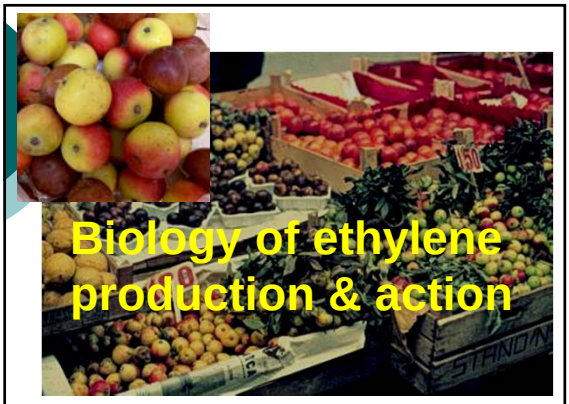
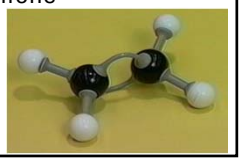


What is ethylene?

- C_2H_4
- Very simple molecule
- A gas
- An important chemical feedstock
- A natural plant hormone



Where does ethylene come from?

- Ripening fruits
- Smoke
- Vehicle exhausts
- Ripening rooms
- Ripening fruit

Ethylene - an important factor

- Useful:
  - Accelerates ripening
  - Causes abscission
- A problem:
  - Accelerates ripening
  - Accelerates senescence
  - Causes abscission

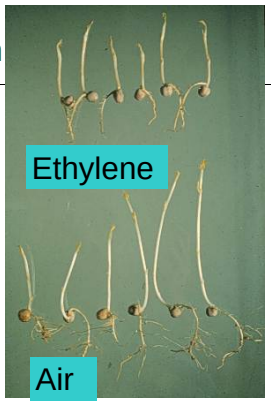
History of ethylene biology

- Prehistoric
  - Fruit ripening, smoky rooms, ripening fruit
- Amos, 1000 B.C.
  - Scarification of figs - wound ethylene
- Neljubow, 1907
  - Ethylene gas - plant growth regulator
- Cousins, 1913
  - Ethylene causes ripening
- Gane, 1932
  - Produced by ripening fruits
- Goeschl and Pratt, 1960
  - Role in plant growth and development
  - Plant hormone
- Veen, 1978
  - Silver thiosulfate
- Yang, 1979
  - Ethylene biosynthesis pathway
- Bleeker, 1988
  - Etr-1
- Sisler and Blankenship, 1996
  - 1-MCP

Ethylene responses

- Reduction in growth (seedlings)
- Loss of leaves and flowers (plants)
- Leaf yellowing or death (plants)
- Epinasty (leaves)
- Senescence (flowers)
- Ripening (fruits)
- Abscission (fruits, leaves, branches)
- Dehiscence (seeds)

Seedling growth



Neljubow, a graduate student in Russia, was the first to show that ethylene caused these strange effects on etiolated pea seedlings

Carnation model system

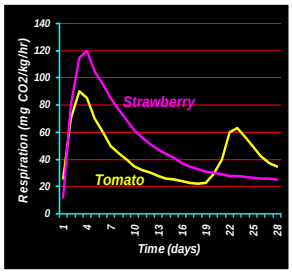
Characteristics of ethylene responses

- Threshold concentration (0.1 ppm)
- Plateau concentration (10 ppm)
- Associated respiration rise
- Temperature optimum (15 - 25 C)
- CO2 (>1%) inhibits

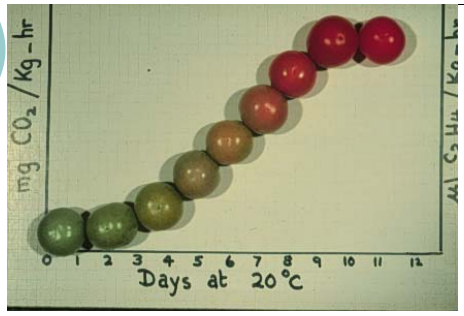
Abscission of snapdragon flowers in response to ethylene shows a typical threshold and plateau response

Respiration - important physiological indicator

- **Non-climacteric fruits**
- Respiration falls steadily throughout development
- Ethylene not involved in ripening
- Citrus, grapes, olives, cherries, many berries

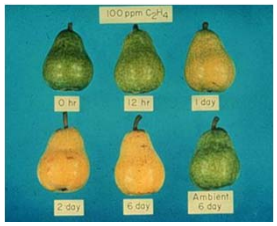


Respiration and ethylene production rise during fruit ripening

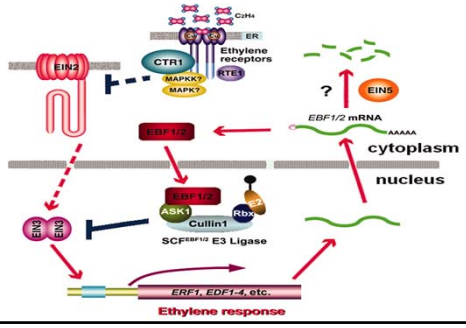


Ethylene as a ripening 'trigger'

- Once ripening is initiated, climacteric fruits produce ethylene
- Ripening is then self-controlled

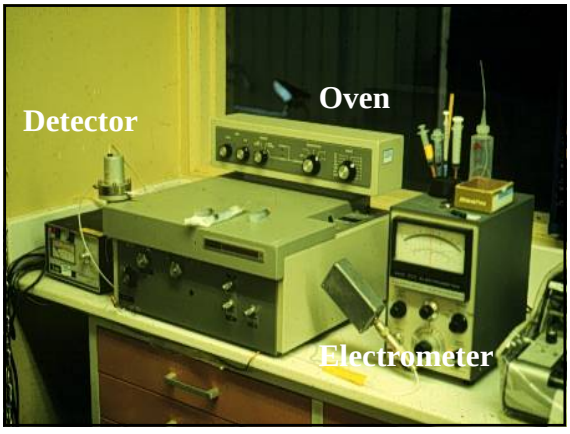


The ethylene response cascade



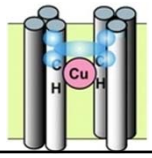
Tools for working with ethylene: **Measurement**

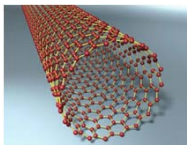
- Expensive, but routine
- Bioassay - cheap, difficult
- Kitagawa tubes - $2 / measurement
- Proprietary analysers - $500 - $1000
- Gas chromatograph - $10,000 - 30,000
- Photo-acoustic detector - $75,000



A nanotechnology ethylene detector

- Based on the ethylene binding site
- Carbon nanotubes 'doped' with copper
- When ethylene binds, the electrical properties of the nanotubes change





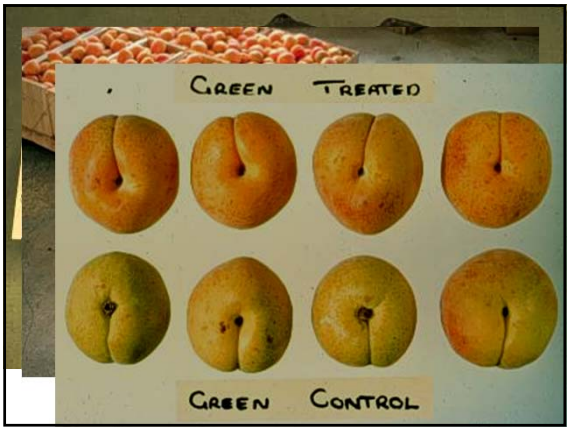
Tools for working with ethylene: **Application**

- Ripening fruits
- Ethylene gas
- Acetylene, CO
- Ethephon
  - Liquid, spray, drench

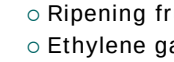
Gas, closed space

Uses of ethylene in horticulture

- Induction of flowering
  - Bulbs, Pineapple & other Bromeliads
- Harvest aid
  - Walnuts, Sour cherries
- Induction of ripening or coloring
  - Bananas, Citrus



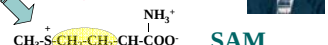
Ethylene biosynthesis



MET

Methionine

SAM synthase



SAM

ACC synthase

S-adenosyl methionine

ACC

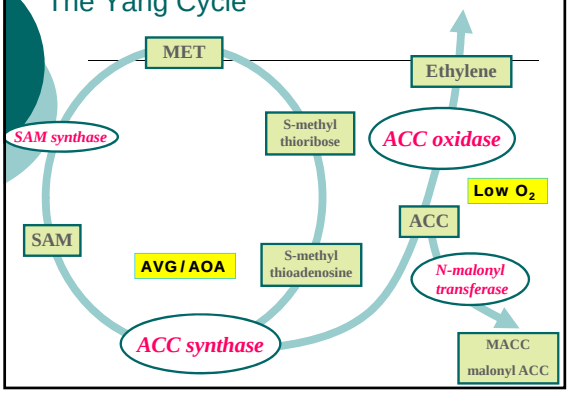
1-aminocyclopropane-1-carboxylic acid

ACC oxidase

$CH_2=CH_2$

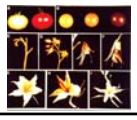
Ethylene

The Yang Cycle

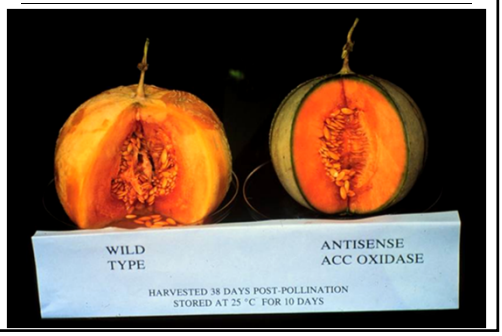


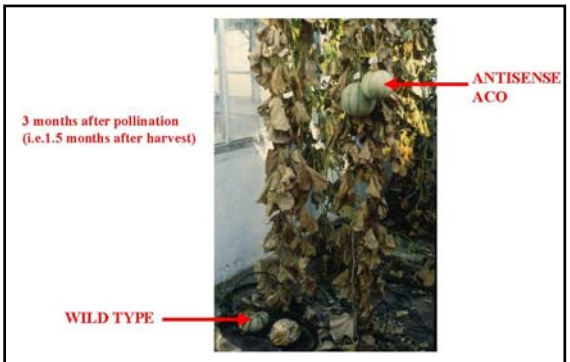
Molecular manipulation of ripening

- Anti-sense ACC synthase
- Anti-sense ACC oxidase
- Result - fruits that ripen very slowly, require ethylene treatment to ripen
- Just like Never Ripe (NR), a tomato mutant, used to develop long shelf-life tomatoes



Anti-sense ACC oxidase in melons





Anti-sense technology will improve marketing of many fruits