SCoPE

Scientists' Collaborative Project with Educators

TEACHER NOTES - UNLOCKING GENE EDITING

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Toolkit Overview

This is a hands-on problem-solving game that is modelled on the idea of an 'escape room'. Students are presented with a fictional scenario in which they are required to solve a series of logical puzzles (related to biology) that reinforce concepts they've already been taught (e.g. transcription and translation). Students should work in teams of 3-4.

In addition to this document, the Gurdon Institute will provide the physical kits (1 for each group of 3-4 students), a Risk assessment, a PowerPoint introduction to the game with a discussion guide for the end of the activity, and laminated clean up instructions for students to use after the game. The PowerPoint is essential for setting up the scenario and explaining the game to the students.

The following information is presented in the PowerPoint for students too, but it's also important for you to know that the scenario presented in the game is **fictional**. In the game, a researcher at the Gurdon Institute has come up with a cure for a specific type of Alzheimer's using gene editing (specifically, CRISPR-Cas9). While the CRISPR-Cas9 technique for gene editing has revolutionised biology research in the last few years and has already been used to treat some human diseases, a cure for Alzheimer's Disease has not yet been identified. CRISPR-Cas9 could offer a new approach to treating this disease (and others). A group at the Gurdon Institute (now recently moved to the Great Ormond Street Institute of Child Health at UCL) has been working on Alzheimer's for 18 years, studying brain development and degeneration. Two of the scientists who helped develop this activity were working in this research group.

Curriculum links

This activity provides a review of transcription and translation and the structure of DNA. Before attempting the activity, students should understand:

- The structure of DNA/RNA
- How to relate a DNA/RNA base sequence to an amino acid sequence

The activity also provides a brief introduction to gene editing and the CRISPR-Cas9 technique.

Preparation (pre-lesson)

Read through the Introductory Presentation and the Risk Assessment we've provided.

If you have time, we also recommend having a go at working through the puzzles yourself so you have an idea of where students might get stuck/need hints and so you know what to expect from the activity. All of the answers are provided on page 11.

You need to ensure that each team (of 3-4 students) has access to a laptop with a classic-style USB port that can connect to the internet.

We also recommend that each team have paper and pen for making notes during the game.

Instructions for running the activity in-lesson

1. Go through the **'Introductory Presentation'** with the class. This includes:

- Information about how the game was created
- **the rules;** please be sure to emphasise:
  - that students do not need to use physical force for any aspect of the game
  - students are not to share answers or objects between teams
- **a crucial introduction** to the game which sets up the scenario and gives a few hints to get the students started
- **important debrief information** – we have created a fictional scenario that is related to research at the Gurdon Institute and feel it is critical to explain how this scenario relates to real science research that is happening currently
- debrief questions to generate a class discussion (if time allows)

- **Instructions for cleaning up** so the kits are ready for the next group of students to use
    - **NOTE**: each group will have a different colour kit (e.g. red, orange, green and blue) and all of the items will be tagged with a small sticker of the corresponding colour. Look for these stickers if items from different kits get mixed up during the game.

2. While the game is happening, please monitor students' behaviour to ensure the environment stays safe (see the Risk Assessment we provided) and the rules (from the PowerPoint) are being followed.

3. In case students stuck, we have included an answer key and a game flow chart on the last pages of this document. However, before simply giving the answer, encourage students to check their work. If, for example, students are unable to unlock a lock, ask them to check that they are lining the numbers up at the correct part of the lock.

4. After the game is completed, you may choose to lead a discussion about the ethics of gene editing and/or review any of the concepts that came up in the game.

5. At the end, encourage each group to put away all of the materials that came in their bags. Each bag will have its own coloured dot stickers on everything that is part of the kit. Please be sure that items don't get mixed between kits, especially if you plan to run the activity multiple times with different classes. We have provided instructions for clean up at the end of this document, in the PowerPoint file and on laminated sheets you can hand out to each team as they finish the game.

Safety considerations

There are only a few safety considerations you need to be aware of:

1. The classroom could become messy during the game, as each kit contains numerous items that could easily end up on the floor and get tripped over. Please keep an eye out for items that could become trip hazards. You should emphasise that once something has been used in the game, it won't be used again and could be put back in the back into the bag.
2. Part of the game involves using a UV torch to find hidden messages. UV light can harm eyes if stared into for a prolonged period of time and does not induce the same natural reaction to squint or look away. Please make sure that students don't shine the UV torches into anyone's face or eyes.
3. Each kit includes 19 amino acid puzzle pieces, each of which has two 0.8mm diameter magnets that have been superglued into recessed areas on the pieces. Though small, these are stronger than normal magnets of the same size. If the magnets come loose, they pose several safety risks that you need to be aware of:
    - They can cause nips, blood blisters and other tissue damage (especially if ingested).
    - They could cause an allergic reaction in anyone with a nickel allergy if exposed for a prolonged period of time (e.g. if ingested).
    - They could chip or shatter into sharp pieces if smashed together.
    - Strong magnets could also affect pacemakers, CRT monitors and televisions, credit cards, diskettes, or any other magnetically stored data (e.g. computers, hard drives, phones).

More details are included in the risk assessment document which has also been provided. Before running the activity, you should read through the full risk assessment and ensure the activity is in line with your school's safety standards.

Return shipping

When you booked your kit(s), you will have provided a return date. One working day before your return date, we will arrange for a courier to come to collect the kit(s) from your school. Please ensure that everything is packed up and ready for our courier to collect. We will email a label for you to print and attach to the case for the courier.

Please contact the Gurdon Institute's Public Engagement team with any questions: public-engagement@gurdon.cam.ac.uk

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Equipment & Cleaning Up

NOTE: Each kit is designed for a group of 3-4 students.

Provided by the school:

- Projector to display the introductory presentation (needs sound!)
- 1 computer for each group of 3-4 students. **The computer must be connected to the internet and have a classic (old-style) USB port.**

Provided by the Gurdon Institute:

- Introductory presentation (PowerPoint file, downloaded from SCoPE website)
- Each kit includes:
    - 1 backpack
    - 1 Gurdon Institute branded reusable plastic water bottle*
    - 1 Gurdon Institute branded keychain torch (attached to outer zipper)*
    - 1 scientific research paper entitled 'The genetic landscape of Alzheimer disease: clinical implications and perspectives'
    - 1 'Internal Use Only' envelope*
    - 3 laminated sheets of a 'genetics test'
    - 1 Gurdon lab notebook with a photo of a lab stapled on the first page*
    - 1 Falcon tube containing 3 AAA batteries
    - 1 UV flashlight
    - 3 pipette tip boxes with labels:
        - DNA to DNA
        - Lost in translation
        - Right a wrong
    - 4 locks:
        - 1 date lock (on 'BLAST' box)
        - 1 small Abus 3-digit lock (on 'Right a wrong' box)
        - 1 LWD 3-digit cable lock (on 'Lost in translation' box)
        - 1 Silverline 3-digit clip lock (on extra small tissue culture flask inside 'DNA to DNA' box)
    - 1 extra small tissue culture flask
    - 1 3D printed bottle lock for extra small tissue culture flask
    - 1 small USB stick (inside the extra small tissue culture flask, attached with wire to the lid)
    - 1 large tissue culture flash (with orange or blue lid)*
    - 2 small Eppendorf tubes (inside the medium tissue culture flask)*
    - 15 amino acid puzzle pieces
    - 4 extra fine whiteboard markers with erasers attached to lids
    - 1 'amino acid reader' machine
    - 1 USB power cable for amino acid reader machine
    - 2 pipette tip organisers*
    - 1 plastic 30cm ruler*
    - 25 laminated cards:
        - 4 lost in translation clues (wildtype sequence and mutant sequence)
        - 3 lost in translation codon wheels
        - 3 DNA to DNA instructions (comparing DNA sequences and Interpreting results)
        - 3 (additional) codon wheel (inside 'Right a wrong' box)
        - 9 CRISPR clue cards (inside 'Right a wrong box')

*These items are not part of any puzzles/do not have any clues.

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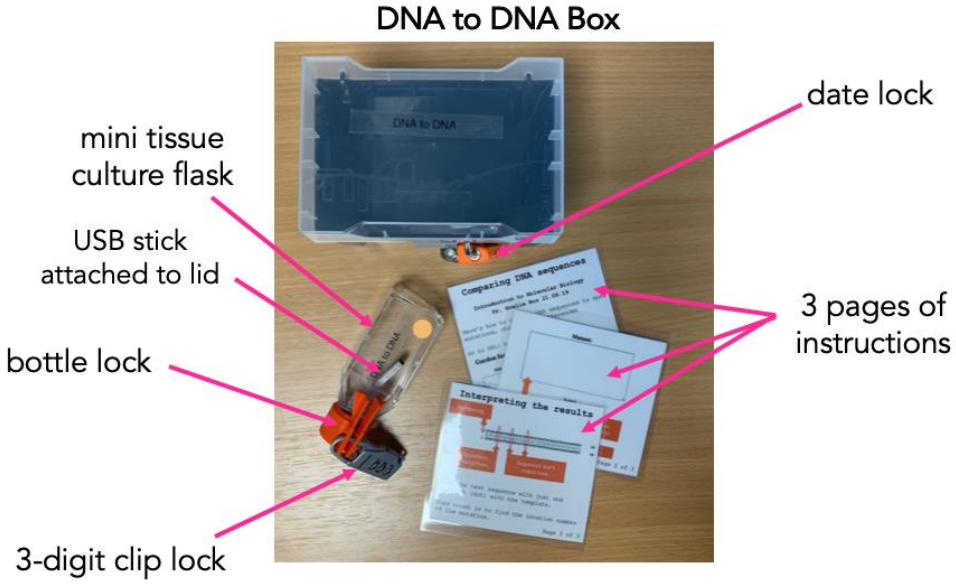
Cleaning Up – Photo instructions



DNA to DNA Box

Make sure that you don't leave the locks aligned so they can easily be opened again.

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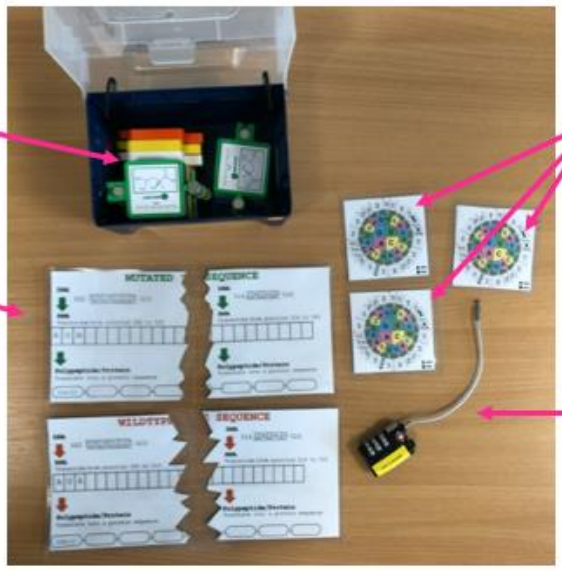
'Lost in translation' box – part 1



'Lost in translation' box – part 2

To close box: add cards first, then aminos, then thread one side of lock through and shut the box.

Make sure that you don't leave the locks aligned so they can easily be opened again.

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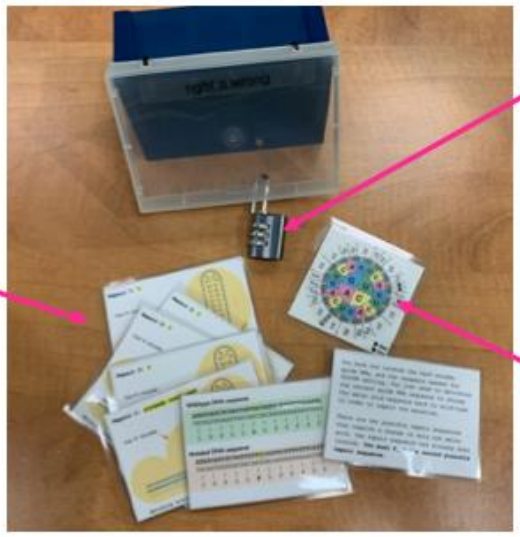
'Right a wrong' Box



'Right a wrong' box

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Make sure that you don't leave the locks aligned so they can easily be opened again.

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Answer Key

(Use this information to give hints if needed…)

Puzzle	Where to find the answer	Teams			
		Red	Orange	Green	Blue
Date Lock on 'BLAST' box	Date circled on academic paper	7 July 2015	27 Aug 2015	4 June 2015	5 May 2016
Lock on mini tissue culture flask	Answers to 'genetics test'	235	364	343	456
Password on word file (found on USB)	Word circled on academic paper	genetic	Alzheimer	AUTOSOMAL	mutations
Lock on 'Lost in translation' box	Nucleotide number of single difference (found when solving the BLAST box puzzle)	519	519	519	519
Wildtype sequence for amino acid reader	Translating the 'Wildtype' sequence from the 'Lost in translation' box	I – S – S – L – L – L – L	I – S – S – L – L – L – L	I – S – S – L – L – L – L	I – S – S – L – L – L – L
Mutant sequence for amino acid reader	Translating the 'Mutant' sequence in the 'Lost in translation' box	I – S – S – L – L – F - L	I – S – S – L – L – F - L	I – S – S – L – L – F - L	I – S – S – L – L – F - L
Lock on 'Right a wrong' box	From running wildtype sequence of aminos in correct order over the 'amino acid reader'	851	492	723	916
Computer interaction	Link provided from running mutant sequence of aminos in correct order over the 'amino acid reader'	bit.ly/GurdonDPB	bit.ly/GurdonDPB	bit.ly/GurdonDPB	bit.ly/GurdonDPB
Correct sequence (submitted through the computer interaction)	From finding the right guide sequence card from the 'Right a wrong' box	Sequence *5*	Sequence *5*	Sequence *5*	Sequence *5*

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Game flow