.

Ethics question panel:

Should genetic test results be kept private?

Answer panels:

- **Yes**
- **No**

Final panel (appears after interaction):

Mission Complete!

You have successfully completed the DNA investigation.

You explored mutations, analyzed chromosomes, and made the right decisions.

Great job, Detective!





External (or extra)
tools required

Links (video,
images, text online
and so on).

Delightex (main): <https://edu.delightex.com>

Optional: Molecular / Genome AR only as model sources (if you already use them).

NHGRI Genetic Disorders: <https://www.genome.gov/Genetic-Disorders>

Wallis (2018) full text:
<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6279436/>





Pedagogical specifications

How can this augmented information be used to address a STEAM topic in a more interesting way for students?

Students actively apply biological knowledge by analysing visual genetic information and making decisions based on previous evidence. The AR format supports inquiry-based learning and cause–effect reasoning.

Which pedagogical objectives are addressed through this scenario?

Understand what a genetic mutation is
Distinguish between gene mutations and chromosomal disorders
Apply knowledge from one task to the next
Reflect on ethical aspects of genetic testing

Which results are expected to be reached with its use?

Correct identification of mutations and chromosomal abnormalities
Improved understanding of genetic terminology
Increased engagement through interactive AR tasks

Which benefits are expected to be reached with its use?

High learner motivation
Visual support for abstract biological concepts
Clear learning progression across zones





Technical specifications

AR INFORMATION

Technology

Delightex (authoring + playback): <https://edu.delightex.com>

If it's needed a marker, description of the marker

The AR activity is primarily markerless and uses plane detection to place the scene on a desk or floor.

If a marker is required due to device limitations, a simple high-contrast A4 marker (for example, a black frame with a central icon) can be used to ensure stable AR placement.

<https://edu.delightex.com/YQT-FXG>





Hardware

and software
needed:

Type of Augmented
data

Written description
of the AR data

a

Teacher: PC/laptop to build the Delightex diorama (projector optional).

Students: smartphone/tablet with camera (iOS/Android), internet for loading.

Text (instructions, questions, feedback, reflection prompts)

Images and icons (badges, feedback icons)

3D models (DNA helix, family tree board, chromosomes/karyotype, protein model, patient case card)

Optional audio cues (not required)

Students open the Delightex scene **“DNA Detective (4 Zones)”**. The activity is presented as a **static AR diorama** placed on a desk or floor.

The diorama consists of **four clearly separated zones**, each containing:

- 3D objects
- Information panels
- Interactive hotspots
- Quiz panels with immediate feedback

All texts, questions, and feedback messages used in the AR environment are **identical to those described below**.

Intro panel (appears first in Delightex)

Panel

title:

Welcome, DNA Detective!

Text (exact):

Explore the genetics lab and complete the investigation.

Tap hotspots, read the information, and answer questions to identify genetic disorders and understand how mutations affect health.





Zone 1 — Mutation Scan (DNA and Gene)

3D objects

- DNA double helix
- Highlighted gene segment

Hotspot text (exact)

A mutation is a change in DNA letters (A, T, C, G).
It can change a protein and cause disease.

Multiple-choice questions (shown on panels)

- Q1. What is a mutation?**
- A. A change in DNA sequence
- B. A type of cell
- C. A vitamin

Feedback:

- Correct: *Correct! Good observation.*
- Incorrect: *Try again. Look at the DNA letters.*

Q2. Why can a mutation cause disease?

- A. It can change a protein
- B. It always improves health
- C. It removes all chromosomes

Feedback:

- Correct: *Correct! Mutations can affect proteins.*
- Incorrect: *Try again. Think about protein function.*

Badge unlocked: *Mutation Spotter*

Zone 2 — Family File (Inheritance Patterns)

3D objects

- Family tree board





- Icons for carriers and affected individuals

Hotspot text (exact)

Some mutations are inherited.
Traits can be dominant or recessive.

Tasks

Short-answer prompt (panel):

Look at the family tree.
Who is a carrier? Write the person's letter.

Q3. A recessive disorder appears when:

- A. A person has two mutated copies
- B. A person has an extra chromosome 21
- C. A person is stressed

Feedback:

- Correct: *Correct! Recessive traits need two copies.*
- Incorrect: *Not quite. Read the family tree again.*

Badge unlocked: *Inheritance Solver*

Zone 3 — Chromosome Check (Karyotype)

3D objects

- Chromosome set / simplified karyotype
- Highlighted chromosome 21

Hotspot text (exact)

Chromosomal disorders happen when a chromosome is extra, missing, or changed.

Interactive questions

Q4. Down syndrome is usually caused by:

- A. Three copies of chromosome 21
- B. A mutation in one gene only





C. Lack of oxygen

Feedback:

- Correct: *Correct! This is called trisomy 21.*
- Incorrect: *Look again at chromosome 21.*

Tap task (panel text)

Tap the correct chromosome set.

Options shown in AR:

- Normal set (46 chromosomes)
- Trisomy set (47 chromosomes)

Badge unlocked: *Chromosome Expert*

Zone 4 — Patient Case (Diagnosis + Ethics)

3D objects

- Patient case card
- Protein model (normal vs changed)

Case text (exact)

Patient A has frequent lung infections and thick mucus.
Doctors found a change in one gene.

Questions

- Q5. This condition is most likely:**
- | | | | |
|----|-----------------------|----------|-------------------------------------|
| A. | Single-gene | disorder | <input checked="" type="checkbox"/> |
| B. | Chromosomal | disorder | |
| C. | Complex disorder only | | |

Feedback:

- Correct: *Correct! One gene is affected.*
- Incorrect: *Think about the type of genetic change.*

Justification prompt (panel)





Explain your choice.

Use: “Because...”

Ethics reflection (same zone)

Panel text (exact):

Should genetic test results be private?

Write one reason.

Final panel (Exit ticket)

Title:

Mission Complete!

Text (exact):

Write 2–3 sentences:

One new thing you learned about genetic disorders.

One ethical question you still have.

If Image

Badge icons (4)

“Correct / Try again” feedback icons

Optional pedigree image

Optional karyotype image

If Text

All instructional texts, questions, and feedback listed above.

If video

Optional short 30–60s “How to use the diorama” clip.

If audio

Optional short sound cue for correct answers.

If 3D model

DNA helix; gene highlight; family tree board;
chromosomes/karyotype; protein model; patient card panel

Formats: .obj, .stl, .glb/.gltf





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