# *Investigating patterns of inheritance*

# Teaching and learning plan

## Learning intentions

Students will be able to:

* describe the structure and function of DNA, genes and chromosomes
* understand that genetics and the environment define traits
* predict offspring genotypes and phenotypes resulting from single gene (monogenic) crosses
* explain why combining class data makes the data more reliable
* make predictions
* identify patterns in findings
* develop and justify conclusions
* explain how to increase the reliability of their data.

## Suggested time for this CLE

The time needed to complete the *Investigating patterns of inheritance* CLE will depend on the depth of the prior knowledge of students, the time to perform the three investigations (‘What traits do you have?’, ‘Exploring the inheritance of single gene traits’ and ‘Predicting the result of crossing two plants heterozygous for pigment’), any associated activities plus any follow up with extension activities. Allow 5–7 hours. Depending on the ability of the group, students could present the results of the final investigation as a scientific report.

[**Planning ahead and equipment list**](http://assist.asta.edu.au/sites/assist.asta.edu.au/files/Planning%20and%20equipment%20list_Yr10_Patterns%20of%20inheritance.docx)

## Safety considerations

When you and your class are completing your Risk Assessment consider the following safety points and add any other relevant ones to the list:

* The seeds may be coated with pesticide. Ensure students wash their hands after handling the seeds.
* If using potting mix handle with care. Follow instructions on the packaging. Avoid inhaling the potting mix. Students should wear gloves and masks.
* **Prior to the lesson**: the teacher should wear a dust mask, to avoid inhaling any airborne particles from the potting mix, and slowly open the bag and dampen the potting mix with a light spray of water.
* **All people handling potting mix should**:
* avoid inhaling airborne particles, by using damp potting mix and wearing a mask
* wear (disposable) gloves, to be disposed in the rubbish after use
* wash their hands thoroughly with soap and water after use.

## Introduction

This CLE focuses on the inheritance of single gene traits and links to Year 10 Australian Curriculum: Science.

Investigation 3 requires the students to identify pigment in barley plants. The seeds need to be germinated in preparation for this activity.

### Setting up investigation 3

### Equipment needed

Per class:

* [‘Investigating patterns of inheritance’](http://assist.asta.edu.au/sites/assist.asta.edu.au/files/PowerPoint_Yr10_Patterns%20of%20inheritance.pptx) PowerPoint – Slides 2–4

Per group:

* 20 x genetic barley seeds (heterozygous for pigment)
* 1 x large petri dish or 2 x small petri dishes (or similar containers)
* enough cotton wool to cover bottom of petri dish/es
* 3 x takeaway food containers or 2 x ice cream containers (or similar)
* potting mix to fill container
* gloves
* face mask

### What to do

1. Inform students they are going to investigate how traits are passed on from parents to offspring. Before they get started they will need to set up the materials for the final investigation. Each group is required to plant their seeds following the instructions on the PowerPoint (Slides 2–4).

*Teacher note*: The seeds need to be left for about a week to give them the opportunity to germinate. During this time students will need to ensure the cotton wool and potting mix don’t dry out.

### Preparing for investigation 1

### Defining terms

It is important for Investigation 1 that students are given an understanding of the terms trait, dominant and recessive. This can be done through explicit teaching or through students completing the ‘Tour of basic genetics’ activity as shown below.

### Activity *– A tour of basic genetics*

In this activity, students will explore heredity, DNA, genes and chromosomes, and the effect of genetics and the environment on traits. The worksheet has hyperlinks to websites students need to visit to help them answer the questions.

This activity could be done individually, in pairs or groups depending on the class and computer access.

### Equipment needed

Per student:

* [A tour of basic genetics](http://assist.asta.edu.au/sites/assist.asta.edu.au/files/A%20tour%20of%20basic%20genetics%20worksheet_Yr10_Patterns%20of%20inheritance.docx) worksheet
* access to the internet
* access to a computer

### What to do

1. Give each student a copy of the worksheet [A tour of basic genetics](http://assist.asta.edu.au/sites/assist.asta.edu.au/files/A%20tour%20of%20basic%20genetics%20worksheet_Yr10_Patterns%20of%20inheritance.docx).
2. Instruct students to work through the worksheet using the hyperlinks to websites to answer the questions.
3. Discuss the answers with the class.

## Core

### Investigation 1 – What traits do you have?

This investigation introduces students to inherited single gene traits. Students will identify the dominant and recessive single gene trait they possess and combine their results with those of the class to determine the frequency of the traits in the class. To conclude the investigation students will discover that the chance of another student having all the same features is very small.

### Equipment needed

Per class:

* [Investigating patterns of inheritance](http://assist.asta.edu.au/sites/assist.asta.edu.au/files/PowerPoint_Yr10_Patterns%20of%20inheritance.pptx) PowerPoint – Slides 5–7

Per student:

* [Human traits checklist](http://assist.asta.edu.au/sites/assist.asta.edu.au/files/Human%20traits%20checklist_Yr10_Investigating%20patterns%20of%20inheritance_DB.docx) worksheet
* [Human traits wheel](http://assist.asta.edu.au/sites/assist.asta.edu.au/files/Human%20traits%20wheel_Yr10_Patterns%20of%20inheritance.docx) worksheet

### What to do

1. Give each student a copy of the worksheet [Human traits checklist.](http://assist.asta.edu.au/sites/assist.asta.edu.au/files/Human%20traits%20checklist_Yr10_Investigating%20patterns%20of%20inheritance_DB.docx) Instruct students to work in pairs to complete the first part of the worksheet. For each trait listed students should circle whether they have the dominant or recessive trait.

*Teacher notes:* A blank slide has been inserted into the PowerPoint for images of the traits (Slide 5). Once students have identified their traits, compile the class results and have students record the results on their worksheet.

1. Ask students the discussion questions on the PowerPoint (Slide 6). The answers are provided below.
2. Did you expect to see more dominant or recessive traits?
3. Why is it a common misconception for people to expect more dominant traits?

*Being dominant doesn’t mean the majority of the population express the trait. Being dominant means that it is expressed over the recessive trait. For example, tongue rolling is a dominant trait, controlled by the dominant form of a gene (R). Individuals who have one or two copies of R will be tongue rollers. Only individuals with two recessive forms of the gene (r) will be non-rollers. How frequently a trait is observed in a population is not related to whether or not it is dominant or recessive. It is a reflection of how frequently the form of the gene responsible for causing a trait is found in people.*

1. Would the results be the same for any class? Why?

*No, because the frequency of the dominant and recessive forms of the trait depends on the frequency of the form of the gene responsible for the trait in students in the class.*

1. Give out the worksheet [Human traits wheel.](http://assist.asta.edu.au/sites/assist.asta.edu.au/files/Human%20traits%20wheel_Yr10_Patterns%20of%20inheritance.docx) Slide 7 can be used to illustrate how to use the wheel.
2. Instruct students to look at the trait in the middle of the wheel, if they have the trait they need to colour in the YES section. If they don’t have the trait they colour the NO section. Working from the middle out, they need to do the same for each trait, until they reach the outermost circle. They should only be colouring the YES.
3. Once they have completed the wheel instruct the students to record their number.
4. Call out each number and ask students to raise their hand if they have the number. See if there are any two students the same. It is highly unlikely to get two students with the same number, unless there are identical twins, as students may have some traits in common but the chance of having all traits is quite low.
5. Discuss why there may or may not be two people alike in the class. If there are siblings in the class they would be more likely to have the same features.

## Conclusion

### Investigation 3: Exploring the inheritance of single gene traits

This investigation uses seeds collected from a cross between two plants heterozygous for pigment. (Green pigment is dominant) In this investigation students predict the possible offspring genotypes and phenotypes from this cross, then collect data from germinating seeds to test their predictions.

There are two options for conducting this investigation described below, depending on the ability level of the class.

**Option 1 – More challenging investigation**

### Equipment needed

Per student:

* [Investigating patterns of inheritance](http://assist.asta.edu.au/sites/assist.asta.edu.au/files/Investigating%20patterns%20of%20inheritance%20worksheet.docx)worksheet

### What to do

1. Give each student a copy of the [Investigating patterns of inheritance](http://assist.asta.edu.au/sites/assist.asta.edu.au/files/Investigating%20patterns%20of%20inheritance%20worksheet.docx) worksheet. Instruct them to work in groups to compete the investigation and report their findings.
2. Inform students that they should start by predicting the results of crossing two parents heterozygous for pigment by answering the questions on the sheet. Then, once the seeds have germinated, they should count the number of each colour seedling and record the results. The class results should be combined to increase sample size.

Inform the students that:

* The genetic barley demonstrates dominant/recessive inheritance where green pigment G is dominant over yellow pigment g. Green, and yellow (or white) phenotypes can be observed.

**Option 2 – A more guided investigation**

### Equipment needed

Per class:

* [Investigating patterns of inheritance](http://assist.asta.edu.au/sites/assist.asta.edu.au/files/PowerPoint_Yr10_Patterns%20of%20inheritance.pptx) PowerPoint – Slides 8–16 (optional)

Per student:

* [Investigating patterns of inheritance](http://assist.asta.edu.au/sites/assist.asta.edu.au/files/Investigating%20patterns%20of%20inheritance%20worksheet.docx) worksheet

### What to do

**A. Prediction**

Students work in pairs or groups to predict the result of crossing two plants heterozygous for pigment.

1. Start by posing the question: What genotype and phenotype ratios would you expect to observe when you cross two plants heterozygous for pigment?
2. Inform students that they will be required to answer the questions on the worksheet to assist them with their answers.
3. If students are answering questions as a pair/group share answers with the class. The PowerPoint can be used to display questions for discussion (Slides 8–15).

**Answers:**

1. **Question:** What colour would you expect leaves containing chlorophyll to be?

**Answer:** Green.

1. **Question:** What colour would you expect leaves that don’t contain chlorophyll to be?

**Answer:** Could be white or yellow.

1. **Question:** If the parent plants are heterozygous for pigment, and green pigment is dominant, what colour would you expect them to be?

**Answer:** Green.

1. **Question:** If you crossed two plants heterozygous for pigment, what genotype and phenotype ratios would expect to observe in the resulting seedlings? Show how you would work this out. (Green pigment G and yellow pigment g)

**Answer:**

Green pigment = G Yellow pigment = g

Parent phenotype: Green pigment x Green pigment

Parent genotype: Gg Gg

Possible gametes: G or g G or g

Punnett square:

|  |  |  |  |
| --- | --- | --- | --- |
|  |  | Pigmented parent | |
|  |  | G | g |
| Pigmented parent | G | GG | Gg |
| g | Gg | gg |

Offspring genotype: 1 GG : 2 Gg : 1 gg

Offspring phenotype: 3 Green pigment : 1 No Green pigment (white or yellow)

1. **Question:** If you planted 20 seeds produced from a cross between plants heterozygous for pigment. How many would you expect to have green pigment and how many would you expect to have no green pigment?

**Answer:** You would expect to see about 15 pigmented (green) and 5 with no green pigment (white or yellow).

Remind students that when we predict possible genotypes and phenotypes of offspring we are predicting genotype and phenotype of each individual offspring. The final number of each phenotype in the sample may not match the predicted outcome, as it is the result of chance. Each plant has a 75% chance of having pigment.

**B. Results**

After about a week, students should be able to observe the phenotypes of the seedlings.

1. Instruct students to look closely at their barley seedlings and count the number of each phenotype present. The most appropriate way for students to record the results is in a table (see example below). The PowerPoint can be used to display the example (Slide 16).

* The genetic barley demonstrates dominant/recessive inheritance where green pigment is dominant over yellow pigment. Green and yellow (white) phenotypes can be observed.

**Table:** The resultant genotypes and phenotypes of a cross between two barley plants heterozygous for pigment

|  |  |  |
| --- | --- | --- |
| Seedling phenotypes | Group results | |
| Number of seedlings | % of seedlings |
| Pigment (green) |  |  |
| No green pigment (yellow or white) |  |  |

1. Ask the students what could be done to get results that were close to the expected results for a cross between two plants heterozygous for pigment? (The PowerPoint can be used to display this question for discussion – Slide 17).

**Answer:** Increase the sample size and combine the results of all the groups.

*Teacher notes:* In this investigation each group has planted 20 seeds. If the results for each group are combined the sample size would increase to X (number of groups x 20 seeds), which would increase the reliability of the results. Combine the class results and calculate the % of seedlings for each phenotype. A table, similar to the one below, could be drawn on the board to display the results.

|  |  |  |
| --- | --- | --- |
| Barley seedling phenotypes | Class results | |
| Tally | % of seedlings |
| Pigment (green) |  |  |
| No green pigment (white or yellow) |  |  |
| Total |  |  |

**C. Analysing the results**

Instruct students to now complete the worksheet analysing both their group and the class results. This could be done in pairs/group or individually if you are going to assess their data analysis. The PowerPoint can be used to display questions for discussion (Slides 18–19).

Students can now prepare a report for their investigation if this is a requirement that has been set.

### Expected results and explanations

* The students will probably find that their group results don’t match the expected results. However, once all groups’ results have been combined to produce the class results they should be closer to what is expected.
* Remember, when predicting the results of crosses the expected ratios are the chance for each individual seedling. When a large sample size is used the results will show patterns similar to the prediction.

### Additional genetics problems to practise:

* Any year 10 or senior secondary biology textbook will have genetics problems that can be used for extra practice if required

### Assessment opportunities

Investigation 3 provides an opportunity to assess student understanding of the concepts related to single gene (monogenic) inheritance and science inquiry skills.

In addition, the level of student achievement of the science inquiry skills, **questioning and predicting,****processing and analysing data and information, evaluating** and **communicating** could be assessed.

In addition:

* When conducting the activity described in this CLE students analysis of results can be assessed if that section of the worksheet is completed individually.
* You could get the students to prepare a scientific report on their investigation. The report could then be used to assess their science inquiry skills.
* Students could be provided with some genetics problems for assessment.