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## Teaching guide 2021

### Objectives

#### General

- Provide students with the opportunity to discover for themselves the process of adaptation by natural selection.

#### Specific

- Understand the processes of natural selection that allow populations to adapt to the environment. This implies an understanding of the three conditions necessary for the act for natural selection to occur.
- Understand that the effects of mutations are dependent on environmental conditions: a mutation is not *a priori* adaptive (good) or deleterious (bad); it all depends on the environmental conditions.
- Understand the importance of variability: if there is no variability, populations will become extinct because there is no possibility of them adapting to environmental changes.

## Transversals

- Stimulate critical thinking: questioning and reaching conclusions based on observations.
- Encourage and promote teamwork (if it is considered appropriate).

## Previous necessary knowledge

Students should be familiar with the following concepts: evolution, mutation, inheritance, frequency.

## Interactive material description

- Elements:



Flies with different mutations



Alert: indicates which flies will not survive

- Controls:



Environment with viruses



A very cold environment



A stable environment



By pressing on this button, you can change from ON to OFF



Button to start an action, or to change the situation

- Comments:

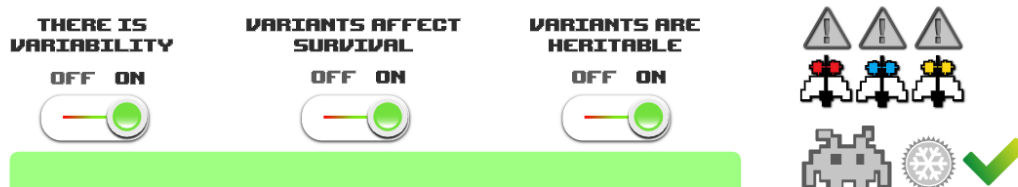
The aim of the exercise is to guide the students and promote reflection, not to just give explanations. The students need to come up with an explanation for their observations themselves.

In the following section we describe three blocks of animations, the learning

objectives and the conclusions that the students have to reach for themselves and if it is necessary with the teacher's guide.

## BLOCK 1

### Description



The game begins with a screen where the three necessary conditions for natural selection to act are turned “ON”: there is variability, there are variants that affect survival and the variants are heritable, and the environment is stable.

### Objectives

1. That the student becomes familiar with the game elements.
2. That the student observes how the frequencies of different mutations vary.
3. That the student makes predictionbased on the observations made until this point—on how the frequencies will vary.

### Conclusions

When the environment is stable, the mutation frequencies will vary slightly from one generation to the next because not all flies will leave the same number of offspring, and some leave no offspring.

At the end of Block 1, the student will be invited to continue exploring.

## BLOCK 2



## Description

Screen where the three necessary conditions for natural selection to act are turned "ON": there is variability, there are variants that affect the survival and the variants are heritable, and the environment is not stable: environment with a virus or very cold environment.

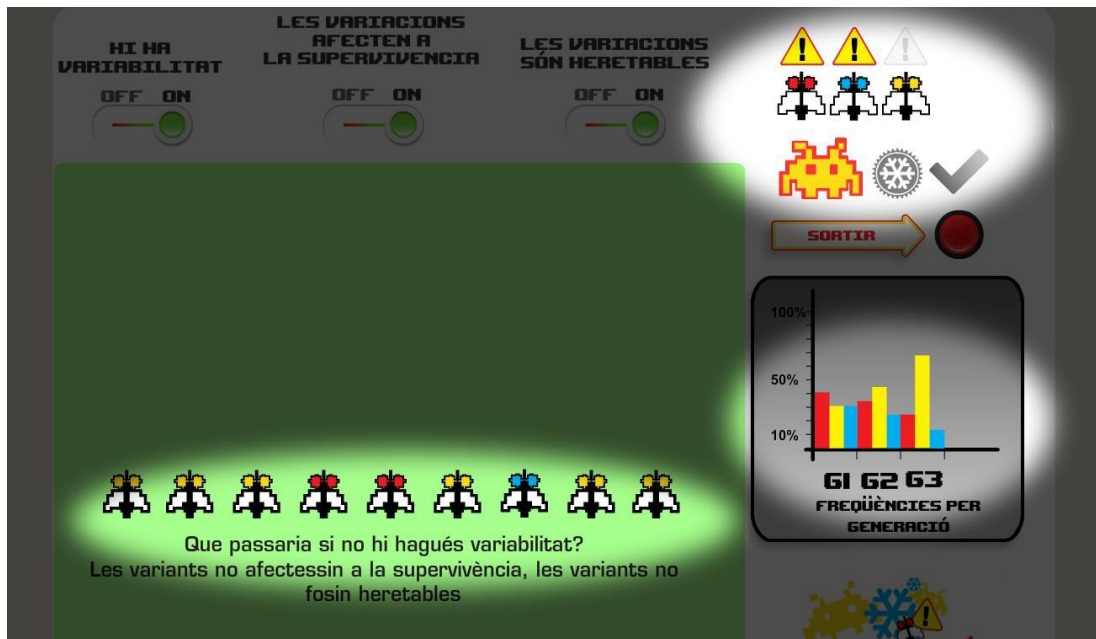
## Objectives

1. Identify which mutations make flies virus resistant or cold-resistant. Flies that have these mutations will survive longer than the others. These flies leave more offspring, and as a result, the mutation frequency increases within these populations: the populations ADAPT TO THE ENVIRONMENT

## Conclusion

Which flies are better adapted? The effect of one mutation depends on the environment. If the environment is very cold, only some flies will survive, and if there are viruses in the environment, others flies will survive. Evolution has no directionality.





### BLOCK 3

#### Description

Screens where one of the three necessary conditions for acting the natural selection are "OFF".

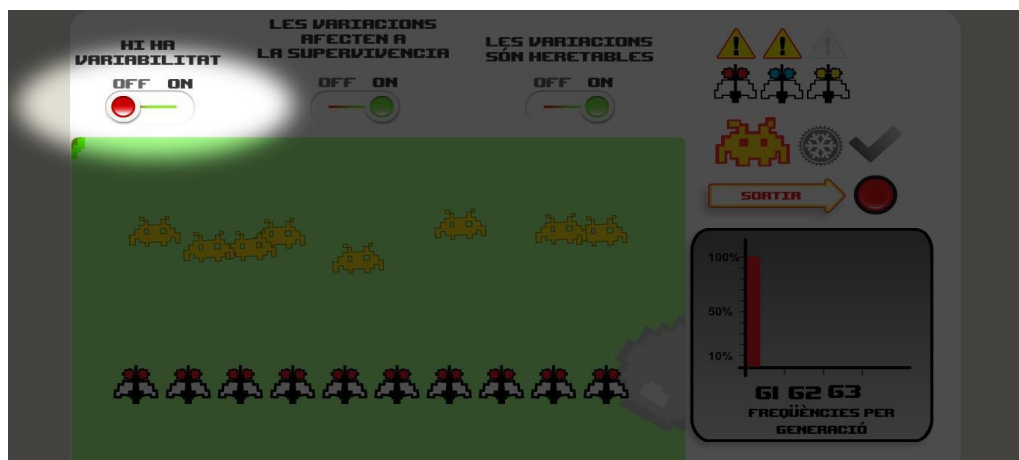
#### Objectives

1. If the environment is not stable (virus in the environment or a very cold environment) and there is no variability, natural selection cannot act: the population does not adapt to changes and the population becomes extinct.
2. If the environment is not stable (virus in the environment or very cold



environment) and the variants do not affect survival: none of the mutations in the population confer resistance to either viruses or the cold, and therefore the population is extinguished. If there were more mutations in the populations, perhaps some of these would allow the population to adapt and survive.

3. If the environment is not stable (virus in the environment or a very cold environment) and the changes are not heritable: mutations confer resistance but if these mutations are not heritable, the population becomes extinct.
4. If the environment is stable and there is no variability or the differences do not affect survival or the changes are heritable, the population remains stable. It should be noted that this situation is not real, there are always changes and therefore such populations would go extinct.



## Conclusions

In order for selection to act and the populations to be able to adapt, there must be variability, the variants must affect survival, and the variants must be heritable. All three conditions are necessary. If one of the three conditions is missed, populations cannot adapt and they become extinct.

