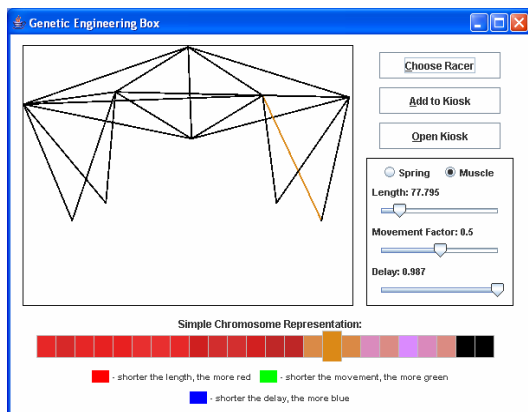


A Brief Synopsis

- **Introduction** [15 minutes]
 - Brief talk introducing pertinent issues.
 - Question and answer session, the purpose of which is to encourage pupils to think about how an individual’s appearance and functionality is determined by his/her genetic coding.
- **Main** [25 minutes]



Pupils will use the ‘Genetic Engineering Box’ feature of our software and will be able to experiment with it, thereby gaining an insight into the way that an individual’s genes determine its appearance and functionality.

Pupils will report back on their findings.

- **Conclusion** [15 minutes]

Questions and answers revisited, giving the pupils a chance to appreciate what has been learned.

Pupils will be asked to fill in a questionnaire.

- **Concurrent simulation**
 - Whilst the lesson is taking place, a simulation (or several) can be run, concurrent to, but separate from, the other activities. Progress can be monitored from time-to-time but will not require constant attention.

Key Teaching Metaphors

- **Genes** are represented as *separate units*, which together are shown in ‘*gene-bars*’ to represent an individual’s *genotype*.
- A *section of this code* will correspond to a *specific feature of the creature’s body*.
- The picture of the creature represents its *phenotype*.
- When a Sodacreature is added to the kiosk and is raced, this race can be thought of as a *race for survival*. The *quicker* a Sodacreature is, the *greater its reproductive success* is. Its success in the race represents the success of its phenotype.
- **Failure to complete** the course can be likened to having a *lethal disease*.
- A Change to the genetic code leading to an unsuccessful Sodacreature can be thought of as a mutation to an *allele causing disease*.
- Successful changes can be thought of as a successful adaptation to the environment.
- A Sodacreature represents a real-life animal or being. **Different types of Sodacreature represent different species.**

Links to the National Curriculum

- understand that genes are parts of chromosomes which are found within the nucleus (2.15)
- understand that the unit of inheritance is the gene, which is a section of a long chain (DNA) molecule (2.16)
- recall that some alleles cause diseases, which can be inherited (2.20)
- understand the terms...genotype and phenotype (2.23)

Key Teaching Points

- A creature’s genetic components, considered as a whole, are known as its **genotype**.
- An individual’s appearance and functionality is known as its **phenotype**.
- A creature’s **genotype determines** its **phenotype**.
- **Changes** in a creature’s **genotype** will cause **changes** in its **phenotype**.
- Most **mutations** (changes to genes) are detrimental. So, a large number of mutations or a big change would be unlikely to succeed.
- Most successful creatures will have undergone few (and minor) mutations.
- The **various forms** of a **gene** are known as its **alleles**.
- A Gene is a long chain (DNA) molecule and several will be found on a chromosome.

The Lesson Plan in More Detail

Preparation

Install our software on the required number of computers, which will require:

- Access to the Internet.
- ‘Windows’.
- Java installed.

Check these issues for all machines before attempting the lesson.

The teacher should become **familiar with the software**, specifically, the ‘**Genetic Engineering Box**’ feature. In addition, if wishing to run an on-going simulation (or more than one), then he/she should become familiar with that part, as well.

The Lesson Plan

1. **Set up an ongoing simulation**, which will last for the duration of the lesson. (It will not take up any time unless prior access to the classroom is not possible, in which case, maybe 2 minutes to set up). *This requires a computer, dedicated to the task* (could set up several of these simulations but each simulation would require a dedicated computer).
 - a. Go to the ‘**Planets**’ feature of the software and choose to ‘**run a new simulation**’. Follow instructions (tool tips).
 - b. This simulation will run, unaided, using our software and the Sodarace application. Over the course of the hour, generations of Sodacreatures will compete in races. The Sodacreatures will interbreed and mutate and will evolve from one generation to the next. The progress will be recorded automatically.
 - c. *Pupils can be referred to this during the introduction.*
 - d. Periodically, between the other stages, the pupils can check the progress of the simulation (2 minutes each time).

Links to the National Curriculum Specific to this Simulation

- explain how sexual reproduction... leads to variation in the new generation (2.07)
- recall that some alleles cause diseases, which can be inherited (2.20)
- understand how adaptations such as...allow survival in particular environmental conditions (2.31)
- describe how new species may evolve from variants which are better adapted to their environment (2.34)
- explain how natural selection can lead to evolution or extinction of species (2.36)

2. *Introduction and Question and Answer Session* (15 minutes).

Introduction... Explain the following:

- a. That coded information giving details of a creature’s physical and functional attributes is held in molecules known as **genes** (DNA, etc.). Like beads, genes are strung along what is known as a **chromosome**.
- b. **Genes are the units of inheritance** from parents to offspring and that each one will store details about a different highly specific part of the body.
- c. Each gene will store details about a different highly specific part of the body.
- d. Considered as a whole, this genetic information is known as a creature’s **genotype**.
- e. The genotype determines an individual’s appearance and performance, its **phenotype**.
- f. Each offspring inherits its genes from its parents but **which genes are inherited from which parent is not pre-determined**. For this reason, offspring of the same parents will differ.
- g. Although genes are passed on independently of each other, it is how well they interact that will determine the success of the phenotype. In turn, this success determines the reproductive success of the individual.
- h. There is variation within a species and still greater variation between species. Is interbreeding possible?
- i. **How to use our software and the Sodarace Kiosk**, explaining that the pupil should use the **‘Genetic Engineering Box’** (and how this should be done).

Question and Answer part: open-ended questions, many of which can be repeated at the end to see what has been learnt. For example:

- j. What is meant by genotype/phenotype?
- k. Are mutations beneficial, I general?

Also, consider issues as outlined in the ‘Key teaching Points’ section.

3. *Main* (25 minutes including the feedback session)

This will require the use of computers dedicated to the task. Pupils could work in groups. Pupils will be asked to:

- a. **Use the ‘genetic engineering box’**, whereby they will be able to take an existing Sodacreature and make changes to its genes by controlling mutations.
- b. Pupils will be given control of the attributes of a Sodacreature and will be able to alter these.
- c. Pupils will be able to see that by changing a creature’s genetic code, they will change its manifestation... that the **genotype determines the phenotype**.
- d. Pupils will see graphical representations of the genotype and the corresponding phenotype and specific links between the two.
- e. Pupils will be able to use the ‘Sodarace Kiosk’ software to see how successful the Sodacreature is, before and after the genetic engineering.
- f. Pupils will be able to see that many mutations are lethal.
- g. Pupils should be able to see that large changes are likely to be counter-productive, which should help them to deduce that ‘Natural Selection’ works by **accumulating small** but advantageous changes over a vast period of time.

‘Hands On’ Feedback Session (5 – 10 minutes)

- a. Each group will report their findings and compare experiences.
- b. Pupils can enter a debate on the various aspects encountered.

Lesson Plan for 'Genes Determine Appearance and Functionality'

4. **2nd Question and answer session + Questionnaire** (15 minutes)
 - a. Similar questions to those posed earlier, an opportunity for reflecting upon what has been learnt.
 - b. Open forum. Pupils can ask questions about evolution, Sodarace and our software, etc.
 - c. In conclusion, pupils should be asked to reflect on the way that Natural Selection uses mutations and recombination (both random) but that due to the struggle for resources, Natural Selection itself is not random.
 - d. Hand out questionnaire during the final Q & A session. The questionnaire should include questions such as:
 - i. Have the pupils learnt about the role of genes in evolution? (If so, what?)
 - ii. Has the software been beneficial in this respect?
 - iii. Has the software been fun?
 - iv. Was it easy to use?
 - v. Any improvements/issues?

5. **Following Up.**
 - a. At a later opportunity, keen pupils should be able to use the parts of the software that they did not use during the hour lesson.
 - b. This will give them more opportunity to compare mutation with recombination and to notice the different ways in which they work.
 - c. They should be able to understand that variation is random but that the more suitable variations will achieve more reproductive success and that this represents the process of Natural Selection.
 - d. Pupils can run longer simulations (as in part 1). This will make it very clear that selective pressure can give rise to better-adapted creatures without having a 'grand designer'.
 - e. ***One of the other lesson plans can be followed.***