Co-funded by
the European Union

Decoding the Human Genome

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

KIT Karlsruher Institut für Technologie · ktu kaunas university of technology · Università degli Studi di Palermo · CEIPES · Eduact

Co-funded by
the European Union

Table of Contents

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

Co-funded by
the European Union

General information

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

Co-funded by the European Union

Name of the exercise:	"Genome Quest" – AR Exploration with Assemblr EDU and Gimkit
Description of the exercises:	"Genome Quest" is a blended interactive learning activity combining a gamified vocabulary quiz (Gimkit) with an augmented reality (AR) exploration created in Assemblr EDU. The exercise is based on Section 1: Explore – From Genes to Complexity of the learning unit *Decoding the Human Genome*. Students first complete a Gimkit quiz to check their understanding of key concepts from the text. They then apply this knowledge in an AR environment, where they explore genomic elements and answer conceptual questions embedded directly in the AR scene. Using their mobile devices (phones or tablets), learners interact with three-dimensional genomic models, tap hotspots, and respond to multiple-choice questions related to: the human genome and DNA, coding and noncoding regions, regulatory elements (promoters and enhancers), chromatin and gene regulation, the goals and discoveries of the ENCODE Project. Immediate feedback is provided during both the Gimkit and AR phases. After completing the AR task, students receive a final message encouraging reflection.
Participants:	Individual participation on a personal device (smartphone or tablet). Optional pair or group discussion after completion to compare answers and reasoning
Participants' age range:	14–18 years
STEM subject and specific topic:	Biology / Life Sciences Topic: Human Genome Project and ENCODE

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

Co-funded by the European Union

Gamification process:	Phase 1 – Gimkit (pre-AR check): A short multiple-choice Gimkit quiz (based on the Explore text) reinforces key vocabulary and concepts before entering the AR environment. Phase 2 – Assemblr EDU (AR application): An AR-based quiz with 5 multiple-choice questions embedded in a 3D genomic scene. ● Correct answer → positive visual feedback (“Correct!”) ● Incorrect answer → short prompt (“Try again!”) ● Completion → final congratulatory message and reflection prompt
Written or graphic description of Augmented info:	Pre-AR Knowledge Check (Gimkit) - Before entering the augmented reality environment, students complete a short gamified quiz using Gimkit. This activity is based exclusively on the Explore section of the learning unit and serves as a formative knowledge check. Purpose of the Gimkit activity: to reinforce key vocabulary and concepts related to the Human Genome Project and ENCODE; to ensure students are familiar with core terms (e.g., genome, gene, noncoding DNA, promoter, enhancer, chromatin); to prepare learners cognitively for the AR-based exploration. Gimkit activity design ● Format: multiple-choice quiz ● Number of questions: 10–12 ● Question focus: factual and conceptual understanding from the Explore text ● Feedback: immediate automated feedback after each question Transition to AR - After completing the Gimkit quiz, students are instructed to open the Assemblr EDU AR activity “Genome Quest”, where they apply their knowledge through interactive exploration and AR-based questions. AR flow and interaction design (Assemblr EDU) The AR experience is designed as a static AR diorama rather than a moving avatar-based game. This supports clarity, accessibility,

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

and ease of interaction for secondary school students.

Opening AR screen - Intro panel text: “Welcome to Genome Quest! Explore the AR scene and answer 5 questions about the Human Genome Project and ENCODE. Tap each hotspot to begin.

AR scene structure: Central 3D object: DNA double helix. Additional AR elements placed around the DNA:

- Protein-coding gene
- Promoter
- Enhancer
- Noncoding RNA region
- Chromatin fiber

Each object includes: a short explanatory text (hotspot); one embedded multiple-choice question.

Question display: Questions appear in Assemblr EDU quiz panels linked to hotspots. Each panel contains:

- one question;
- three answer options (A, B, C);
- automatic feedback provided by the platform.

Optional visual support: Question header text (e.g., *“Q3 / Q5”*) displayed above the object using 3D text. High-contrast colours to ensure readability on mobile devices.

Feedback design

Correct answer: Short confirmation text (“Correct!”) with a positive visual cue.

Incorrect answer: Short message (“Try again!”) allowing the learner to reattempt or move forward.

Feedback duration kept brief (1–2 seconds) to maintain learning flow.

Final AR screen

Info panel title: *Results*

Message: *“Great job! You completed Genome Quest. Think: how do noncoding regions influence health and disease?”*

Optional extension: QR code or link to a short written reflection or

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

	exit ticket.
External (or extra) tools required	**Assemblr EDU** – AR authoring and playback (mobile devices) **Gimkit** – vocabulary and concept check based on Explore section Mobile devices (smartphones or tablets) with camera and internet access
Links (video, images, text online and so on).	

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

Co-funded by
the European Union

Pedagogical specifications

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

The augmented information used in this learning scenario transforms abstract genomic concepts into interactive, spatial, and visually accessible experiences, making the STEAM topic of genomics more engaging for students. Topics such as DNA organization, noncoding regions, regulatory elements, and chromatin structure are typically difficult to understand through text alone due to their microscopic and dynamic nature.
By integrating Augmented Reality (AR) through Assemblr EDU, students are able to explore three-dimensional representations of genomic elements and observe their relationships within a shared biological system. This immersive approach allows learners to actively interact with scientific content rather than passively consuming information. The use of Gimkit as a preparatory gamified quiz further increases engagement by introducing competition, immediate feedback, and motivation prior to AR exploration.
Together, these tools support an interdisciplinary STEAM approach by combining:
Science (genomics and molecular biology),
Technology (AR platforms and mobile devices),
Engineering thinking (system-based understanding of genome regulation),
Arts (visual design, spatial representation, and colour-coded models),
Mathematics (pattern recognition, sequencing logic, and structured reasoning).
This combination increases student curiosity, attention, and willingness to explore complex scientific ideas.

Which pedagogical objectives are addressed through this scenario?

This scenario addresses the following pedagogical objectives:
to develop students' understanding of the structure and functional organization of the human genome;
to explain the difference between coding and noncoding DNA and their roles in gene regulation;
to introduce the scientific purpose and key discoveries of the ENCODE Project;
to support conceptual understanding of chromatin structure and regulatory interactions;
to promote inquiry-based and experiential learning through AR interaction;
to strengthen scientific vocabulary and conceptual accuracy through gamified formative assessment;
to develop digital competence and responsible use of emerging technologies in science education;
to encourage critical thinking and reflection on the role of genomics in health and disease.

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

Co-funded by
the European Union

Technical specifications

Which results are expected to be reached with its use?

The expected results of implementing this scenario include:

- improved comprehension of complex genomic concepts, especially gene regulation and noncoding DNA;
- increased ability to correctly use scientific terminology related to genomics;
- enhanced student engagement and motivation during science lessons;
- improved retention of knowledge through multisensory and interactive learning;
- successful application of theoretical knowledge in an AR-based environment;
- increased student confidence when discussing modern genetic research and its applications.
- Students are expected to demonstrate these results through:
- accurate responses in the Gimkit quiz;
- correct completion of AR-based questions in Assemblr EDU;

Which benefits are expected to be reached with its use?

The use of augmented information in this learning scenario provides several educational benefits:
Pedagogical benefits: AR supports deep conceptual understanding by making invisible biological processes visible and interactive. Gamification reduces cognitive overload and supports incremental learning.
Motivational benefits: Interactive and immersive elements increase student interest and active participation, particularly among learners who may struggle with traditional text-based instruction.
Inclusivity and accessibility benefits: Visual and spatial representations support diverse learning styles and allow students to progress at their own pace.
Digital competence development: Students gain experience using digital tools for learning, enhancing their readiness for future academic and professional contexts.
Relevance to real-world science: The scenario connects classroom learning to authentic scientific research, highlighting the importance of genomics in medicine, biotechnology, and society.
Overall, the scenario demonstrates how thoughtfully designed augmented information can enrich STEAM education by combining scientific accuracy, pedagogical effectiveness, and digital innovation.

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

Co-funded by
the European Union

AR INFORMATION

Technology

Gimkit – gamified formative assessment based on the *Explore* section
https://www.gimkit.com

Assemblr EDU – creation and playback of the augmented reality learning activity
https://assemblrworld.com

Optiona- https://edu.delightex.com/PFG-KCK

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

The AR activity is primarily markerless, using 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 (e.g., black frame with central icon) can be used to ensure stable AR placement.

https://www.gimkit.com/view/6941b934922dae39fa75194e

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

Co-funded by
the European Union

Hardware and software needed:	Teacher: PC or laptop to design the AR experience in Assemblr EDU Students: Smartphone or tablet with camera (iOS or Android, AR-enabled). Internet connection for initial loading of the AR content and Gimkit activity
Type of Augmented data	Text: instructions, explanations, questions, and feedback messages Images: simple icons for correct / incorrect feedback 3D models: DNA double helix, simplified genomic elements (gene, promoter, enhancer, chromatin) Optional: short sound cues for feedback (non-essential)

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

"Funded by the European Union. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or the European Education and Culture Executive Agency (EACEA). Neither the European Union nor EACEA can be held responsible for them."

Co-funded by
the European Union

Written description of the AR data	Students begin the learning sequence with a short Gimkit quiz based on the *Explore* section of the unit. This gamified activity reinforces key vocabulary and conceptual understanding before entering the AR environment. After completing Gimkit, students open the Assemblr EDU activity “Genome Quest” on their mobile device. The AR scene is placed on a desk or floor using the device camera. The experience is designed as a static AR diorama, ensuring clarity and ease of interaction. At the center of the AR scene, students see a 3D DNA double helix, surrounded by additional genomic elements such as a protein-coding gene, promoter, enhancer, noncoding RNA region, and chromatin fiber. Each element contains a hotspotwith a short explanation and one embedded multiple-choice question. Students tap hotspots to read information and answer questions directly within the AR interface. Each response triggers immediate feedback: ● Correct answer: brief positive confirmation (“Correct!”) ● Incorrect answer: short prompt (“Try again!”) The AR environment focuses on clear visuals and concise text to avoid cognitive overload. After completing all five AR questions, a final information panel appears with a congratulatory message and a reflection prompt linking the activity to classroom discussion. The activity is carried out individually, ensuring active participation. It can be followed by a group discussion where students compare answers and address misconceptions.
If Image	-
If Text	Text contest in GimKit **Question 1** What is the human genome? A. A group of human cells B. All the genetic information in DNA (correct) C. A type of protein **Question 2** Which molecule carries genetic information? A. DNA (correct) B. Protein C. Fat **Question 3** What is DNA made of? A. Proteins and lipids

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

Co-funded by
the European Union

B. Four types of nucleotides (correct)
C. Amino acids only

Question 4 Where is DNA found in human cells?
A. In the nucleus (correct)
B. In the cell membrane
C. In the cytoplasm only

Question 5 What is a gene?
A. A whole chromosome
B. A DNA sequence that gives instructions for a protein (correct)
C. A type of cell

Question 6 About how many protein-coding genes do humans have?
A. About 1,000
B. About 21,000 (correct)
C. About 100,000

Question 7 Why did scientists find this number surprising?
A. Humans have more genes than all animals
B. Humans have a similar number of genes as simpler organisms (correct)
C. Humans have no noncoding DNA

Question 8 Which part of DNA does NOT code for proteins?
A. Coding DNA
B. Noncoding DNA (correct)
C. Mitochondrial DNA

Question 9 What is the main role of noncoding DNA?
A. To store energy
B. To regulate gene activity (correct)
C. To build proteins

Question 10 What is an enhancer?
A. A protein that cuts DNA
B. A DNA region that increases gene expression (correct)
C. A type of RNA

Question 11 What was the main goal of the ENCODE Project?
A. To find new human diseases
B. To identify all functional parts of the genome (correct)
C. To count human genes

Question 12 Why are noncoding regions important?
A. They help control when genes are active (correct)
B. They change the DNA sequence
C. They make new chromosomes

Text content used in AR

Intro panel: “Welcome to Genome Quest! Explore the AR scene

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

	and answer 5 questions about the Human Genome Project and the ENCODE Project. Tap each hotspot to begin." Sample AR questions: **Question 1**: Which molecule stores genetic information? ● DNA (correct) ● Protein ● Lipid **Question 2**: What is the shape of DNA? ● Double helix (correct) ● Single strand ● Triple helix **Question 3**: What was the main goal of the ENCODE Project? ● To study only protein-coding genes ● To identify all functional elements in the genome (correct) ● To investigate only human diseases **Question 4:** What is an enhancer? ● A DNA region that increases transcription (correct) ● A protein that cuts DNA ● An enzyme that makes RNA **Question 5:** Why are noncoding regions of DNA important? ● They are useless "junk DNA" ● They regulate gene expression and chromatin structure (correct) ● They code for enzymes **Final AR panel** *"Congratulations! You completed Genome Quest. Which part of the genome surprised you most?"*
If video	-
If audio	-

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

Co-funded by
the European Union

If 3D model	The formats needed are: .obj, .stl, .glb / .gltf

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

Co-funded by
the European Union

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