This week in 206

From 1 week ago:

Any live chickens?

Fungi reproductive structures.

I. Escherichia coli plasmid transformation and gene expression.
antibiotic selection, bioluminescence, melanins

II. Arabidopsis thaliana molecular genetic analysis.
mutants, transgenics, gene expression

Model genetic organisms

Used to study processes in development, physiology, behavior, reproduction, disease, gene regulation, signal transduction, etc. etc.

Traits of models.

EASY + CHEAP

Limitations on space, time, funds.

Model genetic organisms

Used to study processes in development, physiology, behavior, reproduction, disease, gene regulation, signal transduction, etc. etc.

Traits of models.

EASY + CHEAP

Small
Lots of progeny
Fast generation
Inexpensive culture
Simple
Good genetics (diploid or haploid, mutagenesis, crossing)
Relevant-normal or does something interesting or useful
No “societal” problems
Small genome-(sequenced)
Transformable

Examples of model genetic organisms.

Examples of model genetic organisms.

Escherichia coli (and lambda)
Saccharomyces -Baker's Yeast
Drosophila -Fruit fly
Mus -Mouse
Danio -Zebra fish
Xenopus -African Clawed frog
Caenorhabditis -Nematode
Dictyostelium -Slime mold
Arabidopsis

Genetics has had a huge resurgence in the past several years. Biochemistry and molecular biology can't answer all the questions. Functional genomics.

Examples of model genetic organisms.

Escherichia coli (and lambda)

Arabidopsis thaliana
Very small
lots of progeny
short generation (30 days)
Smallest genome (125 million bases)
Easy to grows under many conditions
Easy to mutate and do genetics
Easy to transform.
Has roots, leaves, stems, flowers, fruits, seeds, etc.

Organism	estimated size	estimated gene number	average gene density	chromosome #
Homo sapiens (human)	2900 million bases	~30,000	1 gene per 100,000 bases	46
Rattus norvegicus (rat)	2,750 million bases	~30,000	1 gene per 100,000 bases	42
Mus musculus (mouse)	2500 million bases	~30,000	1 gene per 100,000 bases	40
Drosophila melanogaster (fruit fly)	180 million bases	13,600	1 gene per 9,000 bases	8
Arabidopsis thaliana (plant)	125 million bases	25,500	1 gene per 4000 bases	5
Zea mays (corn)	5000 million bases	~25,000	1 gene per 200,000 bases	10
Oryza sativa (rice)	565	~25,000	1 gene per 23000 bases	12
Caenorhabditis elegans (roundworm)	97 million bases	19,100	1 gene per 5000 bases	6
Saccharomyces cerevisiae (yeast)	12 million bases	6300	1 gene per 2000 bases	16
Escherichia coli (bacteria)	4.7 million bases	3200	1 gene per 1400 bases	1
H. influenzae (bacteria)	1.8 million bases	1700	1 gene per 1000 bases	1


Macdonald


Sisson


Stein


Iyer


Chan


Appling


Jayarrum


Paull


Johnson


Stevens

Saccharomyces


Fischer


Atkinson

Drosophila


Gottlieb


Sung


Roux


Brown


Lloyd

Arabidopsis


Browning


Juenger

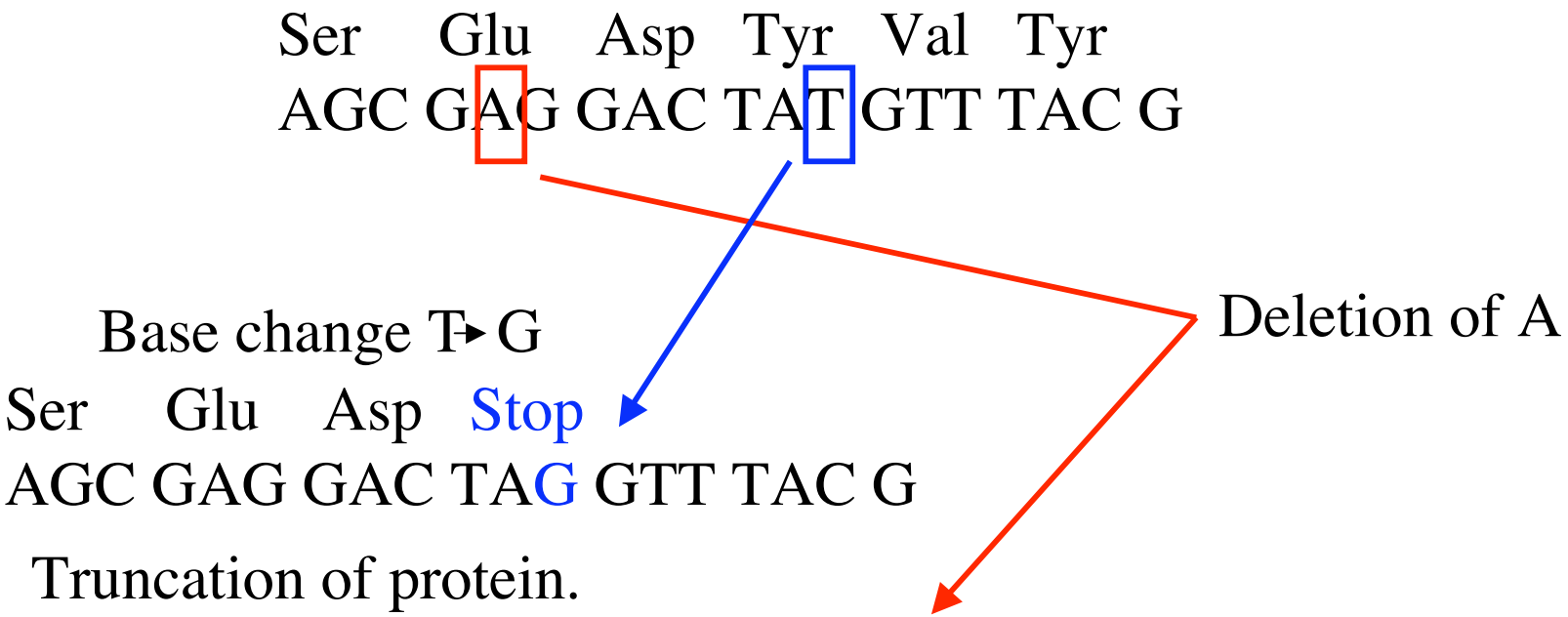

Linder


Huq

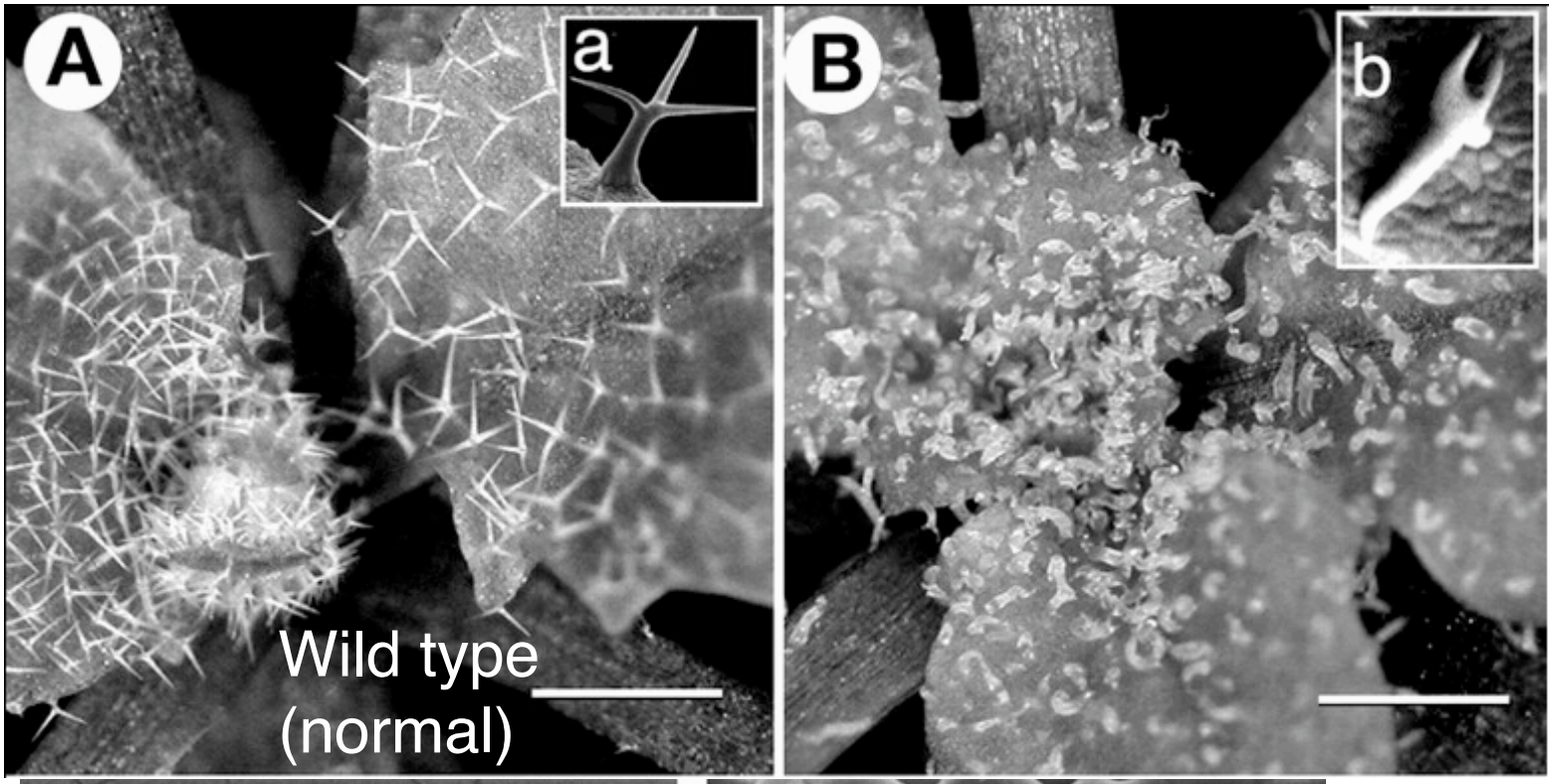

Chen

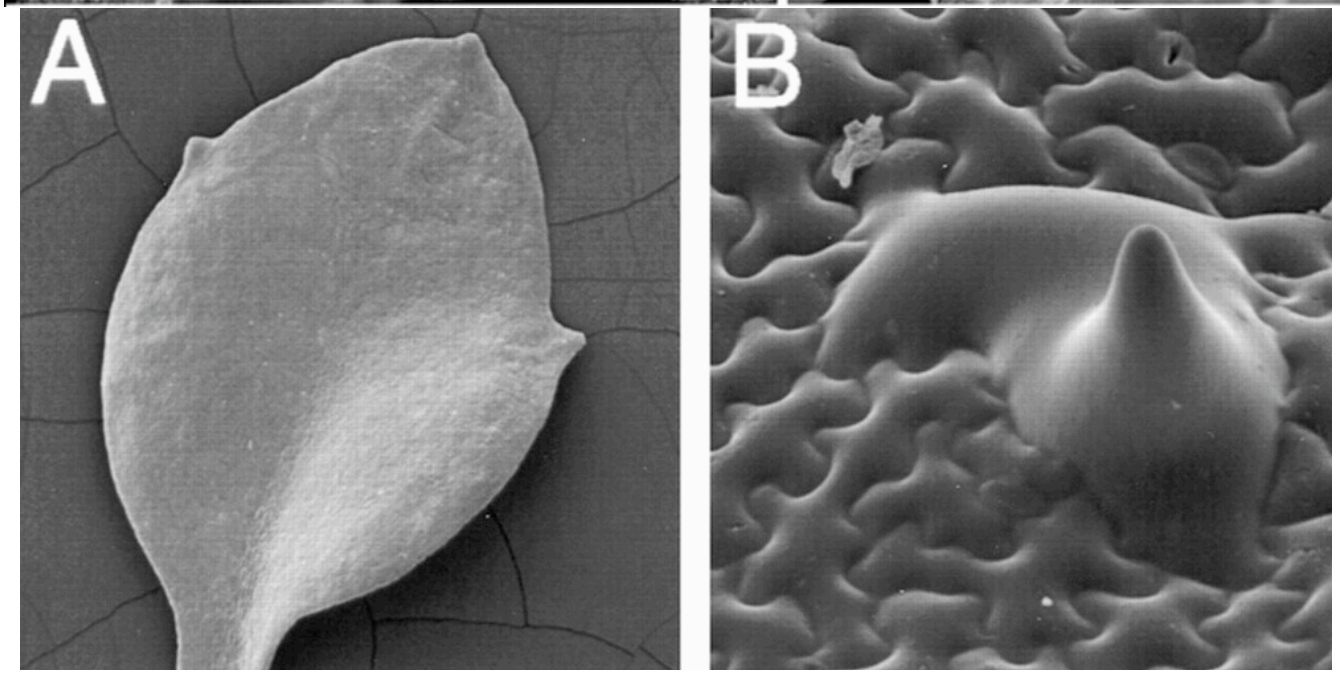

Mehdy

Mutation-change in DNA sequence. Can lead to a change (usually loss) in gene expression.



Other mutations include insertions, inversions, translocations.
Mutagens- chemical, x-ray, UV, sloppy polymerase.

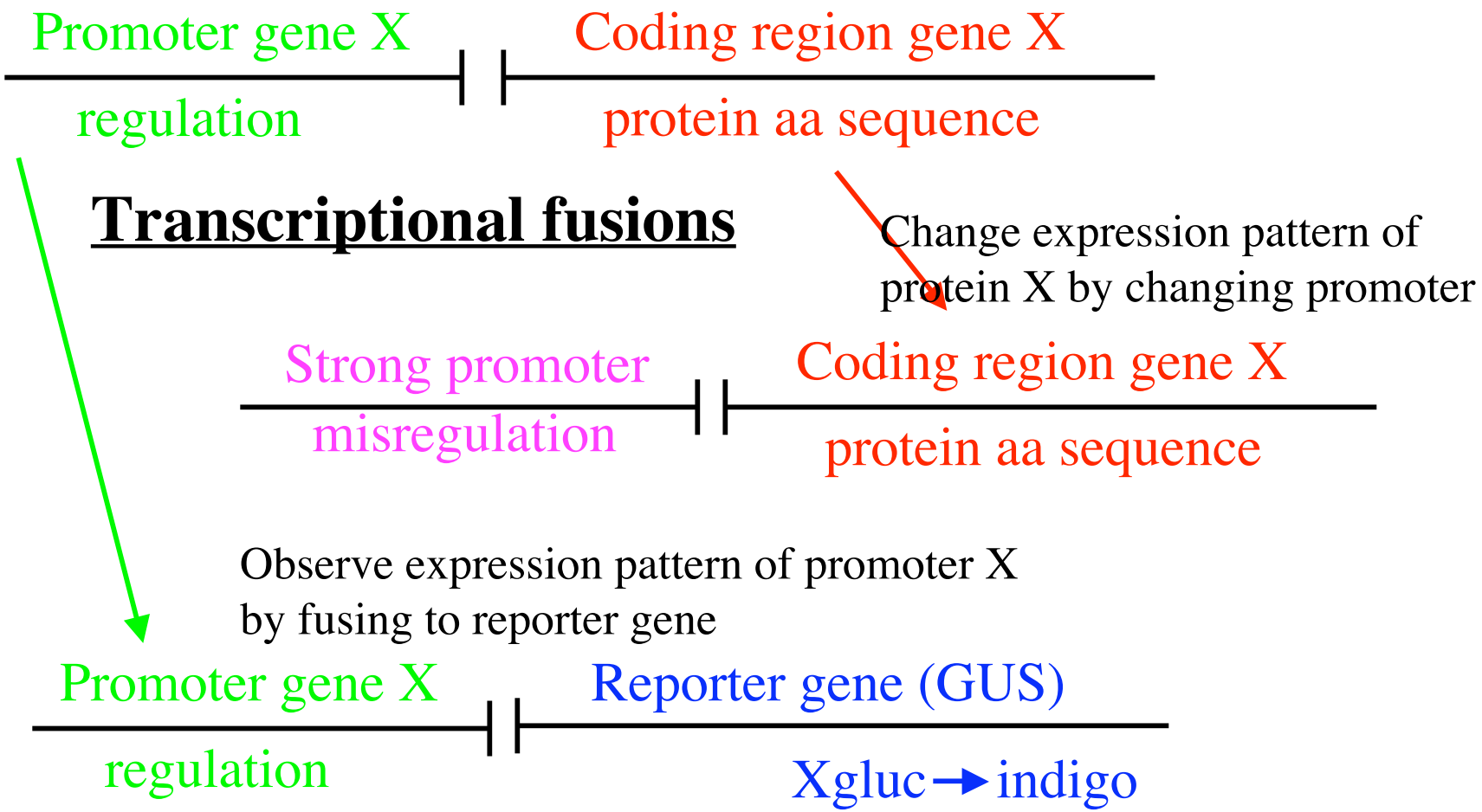




Arabidopsis
trichome mutants

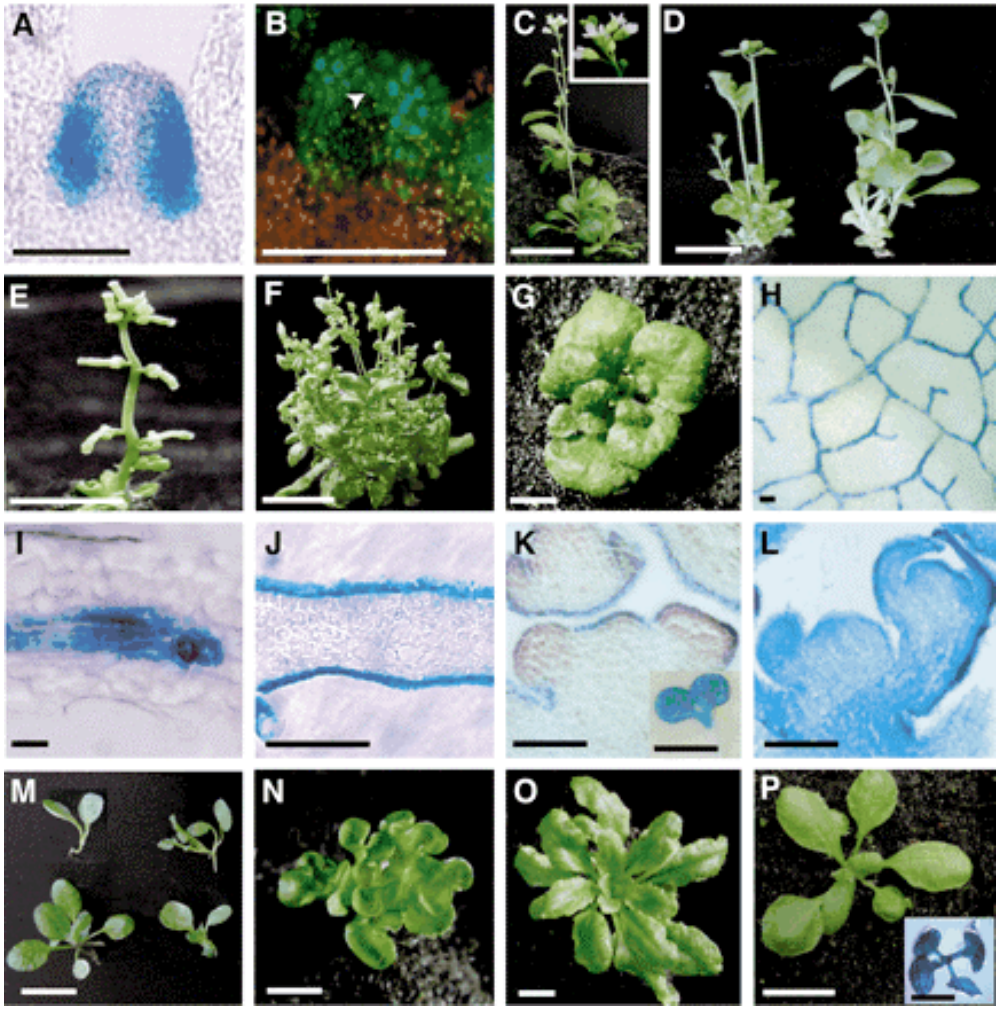
Gene organization and expression.

DNA ⟷ RNA ⟷ Protein **"Central Dogma"**

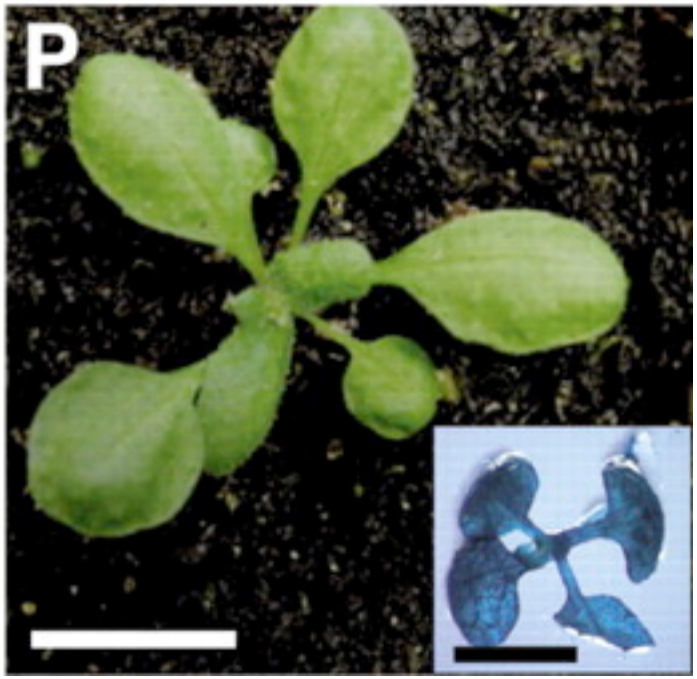


Basic tools to study gene function and expression in "model genetic organisms"

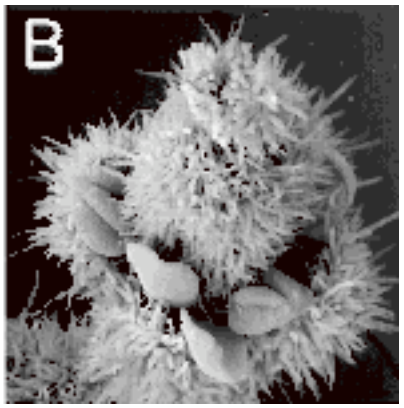
Where is a gene expressed?
What does the gene control?

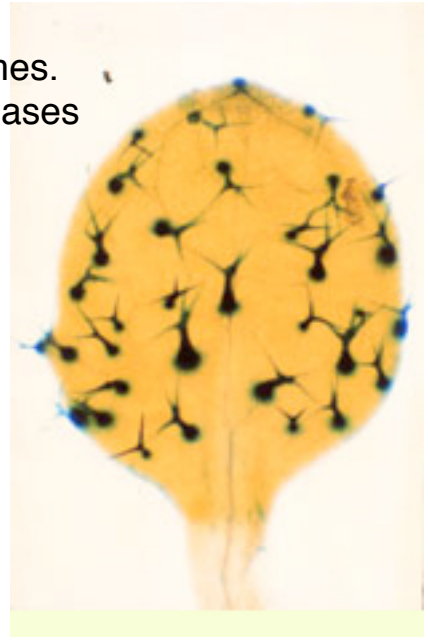


Transgene examples

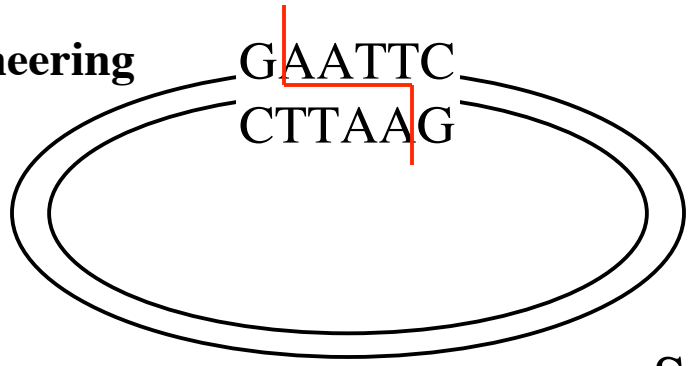


Gene expressed in trichomes.
Overexpressed gene increases trichome number.





Molecular Biology and Genetic engineering With Plasmids



Eco RI

Restriction enzymes or endonucleases
Cut 4 to 6 bases mostly palindromes (dyad symmetry).

Sticky ends

AATTC
G

Gene X (or any DNA)

G
CTTAA

Complementary bases

DNA ligase knits strands together to make circle.

AATTC — Melanin genes — G
G — CTTAA

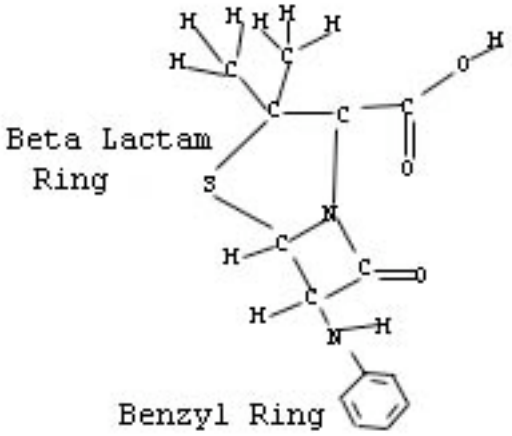
G AATTC — Bioluminescence — G **AATTC**
CTTAA G — CTTAA **G**

Betalactamase

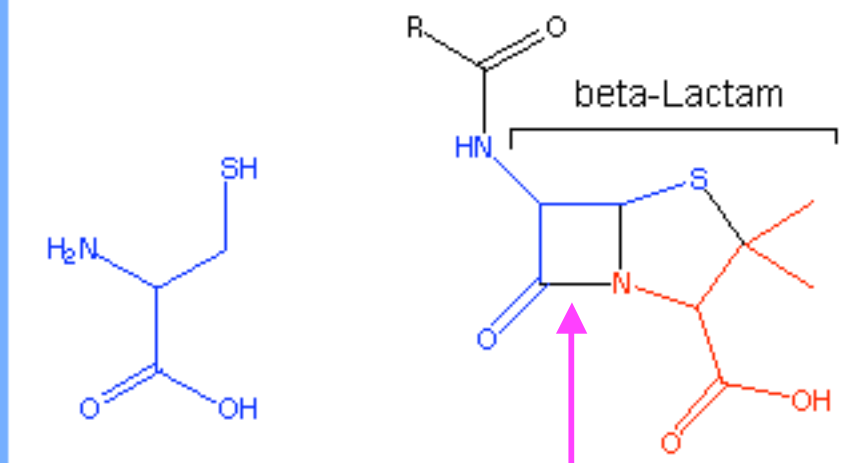
AATTC — GUS gene — G
G — CTTAA

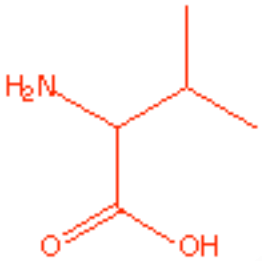
Transform E. coli

Penicillin



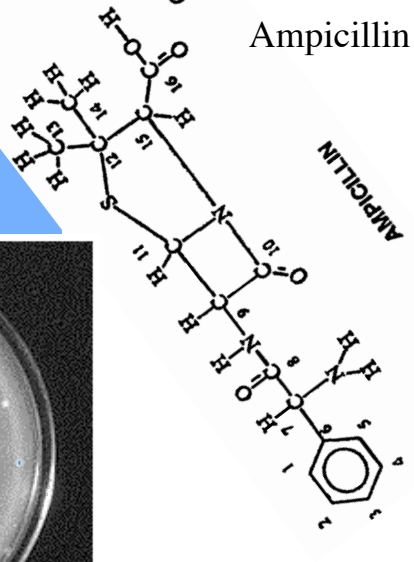
Penicillin - Beta Lactam Structure



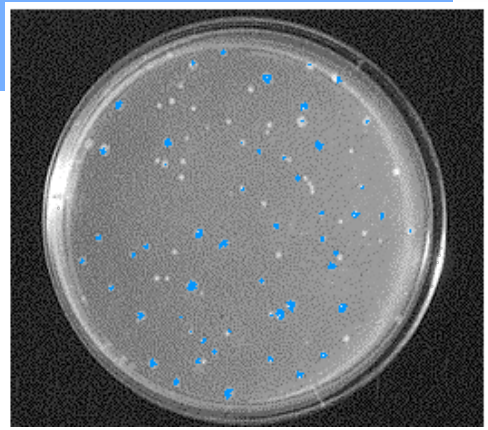


C. Ophardt, c. 2003

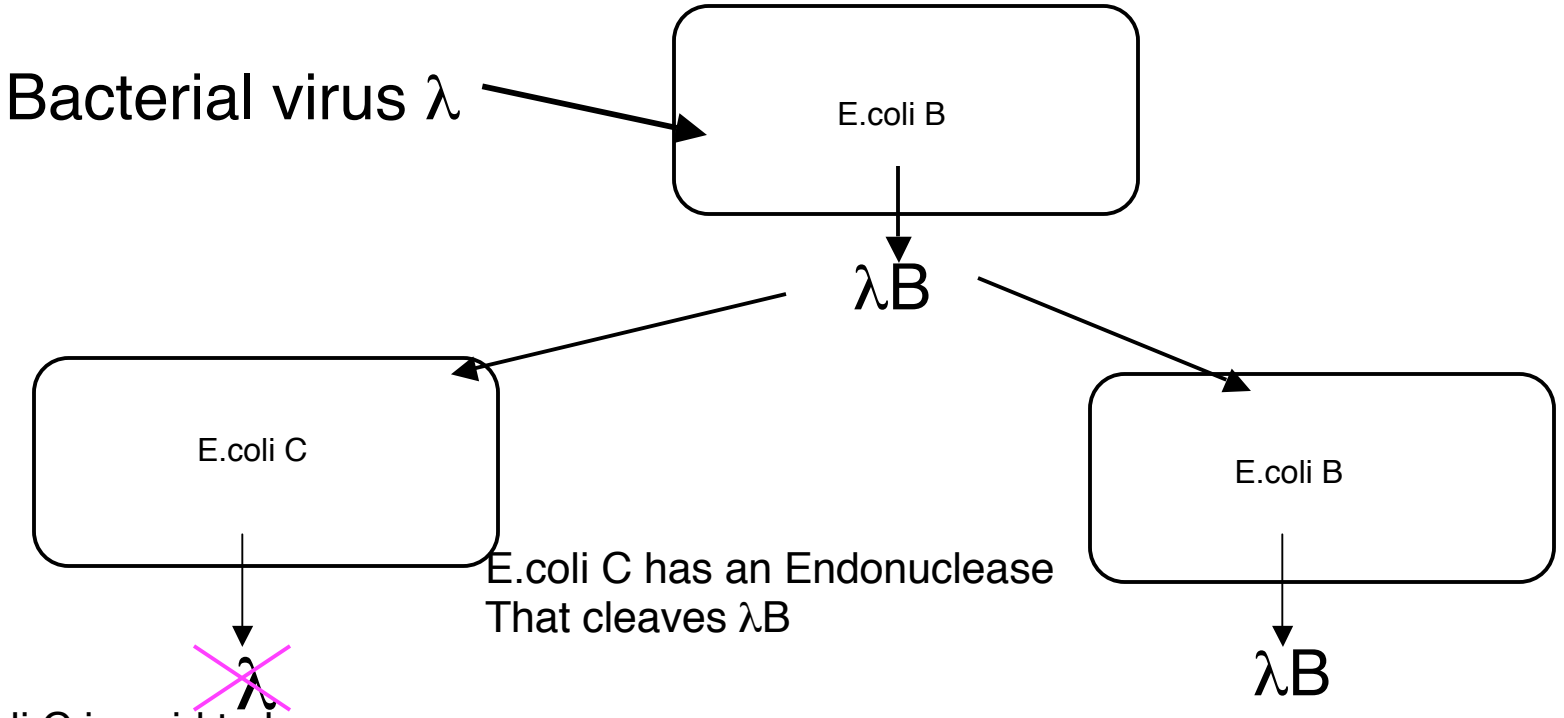
Ampicillin



Beta lactamase cleaves lactam ring.



Restriction Endonucleases part of Restriction System Of most bacteria.



E.coli C has an Endonuclease
That cleaves λB

E.coli C is said to have a
Restriction System which
Restricts the growth of λB.

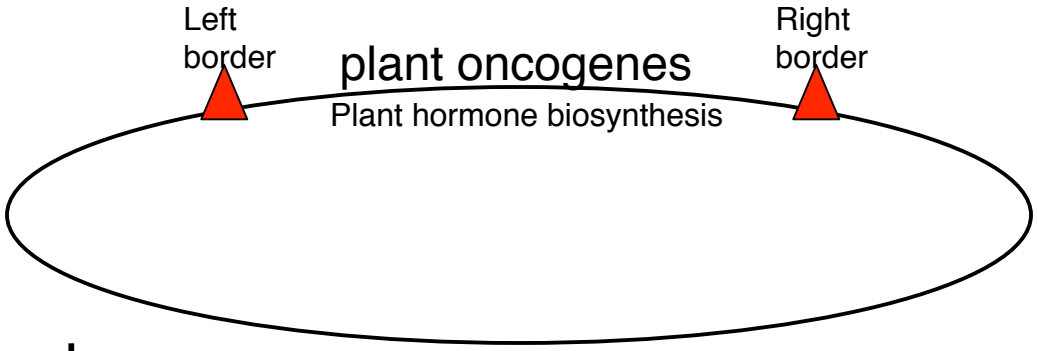
Most bacteria have some sort of restriction system.

Eco R1	*Escherichia coli* restriction 1	GAATTC CTTAAG
Bam H1	*Bacillus amyloliquifaciens* H1	GGATCC CCTAGG
Bgl 2	*B. globigii 2*	AGATCT TCTAGA

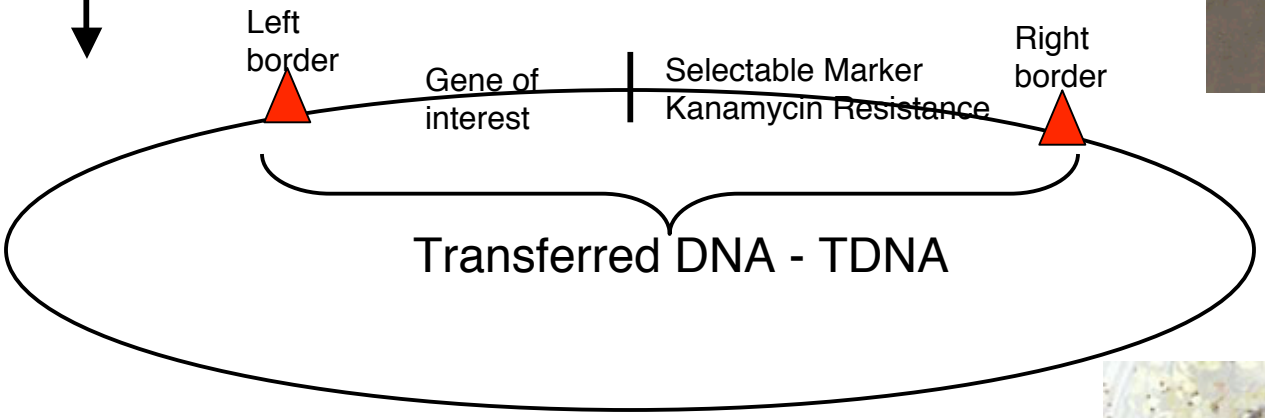
Hundreds have been discovered and are commercially available.

Agrobacterium tumefaciens crown gall disease

TI plasmid tumor inducing plasmid



Engineer oncogenes out--desired genes in.



Transform plant.

Genetically engineered products.

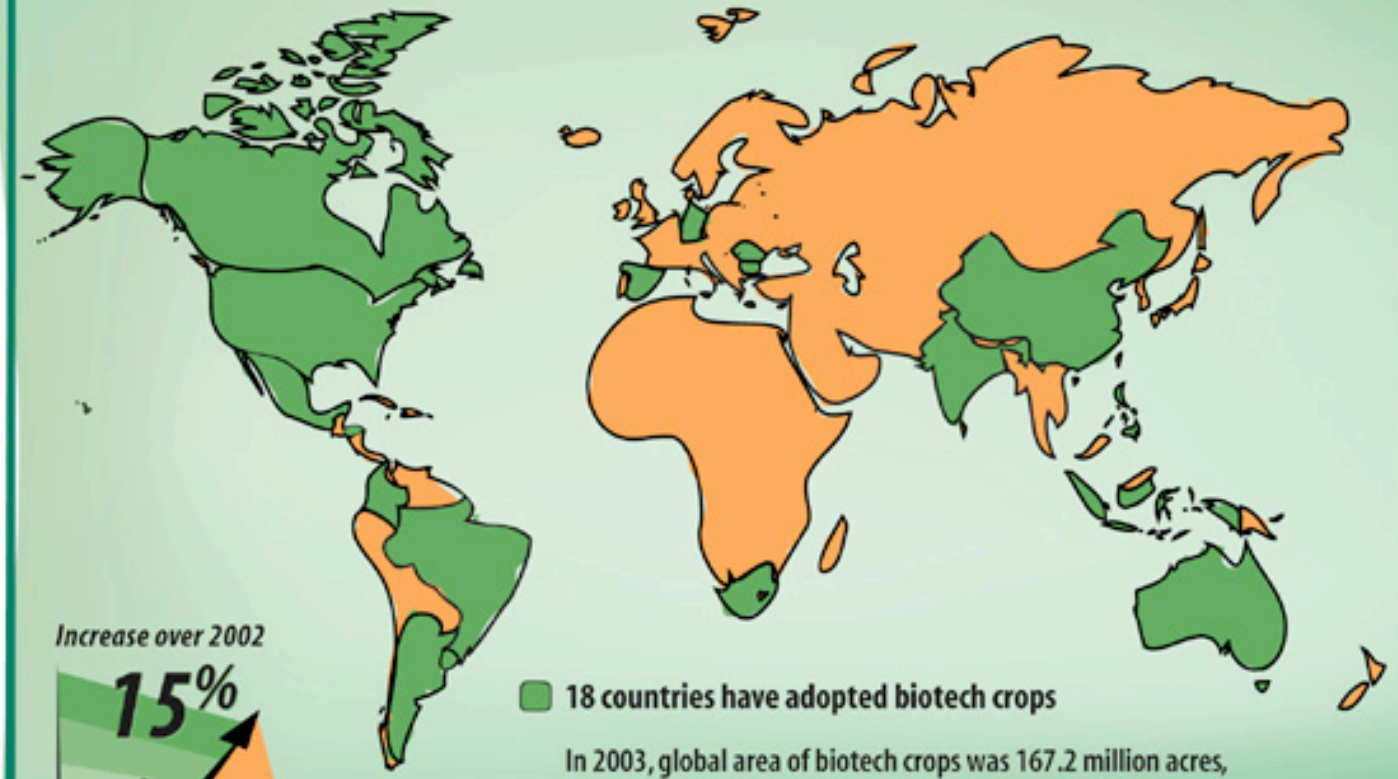
Flavr-savr tomato--altered senescence gene.
turn red on vine but don't soften. 1st commercial transgenic crop product.

Insect resistance--Bacillus thuringiensis insect toxin gene.
Bt cotton, corn, soybean, etc. **Bollgard® YieldGard®**

Herbicide resistance--EPSP synthase-aromatic amino acid.
Roundup Ready®
Roundup-ready cotton, etc.

Companies rejecting GMO--Frito Lay, Gerber, Heinz, Seagram, McDonald's

Global Status of Biotech Crops in 2003



18 countries have adopted biotech crops

In 2003, global area of biotech crops was 167.2 million acres, representing an increase of 15% acres over 2002.

Source: Clive James, 2003, International Service for the Acquisition of Agri-biotech Applications

125,000 acres or more	
USA:	105.7 million
Argentina:	34.3 million
Canada:	10.9 million
Brazil:	7.4 million
China:	6.9 million
South Africa:	0.9 million
Australia:	0.25 million
India:	0.25 million
Romania:	<0.25 million
Uruguay:	<0.25 million

125,000 acres or less	
Spain	Bulgaria
Mexico	Honduras
Philippines	Germany
Colombia	Indonesia

Human single gene traits.

1. A. Hair between 1st and 2nd knuckle.
   B. No hair ----

2. A. Widow's peak.
   B. No widow's peak.

3. A. Detached ear lobe.
   B. Attached ear lobe.