Color Changing Flowers for the Classroom

Overview: In this game, the player can design their own flower by expressing or knocking down genes. A simplified metabolic pathway is shown on the left, and the resulting flower is shown on the right.

Background Information:
Flowers are colored by **anthocyanins**, a family of small molecules that absorb in the visible light range. Each flower has its own unique mixture of anthocyanins, resulting in unique flower shades. Anthocyanins aren't limited to flowers either, they also give color to fruits and vegetables. Plants use them to protect themselves from 'sunburn', generating anthocyanins in the presence of intense light.

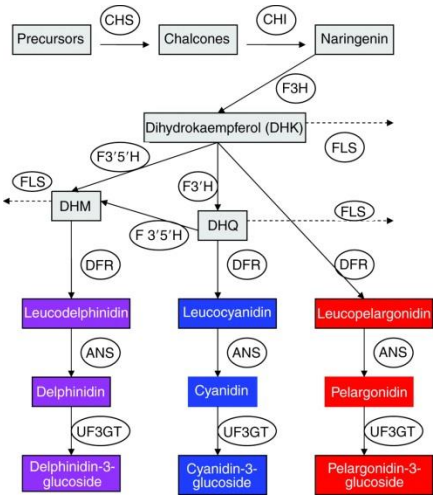
Examples of plants containing Anthocyanins

Petunias

Snapdragons

Roses

Blueberries



Anthocyanin Pathway. For full paper/image size, click here

Plants manufacture anthocyanins in a process known as **biosynthesis**. In this process, **enzymes** convert one small molecule into another, generating colorful anthocyanins from non-colorful molecules. This process is long, but is very similar in every plant. We have simplified these pathways (example below) in the game to five enzymes, each representing a portion of the anthocyanin pathway.

Each enzyme is a protein. Each protein starts as a set of instructions in **DNA**. You can change the instructions in the **DNA** to change the enzyme levels in the plant. If you instruct the plant to produce more enzyme, that is called **overexpression**, if it produces less, that is **repression.**

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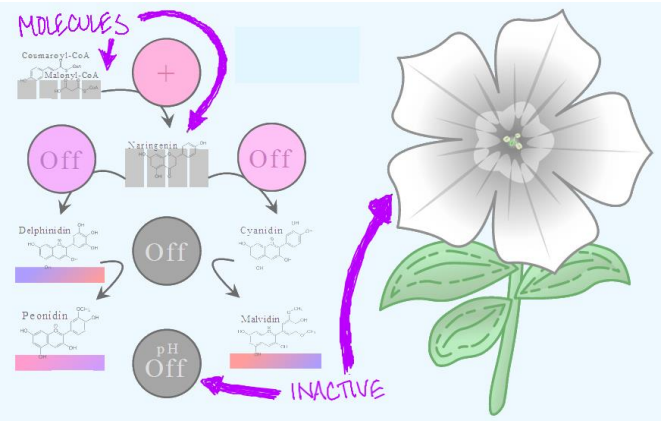
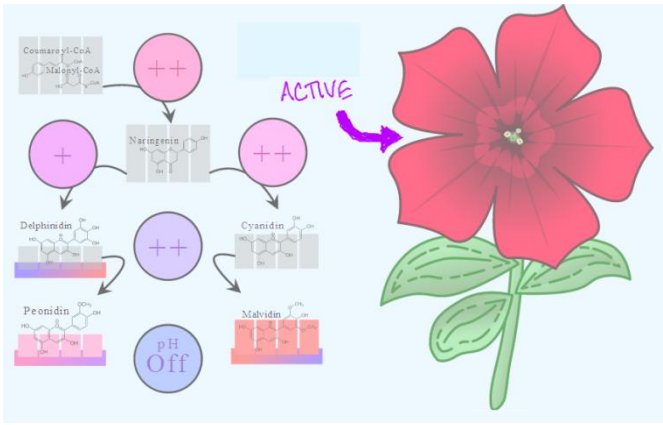
In the game, we represent overexpression by plus signs, and repression by – signs. You can click each colored button in the pathway to over- or under-express the enzymes that make the next step. In order for the pathway to work, the entire pathway must be functional: if you turn off an enzyme at the top of the pathway, it won't make any molecules for the next enzyme in the pathway.

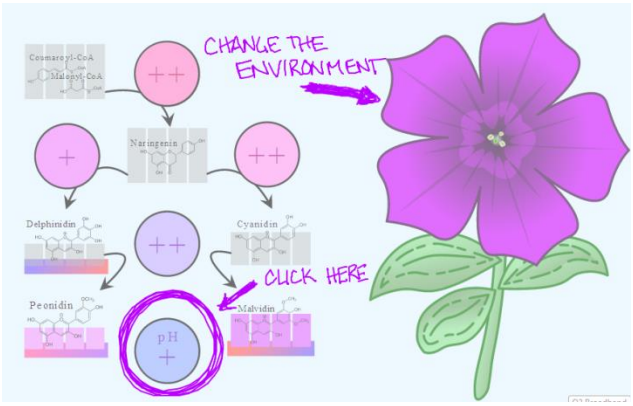


Incomplete anthocyanin biosynthesis



Complete anthocyanin biosynthesis

You can also change the environment of the anthocyanins using the bottom button labeled 'pH'. Anthocyanins are sensitive to their environment – metal ions, other molecules, and pH can all have an impact on the absorbance of the molecules. A famous example of this is the hydrangea – in acidic soil, it is able to take up more aluminum , which combines with the existing anthocyanins in the flowers to turn them blue.



Change the environment, change the color

Differently colored hydrangeas

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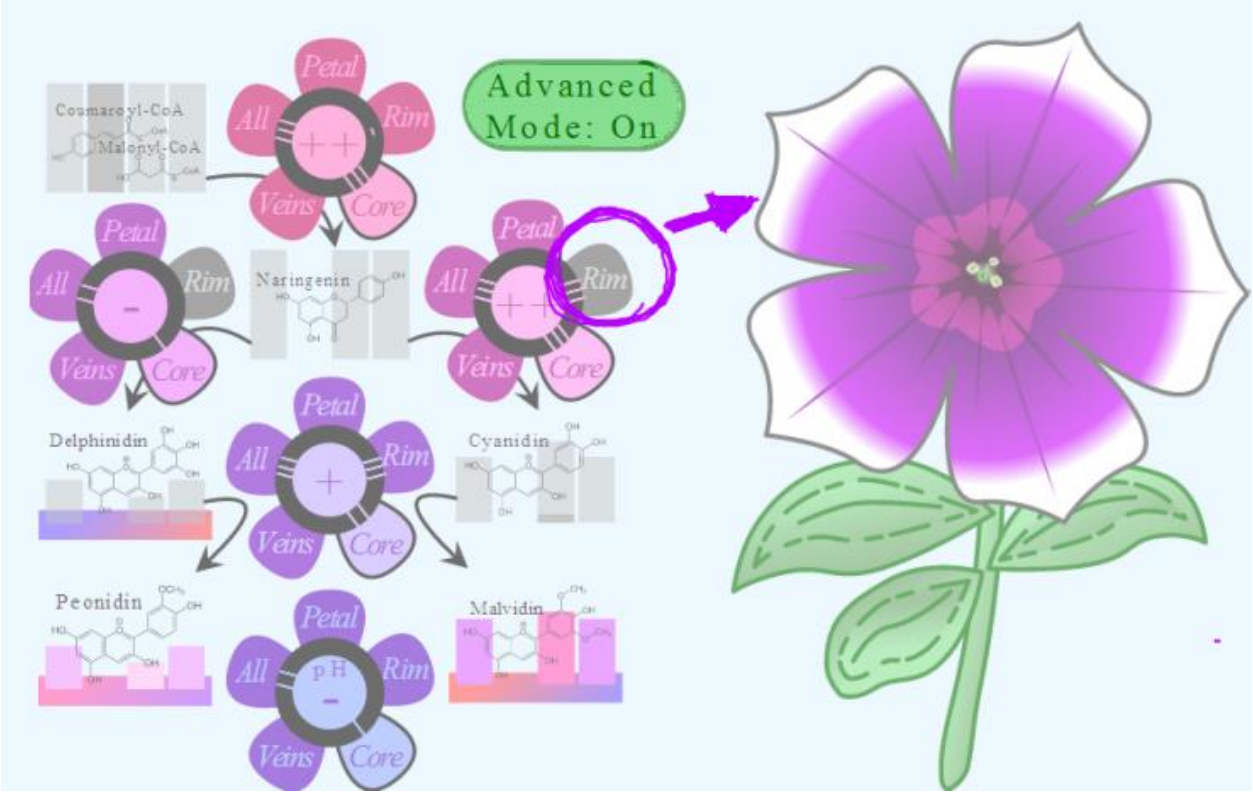
Every part of the flower can produce different levels of anthocyanins in different environments, just like real flowers. Turn on the big green advanced mode button, and select the flower part that you want to color in.

This flower was created by knocking out anthocyanin biosynthesis only on the rim of the flower (white) and changing the environment of the core to make those pigments redder.



Hope you enjoy the game! Questions, comments, concerns, please send to keira@revolutionbio.co
Looking forward to hearing from you!