



**Southern**  
Illinois University  
**Carbondale**

# Anticancer Drugs from Moss

- **Transgenic Moss Producing Terpenoids**
- Southern Illinois University Carbondale
- Aldwin Anterola  
Assistant Professor of Plant Biology

# Technology Summary

- Moss was genetically engineered to produce anticancer terpenoids.
- Developed by:
  - Aldwin Anterola, Southern Illinois University
  - Pierre Francois Perroud, Washington University
  - Ralph Quatrano, Washington University
- Potential application: Production of anticancer drugs such as Taxol and/or its analogs.

# Technology Details

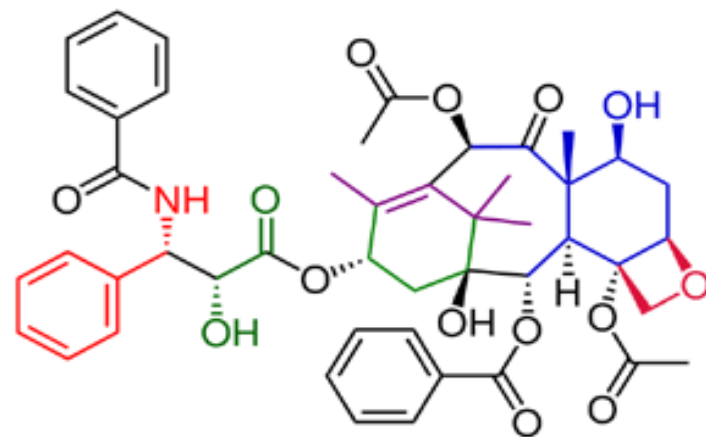
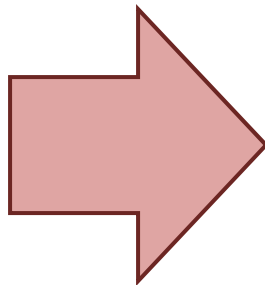
- Genes from yew trees (which produce Taxol) were transferred into a moss.
- Transgenic moss produced Taxol precursors, as well as unexpected metabolites (taxanes).
- Unexpected taxanes were tested for bioactivity and showed promising anticancer properties.

GGPP



One step

TXD



Seven steps

Specific Yew (*Taxus brevifolia*)

One step

TX1

Three steps

TX3A

Seven steps

DAB

Taxol comes from the bark of Pacific yew.

GGPP

1  
step

TXD

2  
step

TX1

Three  
steps

TX3A

Seven  
steps

DAB



DAB is a starting material in Taxol manufacture.

# Taxol Production in Transgenic Plants



## Arabidopsis

- Stunted growth



## Tomato

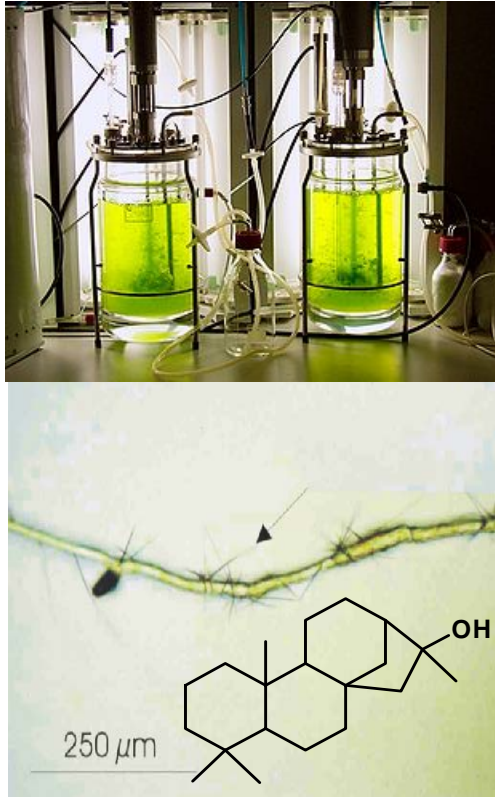
- GA prevented stunted growth



## Tobacco

- Tissue specific expression

# Taxol Precursor Production in Moss



Schwartzenberg et al. *Plant Cell Reports* 22, 780-786 (2004).

## Why moss?

- ✓ Not edible
- ✓ No flowers
- ✓ No seeds
- ✓ Culturable
- ✓ Totipotent
- ✓ Transformable
- ✓ Gene targeting
- ✓ Diterpenoid producer



GGPP

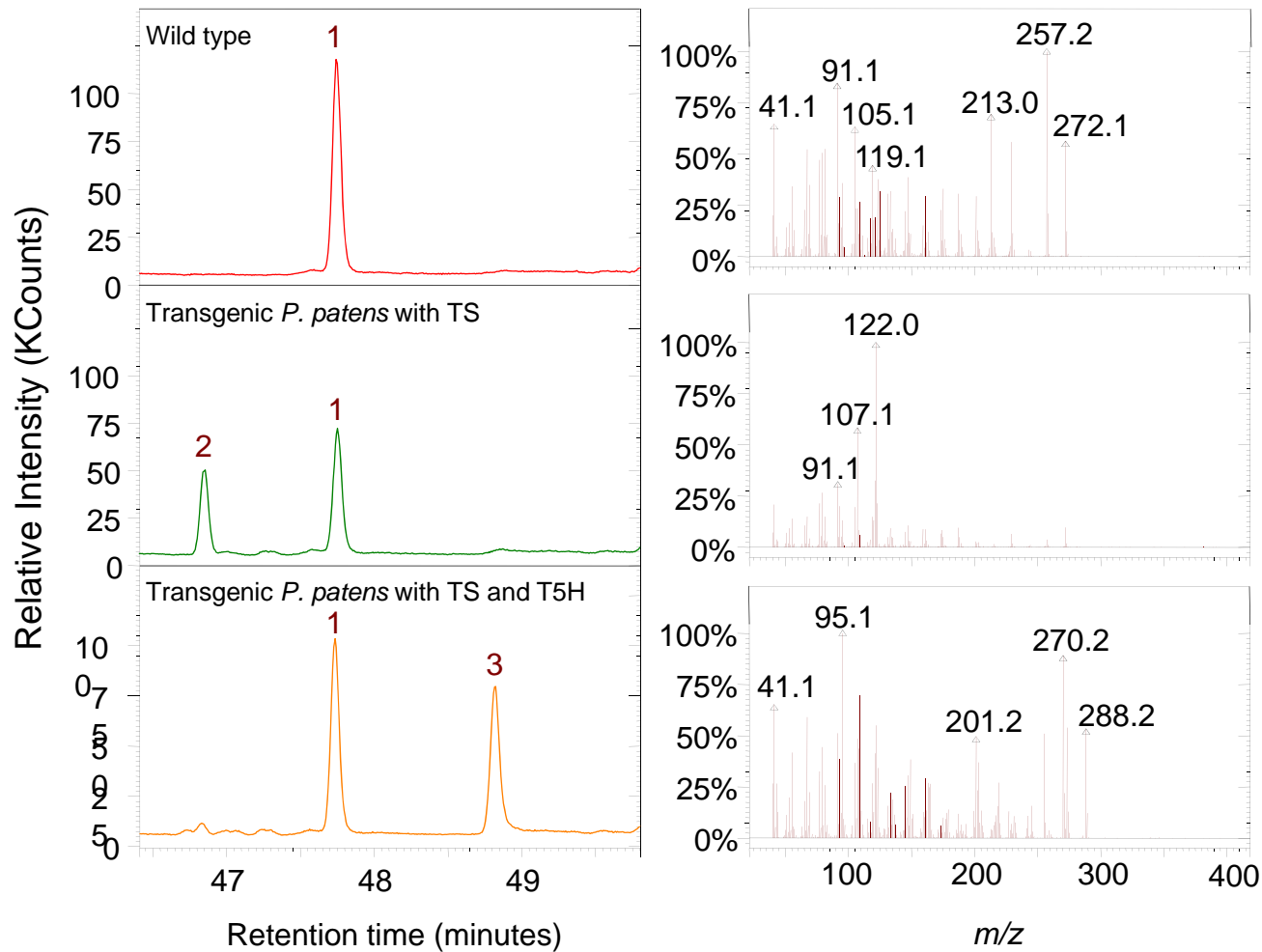
TS

TXD

T5H

TX1

# Moss Metabolic Engineering



Taxol precursors are produced in transgenic moss.

GGPP

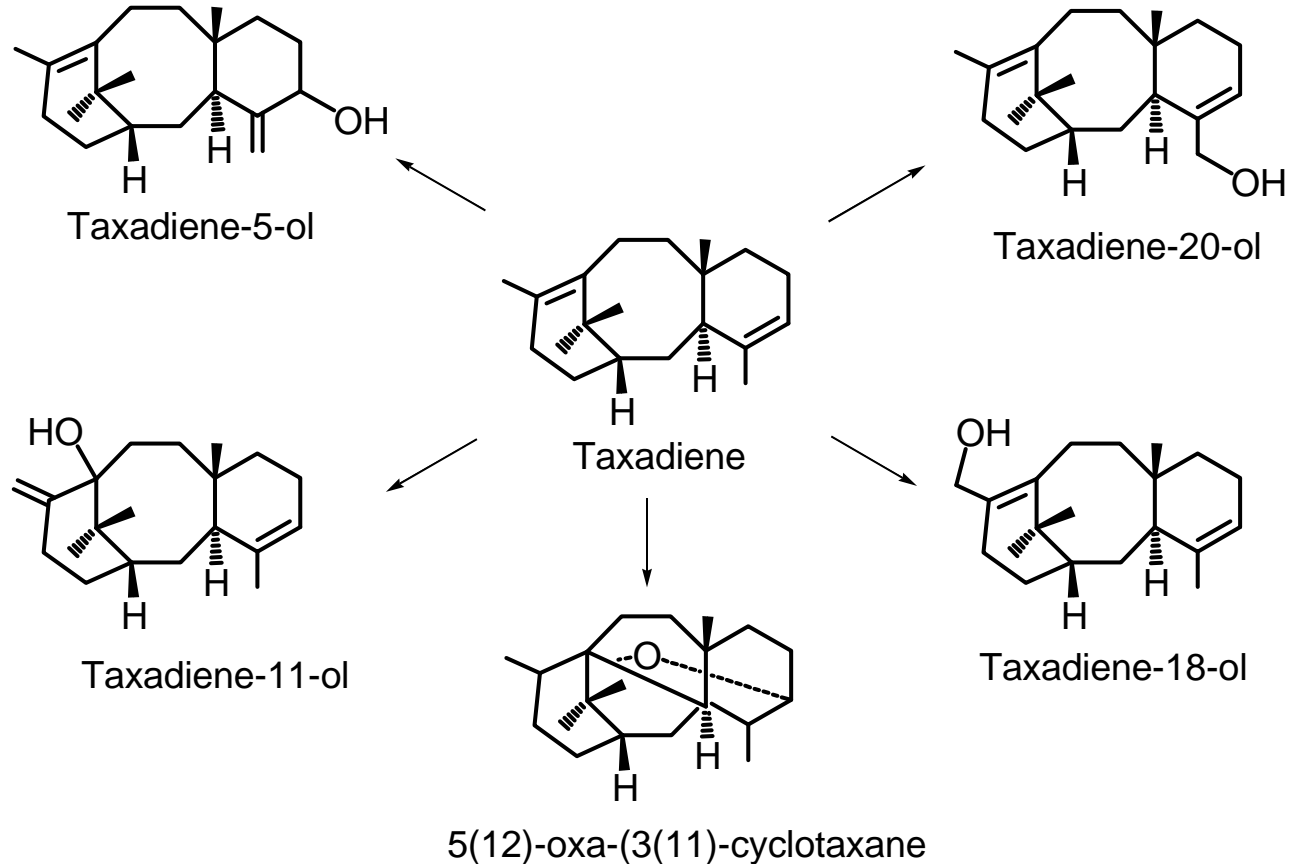
TS

TXD

T5H

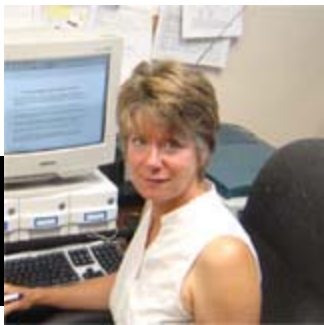
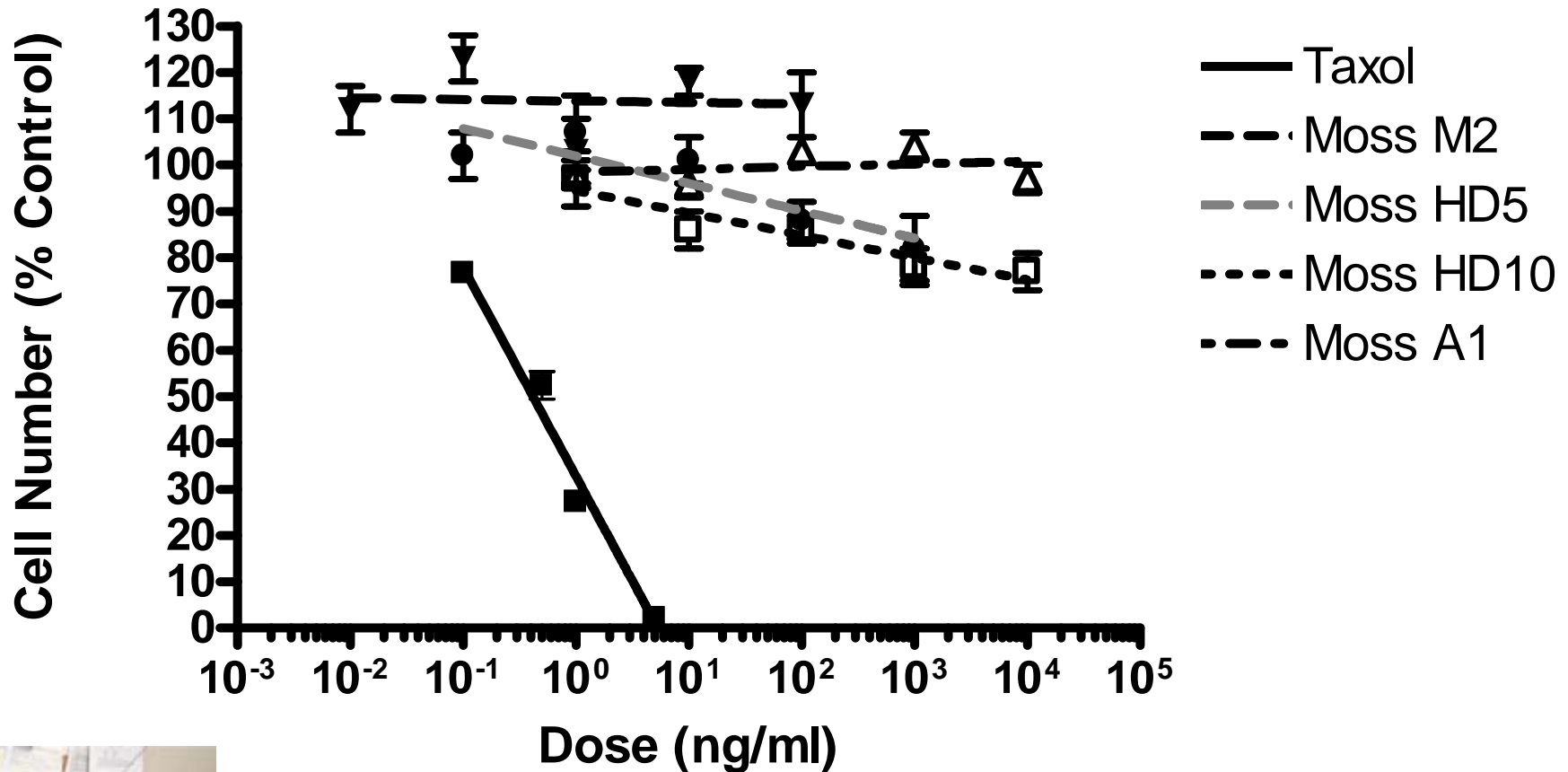
TX1

# Moss Metabolic Engineering



Novel taxanes are formed in transgenic moss.

# Anticancer Activity of New Taxanes



New taxanes show promising anticancer activity.

# Current Developmental Status

- Progress to date
  - Moss are now grown in bioreactors (conditions have been determined for their rapid growth).
  - Isolation protocols for taxanes have been developed, but they have not yet been purified.
- Developmental hurdles
  - Scale up taxane production in bioreactors
  - Animal testing prior to clinical studies
  - Identify and add more genes to produce more advanced taxanes and Taxol analogs.

# Technology Market

- One million cases of breast cancer every year.
- Breast cancer treatments market generated revenues of over \$11bn worldwide in 2009.
- The demand for breast cancer drugs is expected to grow by 40% in the next 4 years.

# Technology Opportunities

- Commercialization opportunities :
  - Production of taxanes as new anticancer drugs
  - Production of Taxol analogs
- Other uses:
  - Production of diterpenes with novel structures
  - Production of other terpenoids (e.g. scented moss)

# Intellectual Property Protection

- Patent pending (filed May 23, 2009)
- Claims:
  - Transgenic mosses expressing genes in the terpenoid pathway
  - Method of producing of diterpenes (not just Taxol) using transgenic moss

# Anticancer Drugs from Moss

- For more information:
  - Visit our web site:
    - <http://www.techtransfer.siuc.edu/techavail/anterola.html>
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    - Phone: (618) 453-4543
    - Fax: (618) 453-8038
- Questions?