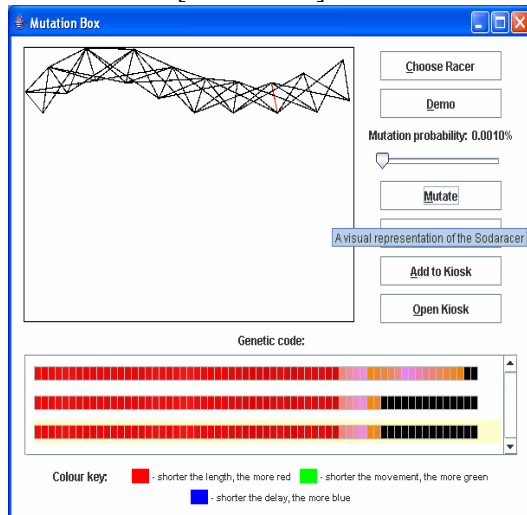


Lesson Plan for ‘The Role of Mutation in Evolution’

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 the effect of a gene undergoing mutation to another form (*allele*).
- **Main** [25 minutes]



Pupils will use the ‘**Mutation Box**’ feature of our software and will be able to experiment with it, thereby gaining an insight into the way that changes to an individual’s genes (*genotype*) cause changes in its appearance and functionality (*phenotype*).

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

- The ‘*gene-bars*’ represent an individual’s genetic code (genotype).
- A *section of this code* will correspond to a *specific feature of the creature’s body* (such as a leg). This correspondence is illustrated by the use of *colour coding*.
- **The colour** of a section of code describes its function (e.g. whether it refers to a mass or a muscle) and certain characteristics.
- 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.
- The picture of a creature represents its appearance (phenotype).
- A Sodacreature represents a real-life animal or being.

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)
- describe how asexual reproduction leads to genetically identical individuals (clones) (2.27)

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Key Teaching Points

- An individual’s *genotype* (coding of the genes) *determines* its *phenotype* (its appearance and performance).
- A creature inherits its genetic components from its parents. The recombination of existing genes can provide a near endless source of variation.
- A further *source of variation* is that of *mutation*.
- A gene can exist in many forms. These forms are known as ‘*alleles*’.
- On very rare occasions, one or more of an individual’s genes may have undergone mutation into a different allele.
- *Most mutations are not beneficial*.
- *Some mutations are advantageous* but too many at one time will also lead to failure.
- Evolution works by the gradual *accumulation* of *small but advantageous mutations*.
- Even advantageous mutations are often lost in subsequent generations.

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 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 Sodacreatures 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)

Lesson Plan for 'The Role of Mutation in Evolution'

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.) that are part of what is referred to as a chromosome.
- b. Genes are the units of inheritance from parents to offspring and that each gene will store details about a different highly specific part of the body.
- c. Considered as a whole, this genetic information is known as a creature's *genotype* and that the genotype determines an individual's appearance and performance, its *phenotype*.
- d. The recombination of existing genes can provide an almost endless source of variation but a further source of variation is that of *mutation*.
- e. 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.
- f. See '*Key Teaching Points*' on the second page.
- g. *Introduce Sodarace and our software.*

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

- h. How does variation amongst a species arise?
- i. What is meant by genotype/phenotype?
- j. Is mutation a good or a bad thing?
- k. How might mutation help a creature to adapt to an environment?
- l. How does mutation fit in to the theory of 'Natural Selection'?

Please read page 4...

Lesson Plan for ‘The Role of Mutation in Evolution’

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 use the ‘**Mutation Box**’ part of the software, whereby they will be able to choose an existing Sodacreature and make a series of changes to its genes by making **random** mutations.

- a. Pupils will see *changes*, graphically represented, to both the *genotype* and the *phenotype* of the Sodacreature and see *connections between the two*.
- b. Pupils will be able to use the ‘Sodarace Kiosk’ software to see how successful a Sodacreature is, before and after each mutation.
- c. Pupils will be able to see that not all mutations are beneficial.
- d. Pupils will be able to **experiment with the ‘mutation rate’**, noting that high mutation rates will lead to unsuccessful Sodacreatures (probably), which should help them to deduce that ‘Natural Selection’ works by **gradually accumulating small** but advantageous changes over a vast period of time.
- e. Pupils will note that a *mutation rate of ‘0’ produces a clone*.

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.

4. **2nd Question and answer session + Questionnaire** (15 minutes)

- a. Same questions as before, an opportunity for reflecting upon what has been learnt.
- b. Open forum. Pupils can ask us 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 mutation and its role 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 random way that 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 makes it very clear that without having a ‘grand designer’, how selective pressure can give rise to better-adapted creatures.
- e. **One of the other lesson plans can be followed.**

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