

# COLOR-CHANGING FLOWERS

How do transpiration and pH affect the color of petals?



Presenter: Victoria Hristova  
Team: Bulgaria - Sofia

# Table of Contents

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- Main problem
- Main problem – a deeper look
- Carnation flowers experiment
- Results and conclusion
- pH and its significance for plants
- Hydrangea flowers experiment
- Results and conclusion



# Main Problem

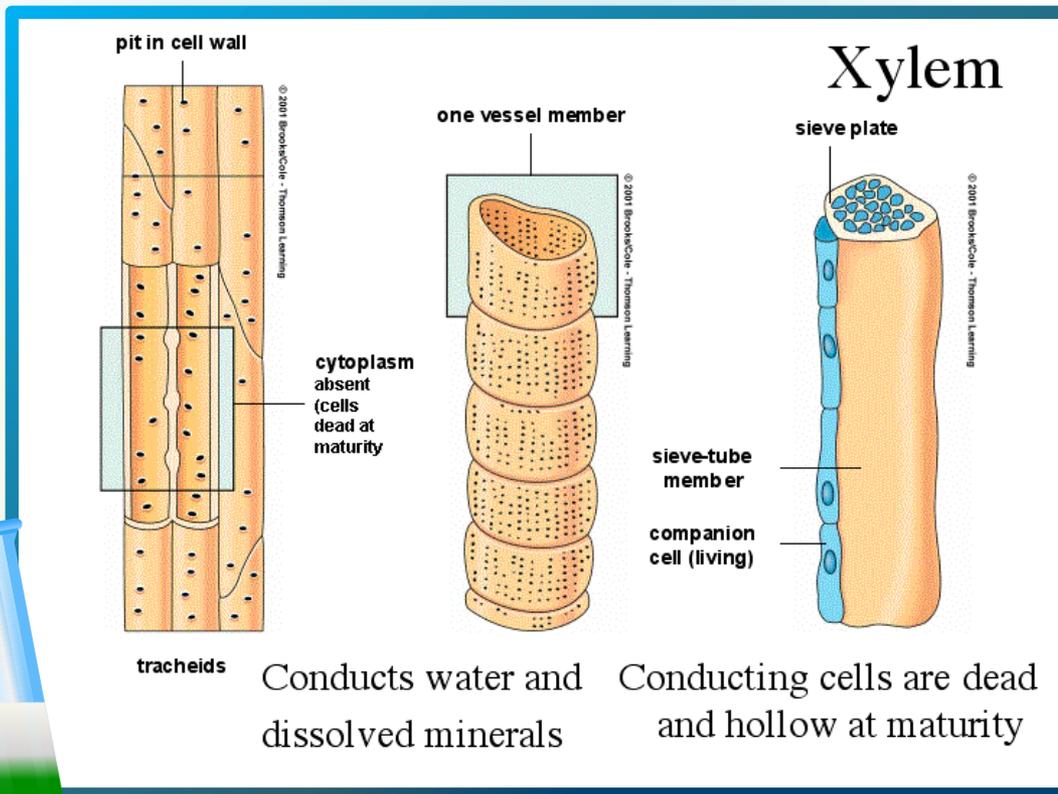
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## 11. Colorful bouquet

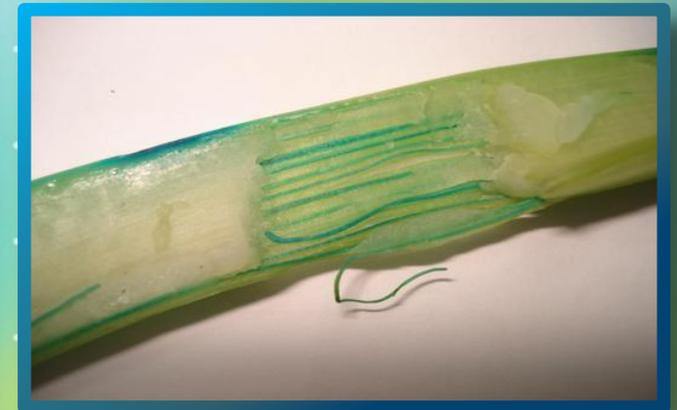
It is known that the color of a carnation flower can be changed if the plant is watered with an ink solution. Can the color of the flowers be changed by other methods? Explain the principle of your method. To what flowers is it applicable?



# Color-change? Why?



- Plant water transport - Xylem
- Plant transpiration



# Carnation Flowers Experiment

## Materials needed

- White carnation flowers
- Food coloring (different colors)
- Water
- Test tubes
- Knife



# Carnation Flowers Experiment

## Step 1

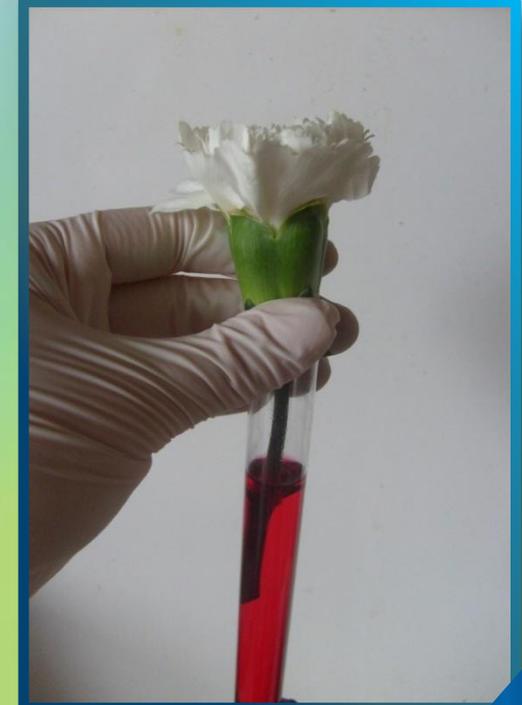
Cutting the stems  
(40° angle)

## Step 2

Filling the test tubes  
with water and  
adding food coloring

## Step 3

Placing the flowers  
into the test tubes



# Carnation Flowers Experiment

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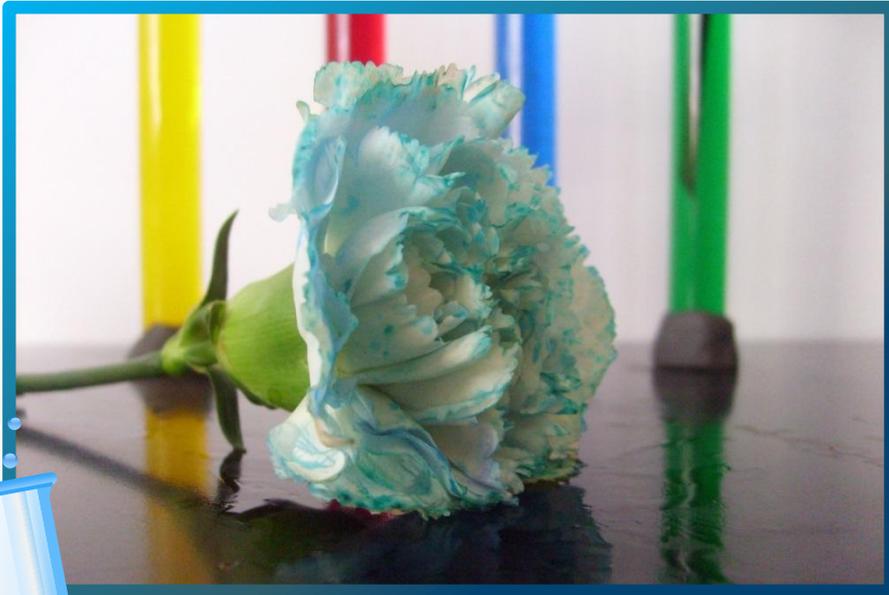


After 48h



# Carnation Flowers Experiment

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After 12h



After 48h



# Carnation Flowers Experiment

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## Two-color carnations

- I. Slit the stem down the middle
- II. Put each half of the stem in different colored water
- III. Leave for 48 hours



# Conclusions

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- When a flower is cut, it no longer has its roots, but the stem of the flower still "drinks" up the water and provides it to the leaves and flowers
- Xylem vessels in run all the way from the roots to the petals of the flowers
- The color intensity of the carnations depends on the time period

| Time period | Color intensity   |
|-------------|-------------------|
| 5-6 hours   | Very pale color   |
| 11-12 hours | Pale color        |
| 23-24 hours | Medium brightness |
| 47-48 hours | Very bright       |



# What are Anthocyanins?

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- Water-soluble pigments
- Found in plant cell vacuoles
- May appear red, purple, or blue depending on the pH
- Occur in leaves, stems, roots, flowers and fruits



"By Indikator-Blaukraut" by Haltopub - [CC-BY-SA-3.0](#) or [GFDL](#)



# The Influence of pH

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- pH – Potential of Hydrogen
- pH does not change what elements are in a soil
- pH can have an effect on the concentration of an element
- It affects the **availability** of those elements to plants

| pH               | Plant Food |             |           |
|------------------|------------|-------------|-----------|
|                  | Aluminum   | Phosphorous | Potassium |
| 8.0<br>Alkaline  | Very Low   | High        | High      |
| 7.0<br>Neutral   | Low        | Medium      | Medium    |
| 6.0<br>Acid      | Medium     | Low         | Low       |
| 5.0<br>Very Acid | High       | Very Low    | Very Low  |



# pH and Hydrangeas

## Hypothesis

The pH of the soil and the amount of aluminum ions determine whether a hydrangea flower is **pink** or **blue**.



# pH and Hydrangeas

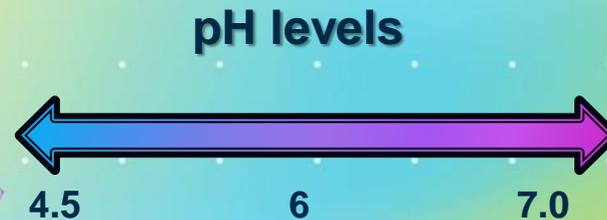
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## Change to blue

- Aluminum needs to be present in soil
- Lower pH – 4.8 – 5.5
- Fertilizers high in potassium

## Change to pink

- Aluminum **must not** be present in soil
- Higher pH – 6.2 – 7.0
- Fertilizers high in phosphorus



# Blue Hydrangeas Experiment

## Materials needed

- Two **pink** hydrangeas
- Aluminum sulfate
- Fertilizer with potassium
- pH indicators



$\text{Al}_2(\text{SO}_4)_3$  Solution



KCl Solution

| Plant              | Color | Initial soil pH | pH goal         |
|--------------------|-------|-----------------|-----------------|
| Experimental plant | Pink  | 6.5             | 5.0             |
| Control plant      | Pink  | 6.5             | 6.5 (unchanged) |

# Blue Hydrangeas Experiment

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Step 1

Making a 2% aluminum sulfate solution

Step 2

Testing initial soil pH

Step 3

Applying the solution to the experimental plant for 8 weeks





# Blue Hydrangeas Experiment

Step 2



Testing soil  
pH

- At start, soil pH = 6.5



# Blue Hydrangeas Experiment

Step 3



Experimental plant *Hydrangea macrophylla*

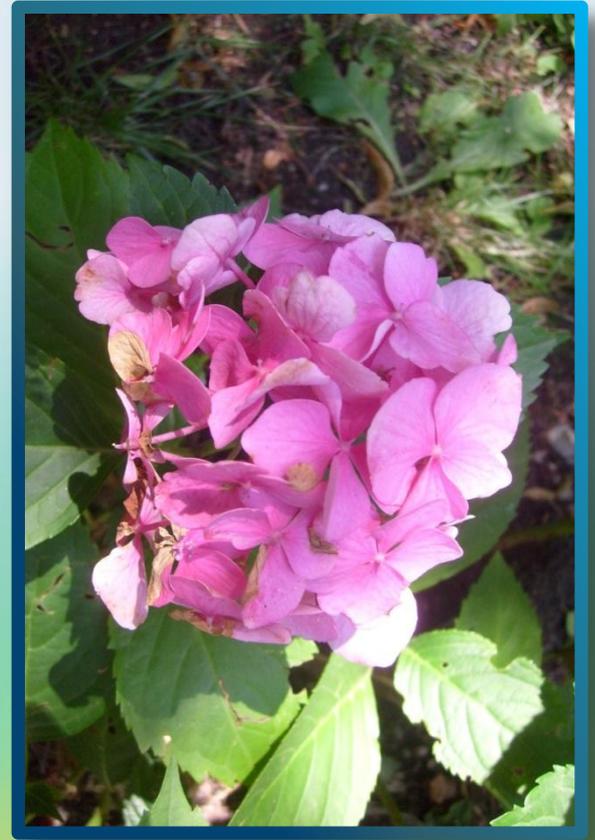


Control plant *Hydrangea macrophylla*

# Weeks 1-2 /soil pH 6.1 – 6.2/

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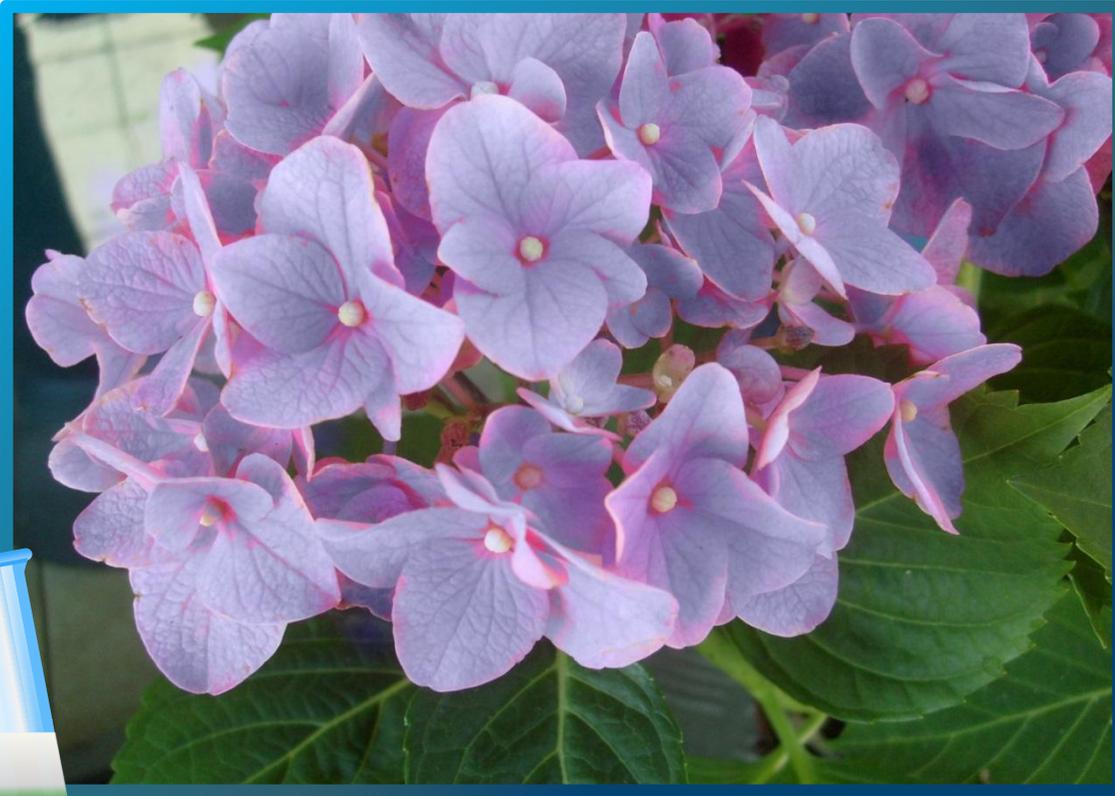
# Weeks 3-4 /soil pH 5.7 – 5.9/

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# Weeks 5-6 /soil pH 5.6 – 5.7/

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# Weeks 7-8 /soil pH 5.2/

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# Comparison

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1<sup>st</sup> week

8<sup>th</sup> week



# Conclusions

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- Hypothesis **confirmed**: the color of a hydrangea flower depends on the pH of the soil and the amount of aluminum ions

| Time period | Changes in color (experimental plant)  |
|-------------|--|
| 1-2 week    | <ul style="list-style-type: none"><li>▪ Pale pink with barely visible purple shades /2<sup>nd</sup> week/</li></ul>                      |
| 3-4 week    | <ul style="list-style-type: none"><li>▪ Changes are more noticeable</li><li>▪ Color is visibly pale purple with shades of pink</li></ul> |
| 5-6 week    | <ul style="list-style-type: none"><li>▪ Color remains purple</li><li>▪ Pink shades disappear</li></ul>                                   |
| 7-8 week    | <ul style="list-style-type: none"><li>▪ Purple-blue color</li></ul>  |



**Thank you for  
your attention!**



# Blue Hydrangeas Experiment



| Time period | Weather conditions             |   |
|-------------|--------------------------------|---|
| Week 1-2    | Mostly sunny,<br>Partly cloudy |       |
| Week 3-4    | Mostly cloudy                  |       |
| Week 5-6    | Very sunny                     |     |
| Week 7-8    | Mostly cloudy,<br>Light rain   |   |



# What are Anthocyanins?

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Typical blue and pink colored hydrangea -  
*Hydrangea macrophylla*



Yoshida K et al. Plant Cell Physiology 2003;44:262-268

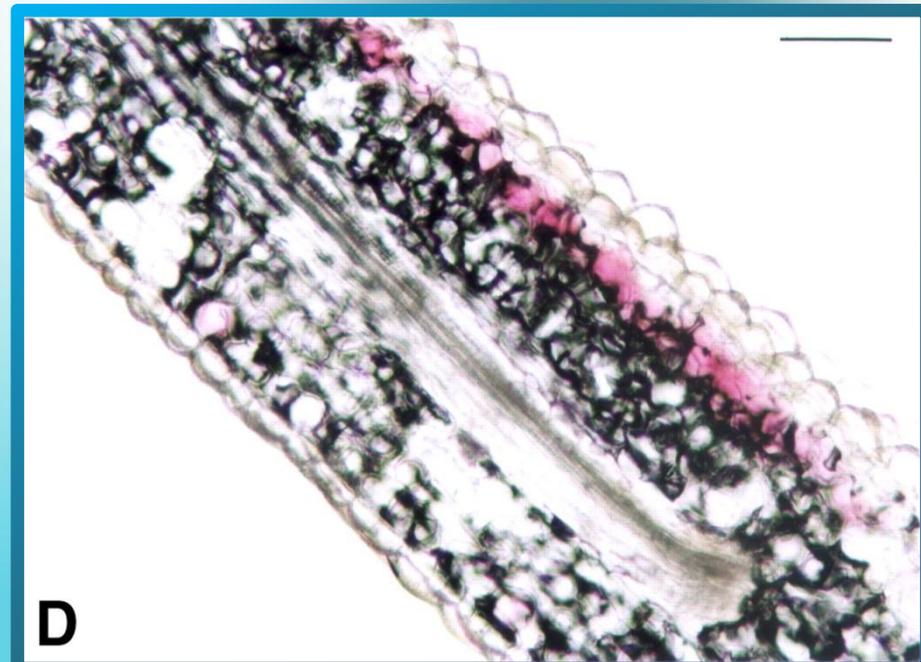
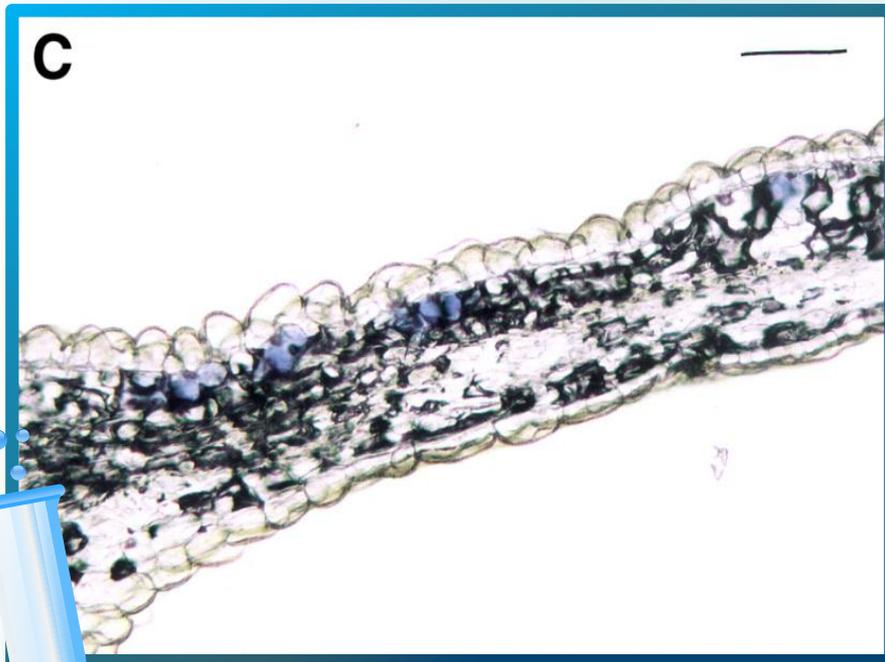


# What are Anthocyanins?

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(C) Transverse section of a **blue** sepal

(D) Transverse section of a **pink** sepal



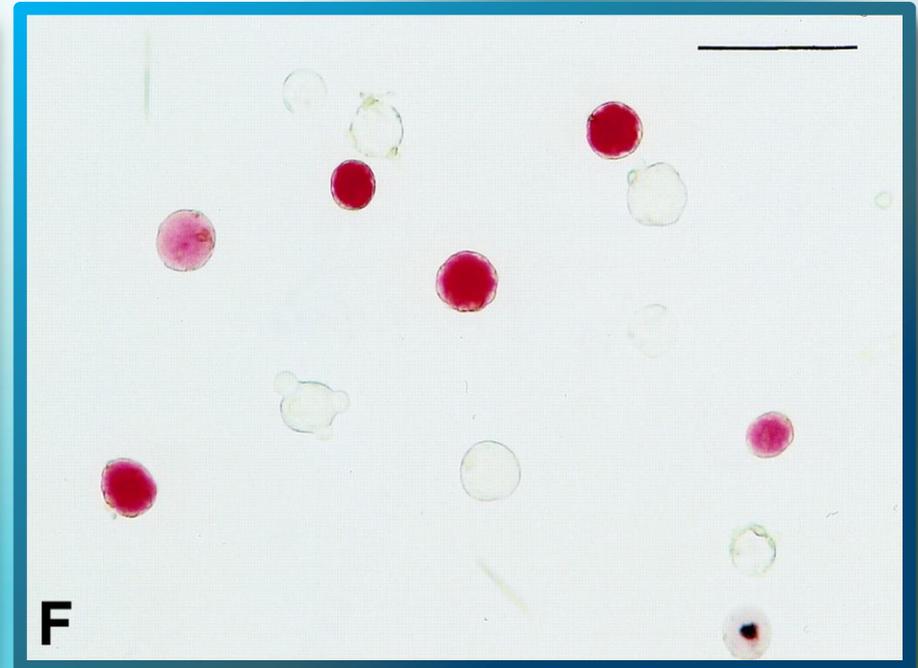
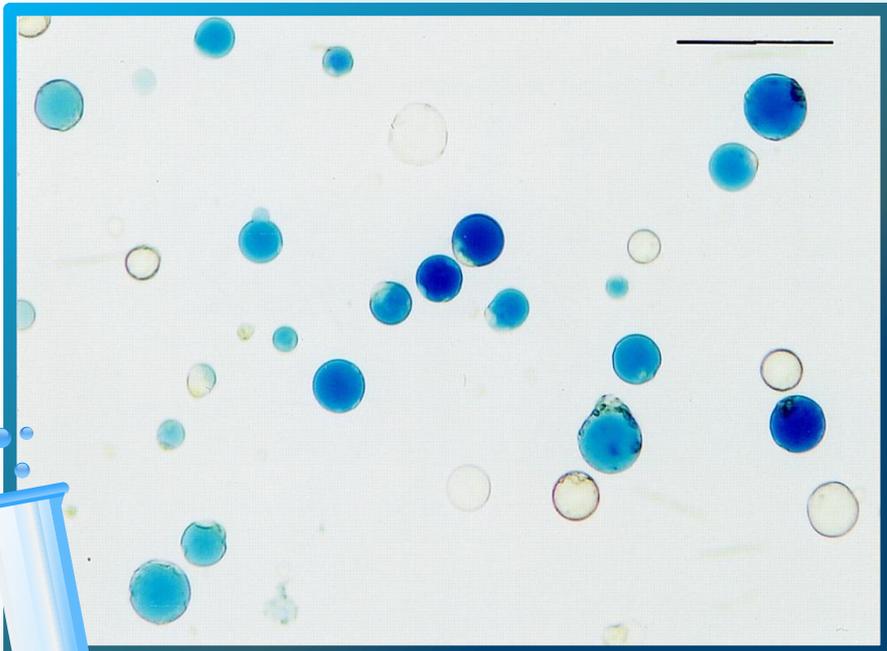
Yoshida K et al. Plant Cell Physiology 2003;44:262-268

# What are Anthocyanins?

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(E) A protoplast mixture from blue sepals

(F) A protoplast mixture from pink sepals



Yoshida K et al. Plant Cell Physiology 2003;44:262-268



# Carnation Flowers Experiment

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If you take the carnation out of the test tube, does the color disappear as it dries up?



# Carnation Flowers Experiment

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If you take the carnation out of the test tube, does the color disappear as it dries up?



# Color-changing Plants

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- Flowers with light-colored petals
  - carnations
  - daisies
  - white roses
- Flowers with herbaceous stems (preferable)

