# Plant genetics

with Dr Bill Rolling and Dr Jenyne Loarca

## Talking points

#### Knowledge

1. What is a cultivar?

2. What are three factors that could affect carrot germination?

#### Comprehension

- 3. What is the difference between a genotype and a phenotype?
- 4. What is selective breeding, and how is it used to create better crops?

#### Application

- 5. Bill's research indicates that larger carrot seeds result in more and larger seedlings. How could carrot farmers use this information to increase their yields?
- 6. How could plant breeders combine Bill and Jenyne's research findings to help carrot farmers increase their yields?

#### Analysis

- 7. What are the advantages and disadvantages of studying carrot germination in petri dishes compared to outdoor fields?
- 8. Why is it important for plant breeders to develop crops that are more efficient in their use of water and soil nutrients? How will these cultivars improve the sustainability and reduce the environmental impacts of agriculture?
- 9. Why do you think it is important that Jenyne studied 700 carrot cultivars, compared to previous studies that looked at fewer than 20? What do you think are the challenges of conducting such a large-scale analysis, compared to the smaller studies in the past?

#### Synthesis

- 10. How would you design an experiment to test the effect of temperature on carrot seed germination and carrot root and topgrowth characteristics?
- 11. How would you encourage people to increase the plant biodiversity in their diets?

#### **Evaluation**

- 12. Rice, wheat and corn/maize account for more than 50% of the calories in the average human diet. To what extent do you agree that this lack of biodiversity in our food systems is a problem for global food security? What challenges could this cause, and how could we prevent/solve them?
- 13. How important do you think plant breeding and agricultural research will be for ensuring global food security as the climate crisis continues? Why?

## Activities

#### 1. Get growing!

While you cannot study plant genotypes without specialist genetic lab equipment, you can conduct your own germination and growth experiments to discover how environmental conditions influence plant phenotypes.

Design an experiment to test how the amounts of water and sunlight influence seed germination rates, seedling growth rates and other phenotype characteristics. Consider the following:

- What is your starting hypothesis about how water and light will influence plant phenotypes?
- What type(s) of plant(s) will you grow?
- For each seed/plant, what variables will you keep the same, and what will you change? How will you set up the experiment to do this?
- How will you control for changes in other environmental conditions?
- What phenotype characteristics (e.g., seed size, plant height, number/length/colour of leaves, root length. etc.) will you measure?
- How will you collect phenotype data, and how often?
- How will you analyse your data to test your hypothesis?
- How could you expand your experiment to test other environmental conditions, such as temperature or soil type?

Conduct your experiment and analyse your results. How do environmental conditions influence seed germination rates, seedling growth rates and other phenotype characteristics?

#### 2. Seeds of change

Humans have been selectively breeding plants for thousands of years, resulting in varieties that are more appealing to grow and eat than their wild relatives. Research online to discover how modern fruits and vegetables have been bred to have specific characteristics, such as a sweeter taste, smaller seeds or juicier flesh. Watermelon, corn/maize, bananas and the cultivated crops descended from wild mustard are interesting places to start.

Create a poster or infographic to educate the public about how selective breeding has resulted in the plants we eat today. Include images to show how modern fruits and vegetables differ from their original wild ancestors, as well as fun facts and figures to interest and engage your audience.

### More resources

- Learn more about the importance of plant phenotyping with this Futurum article: www.futurumcareers.com/how-can-computers-help-crops-grow-better
- Carrot seeds are so small that you can fit 2,000 of them in a teaspoon! Learn more fun carrot facts: blog.aghires.com/carrot-facts
- The National Association of Plant Breeders has a YouTube channel full of interesting videos covering all aspects of plant breeding and research:
  www.youtube.com/user/plantbreedgenomics