DNA Day: Genetics at UH Mānoa

Examples of classes and research

Floyd Reed

Dept. of Biology

BIOL 375 Genetics (Fall, Reed)

General genetics topics:

Predict the outcome of a cross.

Infer the interaction of genes.

Learn about genome structure.

Understand how the environment and genetics interact to produce traits.

Learn how organisms are genetically modified.

Introduction to genetic drift and evolution.

Clasp your hands together.

Is your

A) left thumb on top

B) right thumb on top

Which thumb is on top is not determined by handedness. Children are correlated with their parents.

Parents	L	R	% Left
L x L	1,252	880	59%
L x R	2,309	2,573	47%
R x R	1,298	2,815	32%

Reiss (1999)

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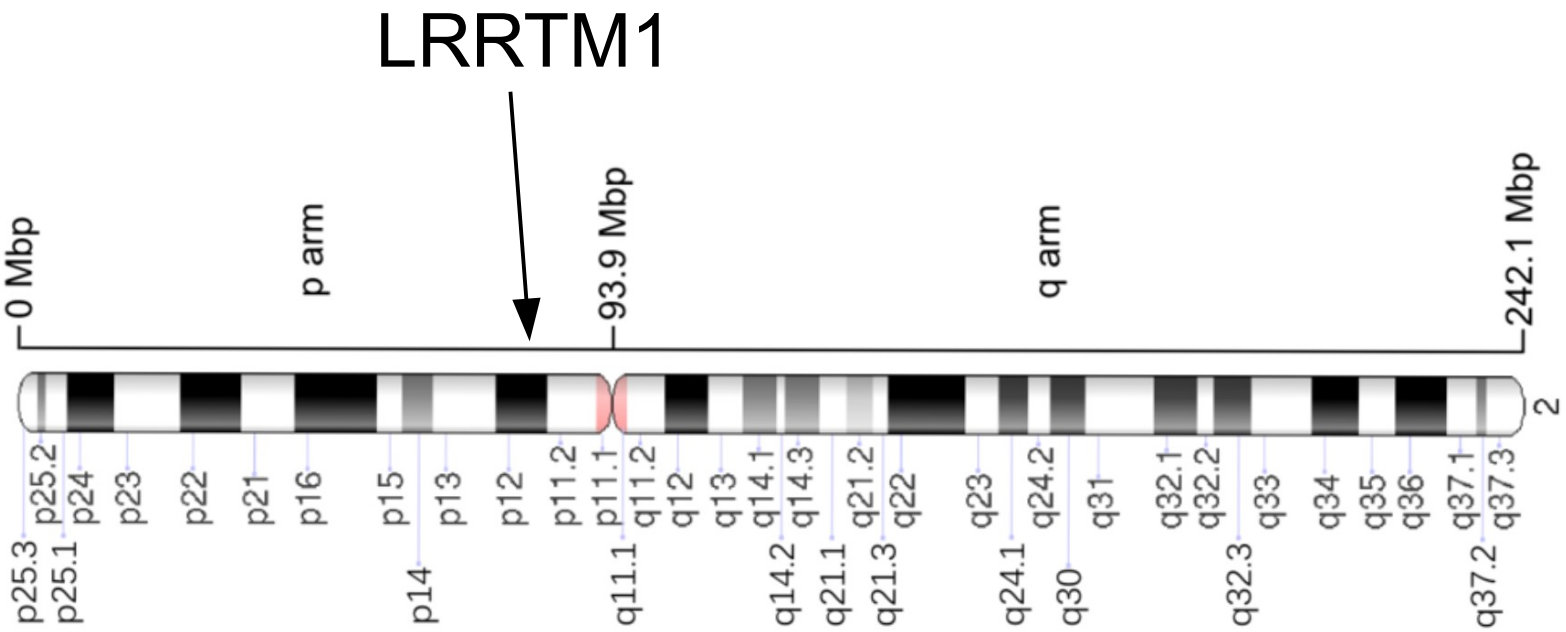

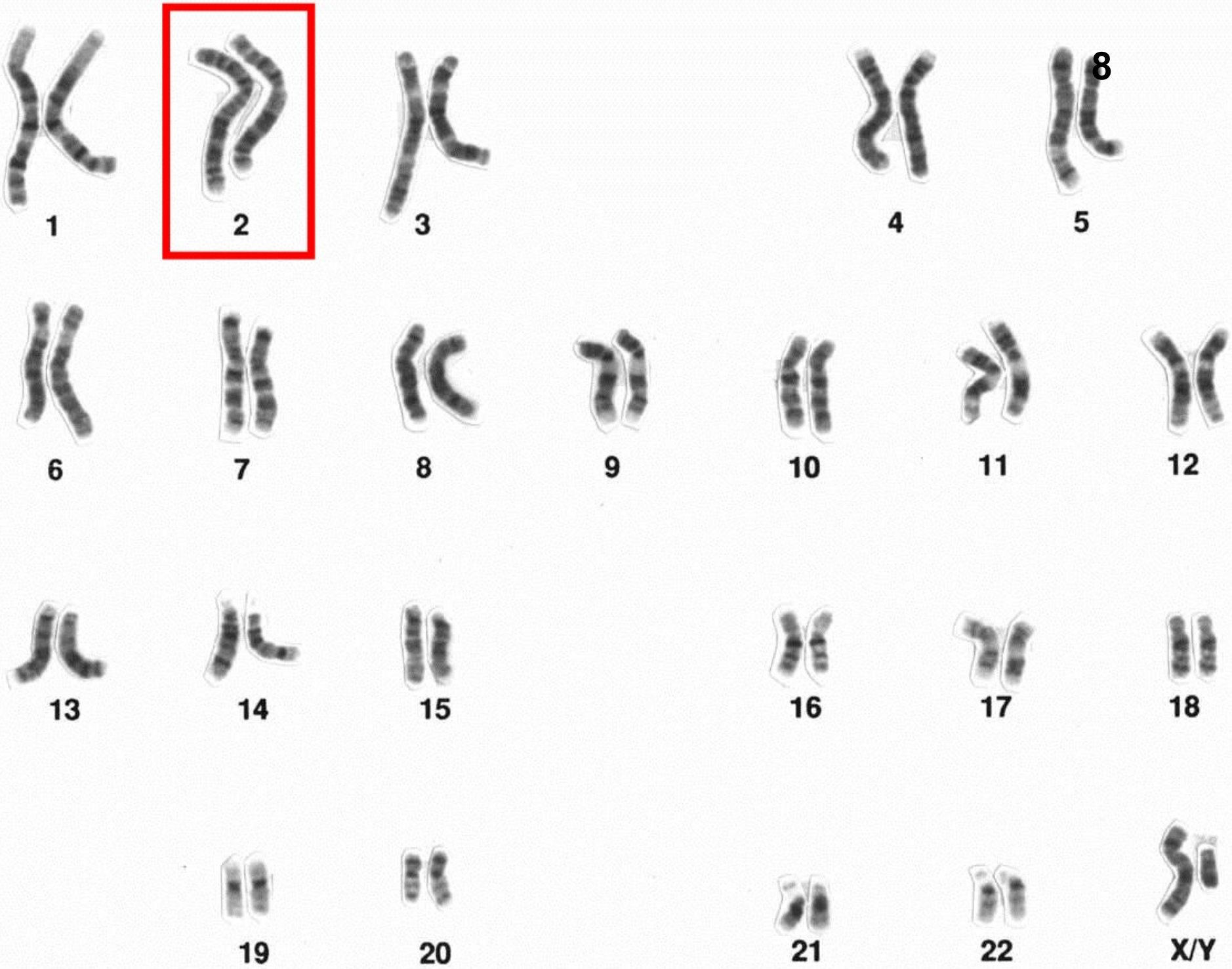
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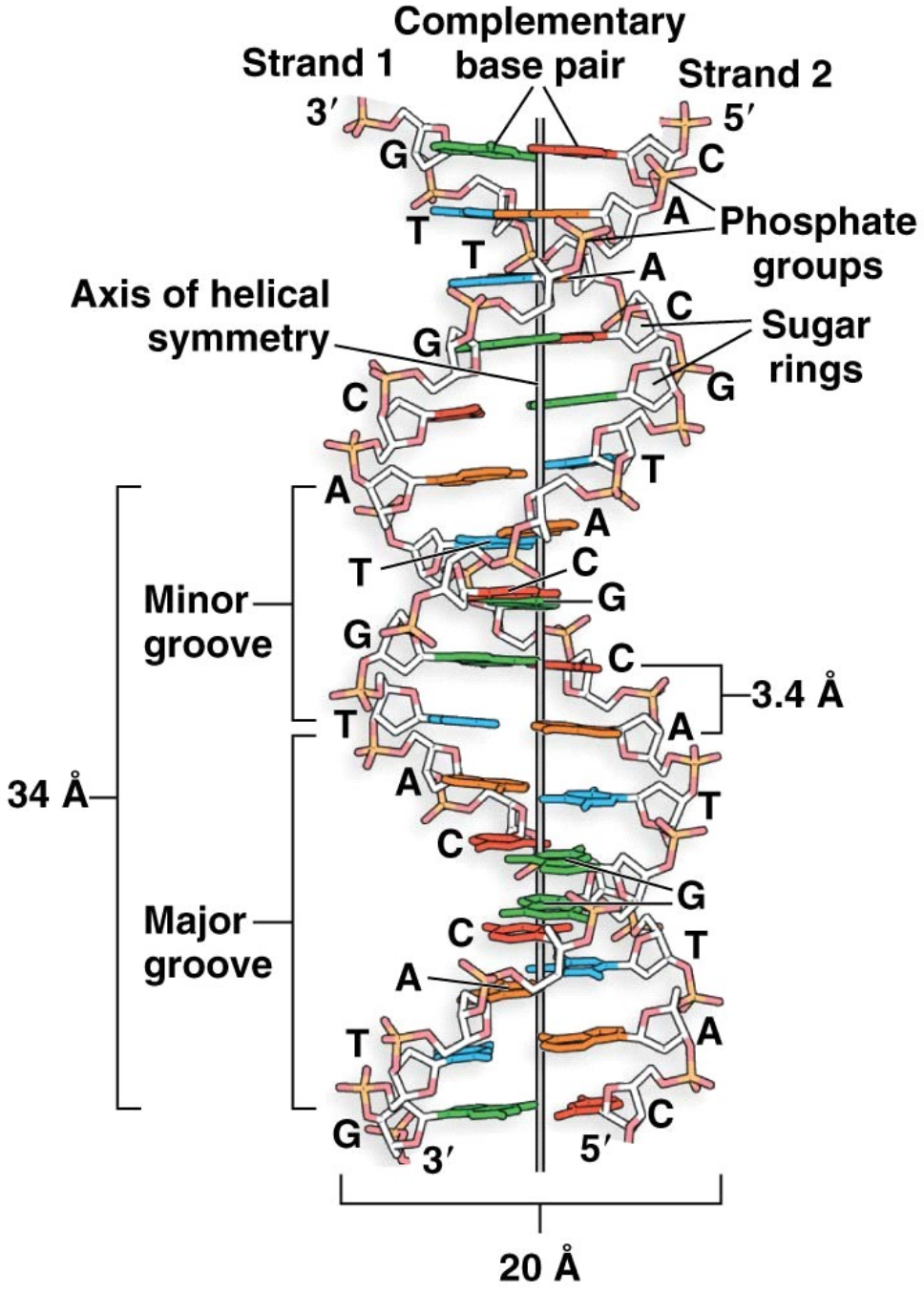
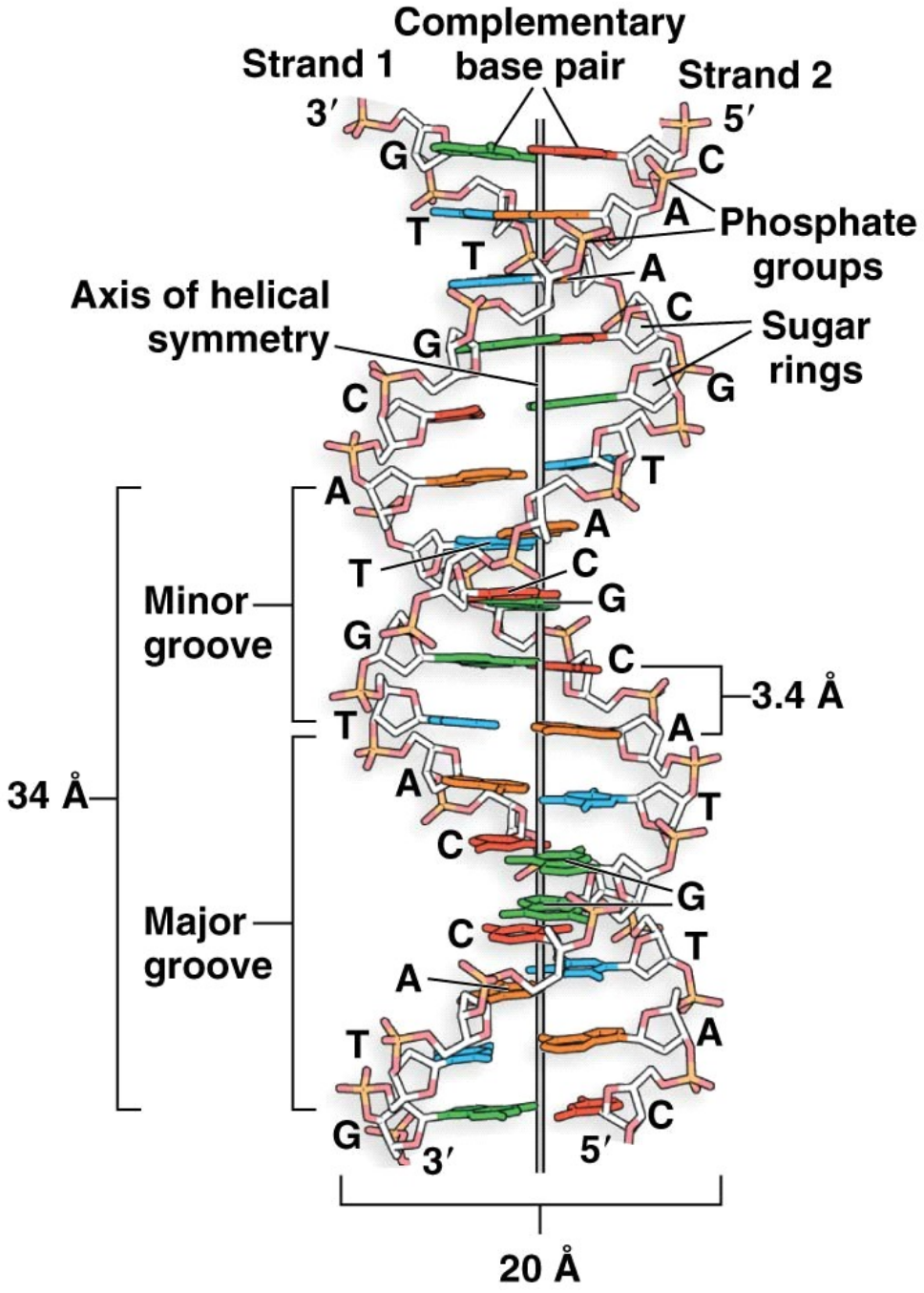
X/Y



The human genome is 3.3 billion (10^9) nucleotide pairs long.

How long is one copy of the human genome (chromosome DNA laid end to end) from a single cell?



1.1 m (3.6 feet)

On average a single chromosome is 1/23 of this distance.

= 4.8 cm (1.89 inches)

A single molecule can be over an inch long!

We actually have two copies of our genome (7 feet of nuclear DNA per cell).

There is a total of 2.2 meters of DNA (diploid) per cell.

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Or 2.2×10^{10} kilometers (22 billion km).

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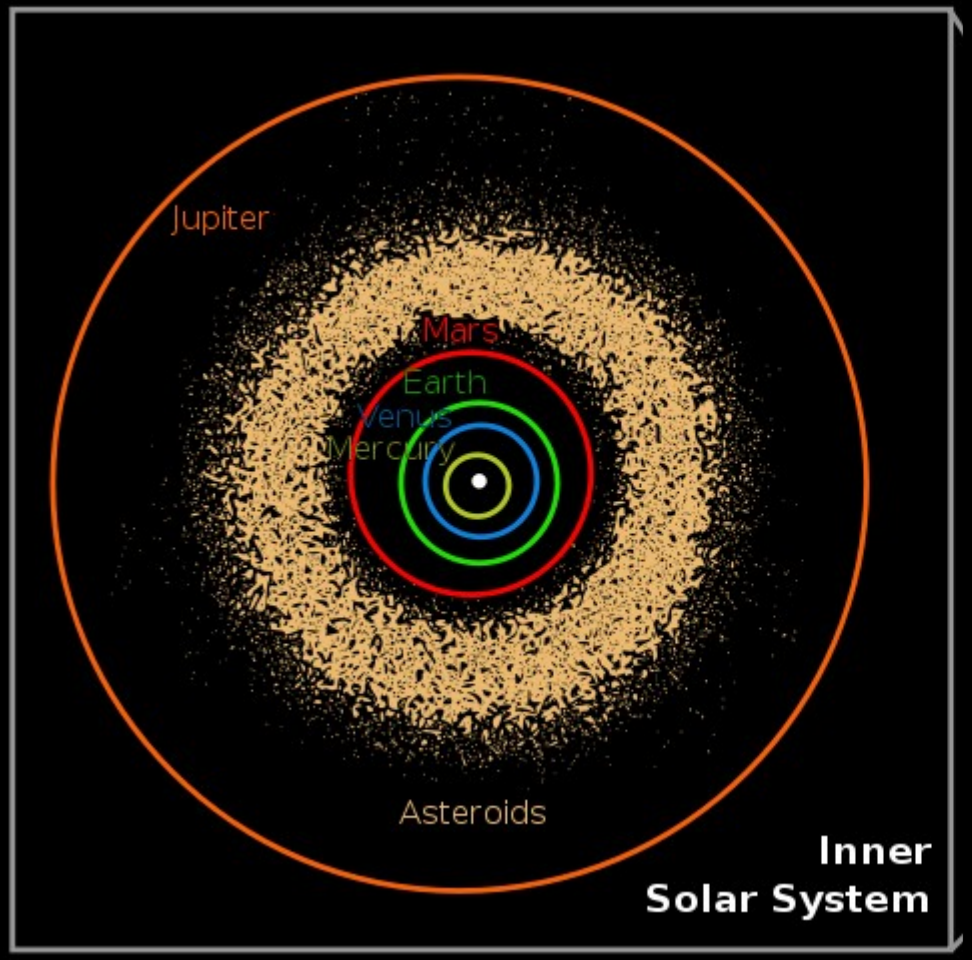
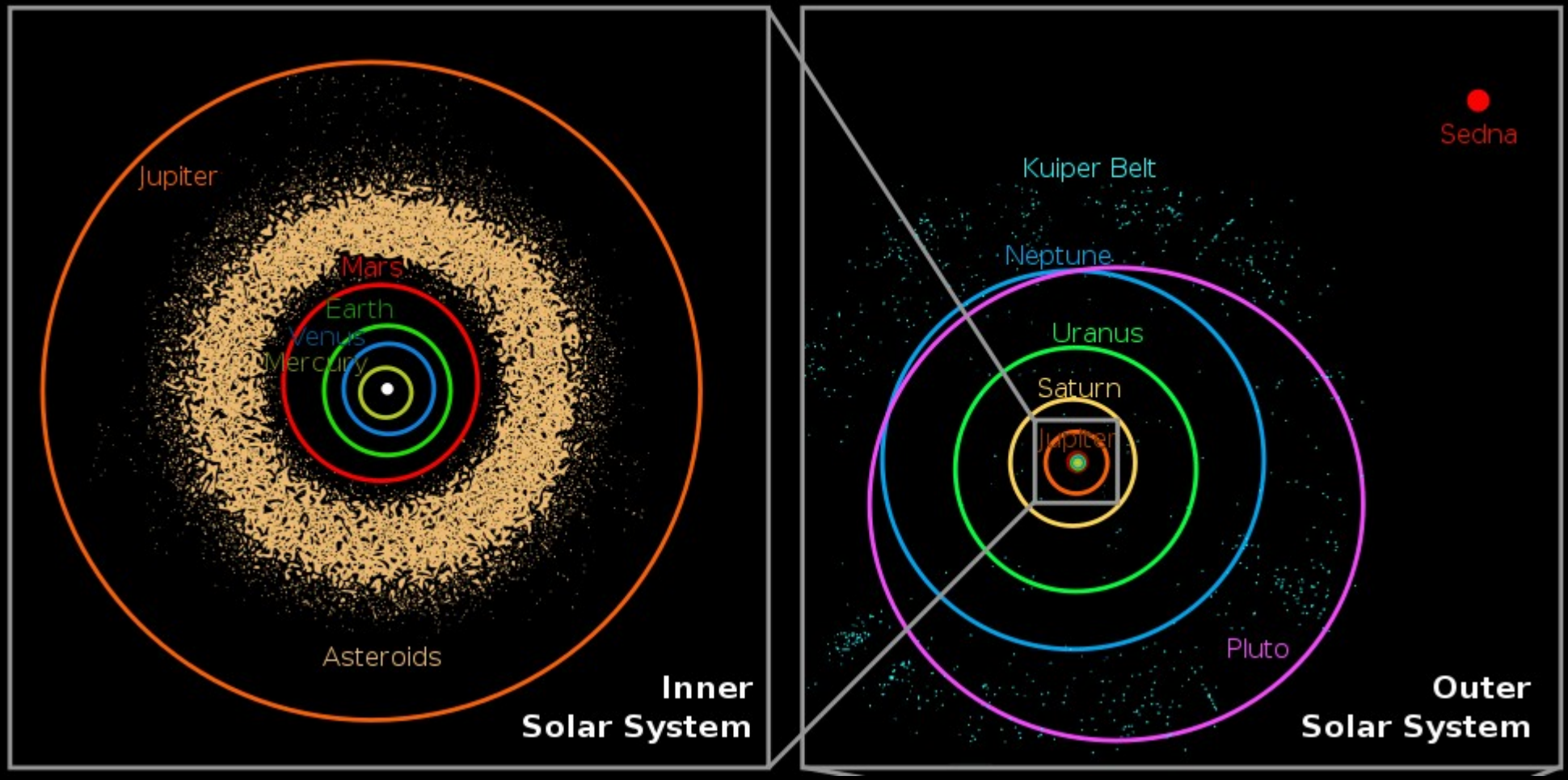
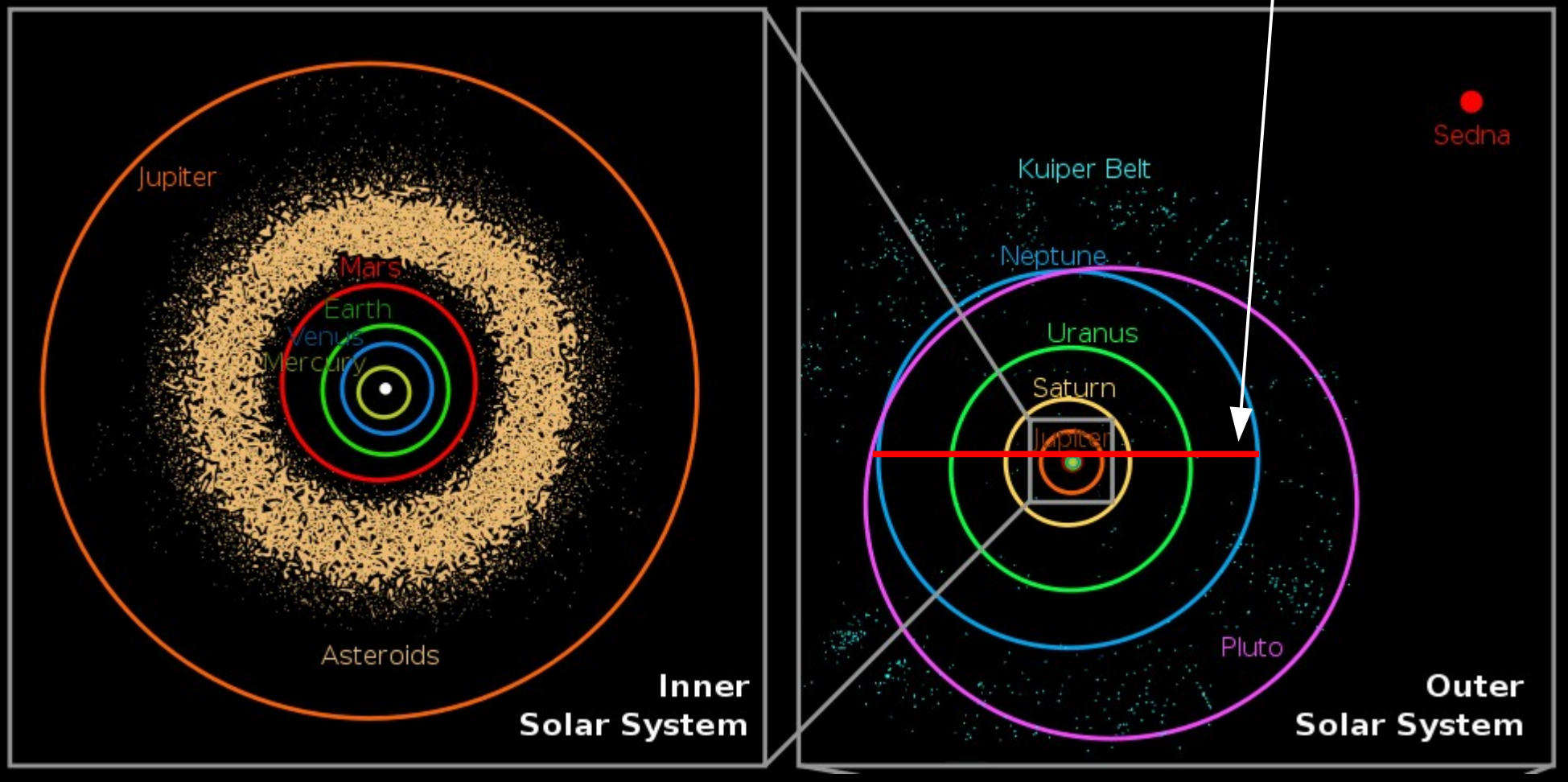
Or 2.2×10^{10} kilometers (22 billion km).

Neptune is 4.5×10^{9} (4.5 billion) kilometers from the sun.


Jupiter
Mars
Earth
Venus
Mercury
Asteroids
Inner
Solar System


Jupiter
Mars
Earth
Venus
Mercury
Asteroids
Inner
Solar System
Sedna
Kuiper Belt
Neptune
Uranus
Saturn
Jupiter
Pluto
Outer
Solar System

9 billion km diameter

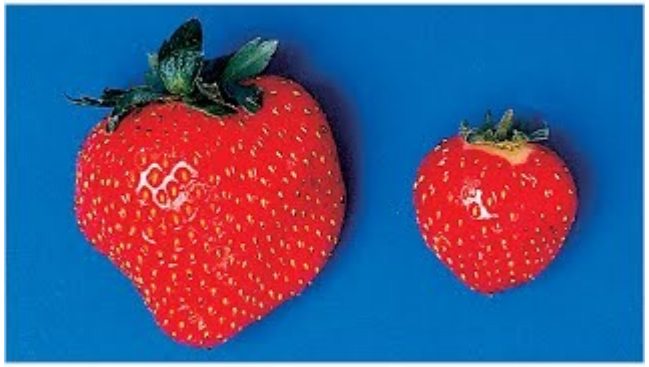


Your DNA 22 billion km

Your DNA is as long as the diameter of the solar system.

Some species genomes can be much larger than humans, e.g. many plants and salamanders.

The larger the genome (DNA) contained in a cell, the larger the cell is, and the larger the organism becomes.



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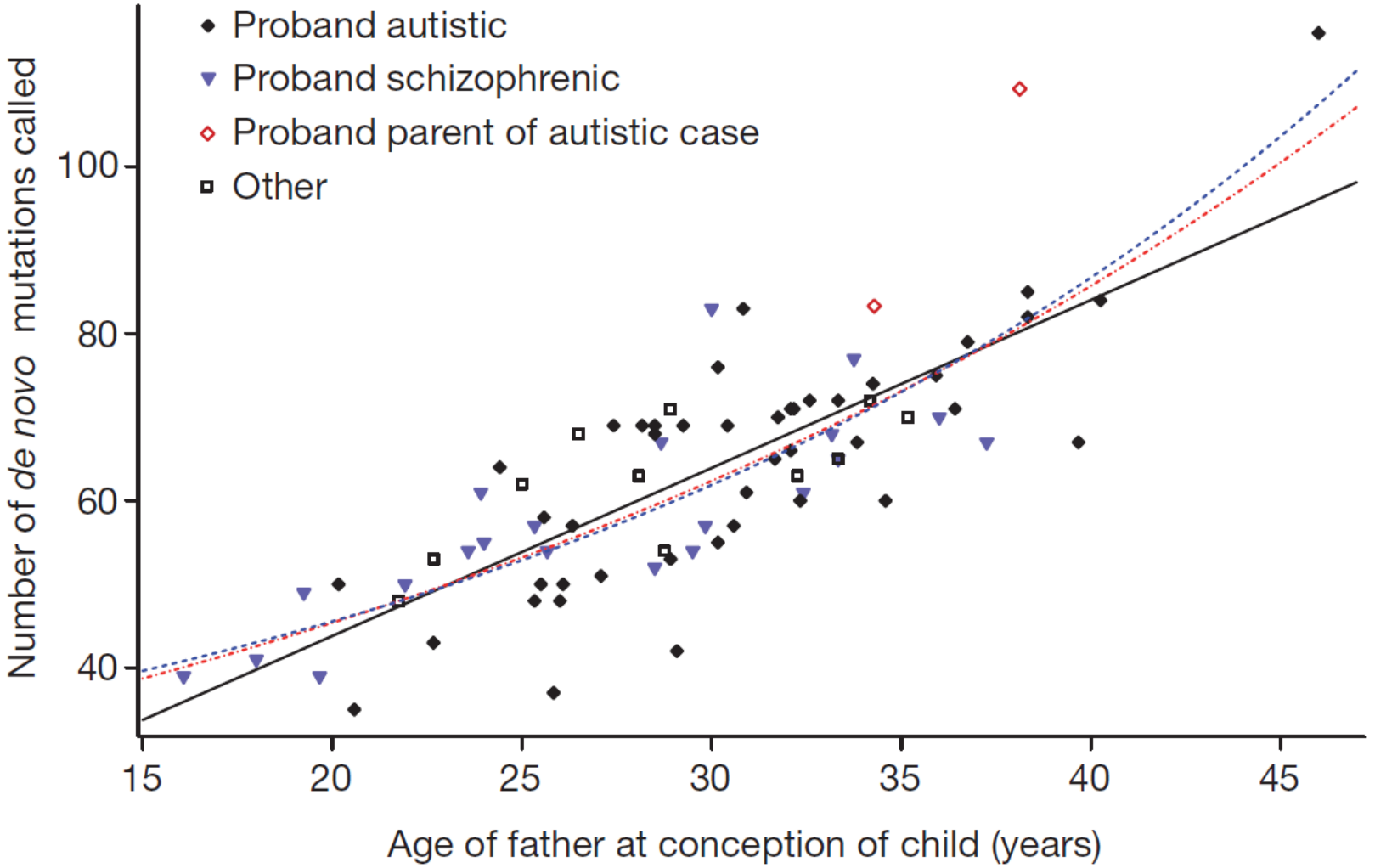
Mutation Rates and the Genome

I am a new mutant (from my parents)

A) Yes

B) No

Result from whole genome sequencing



~60 mutations per person

Each year of the father adds two more mutations on average

Kong *et al*. 2012

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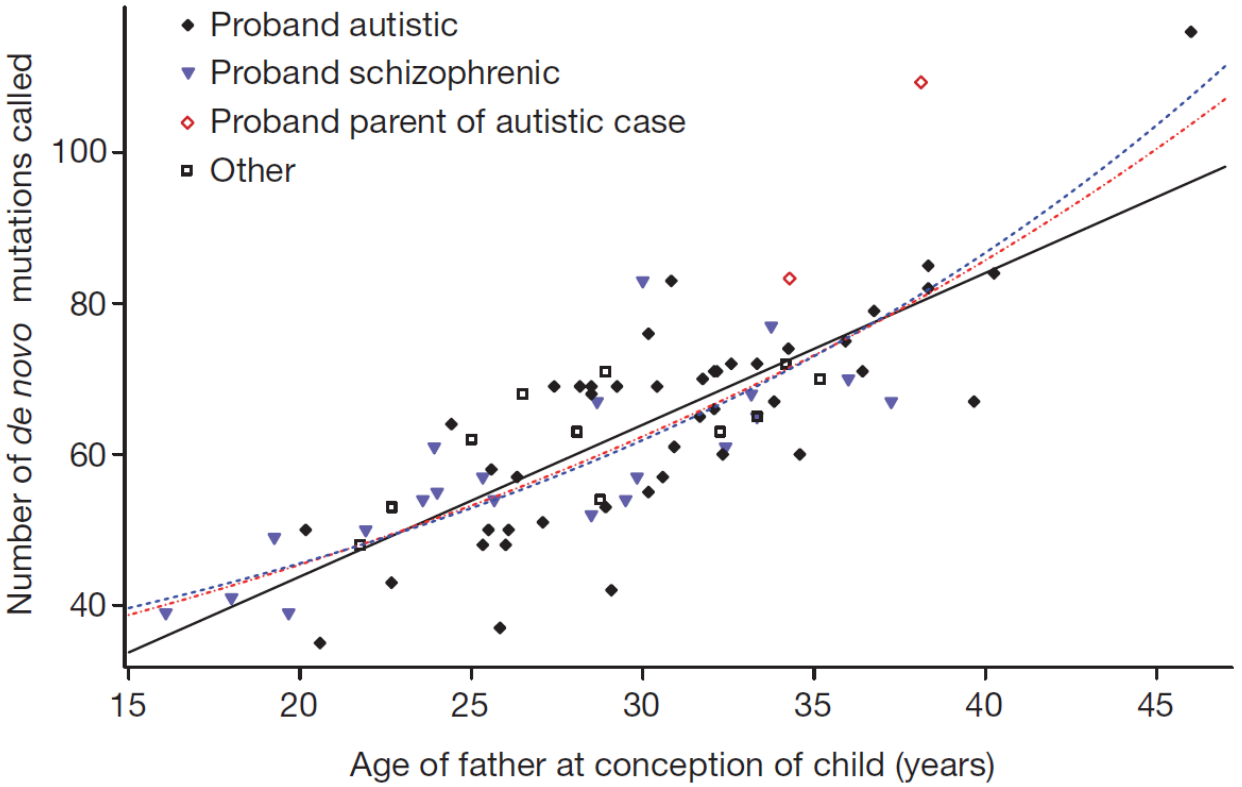


~60 mutations per person

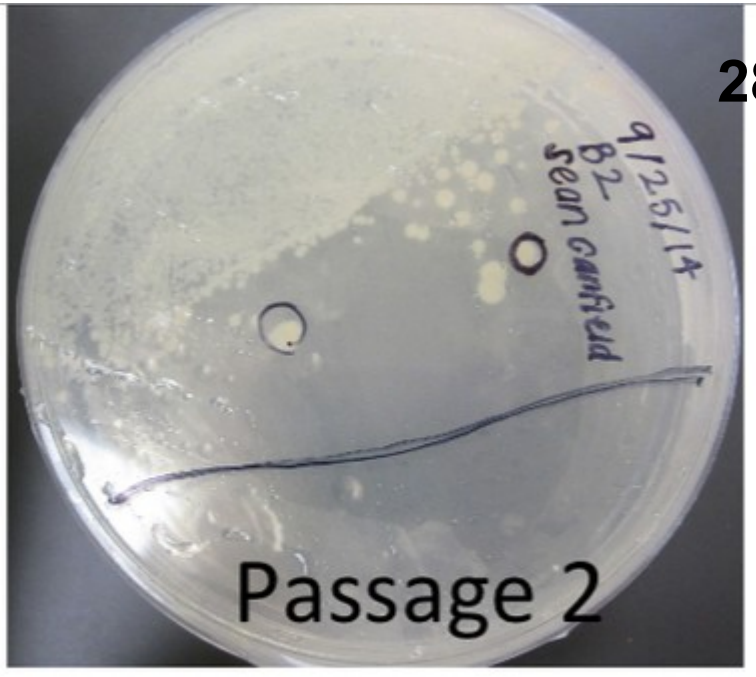
About 10% of these, ~6, are “important” (~1 is in an exon).

The chance of not having any (of 6) is 0.0025 (1 out of 400)

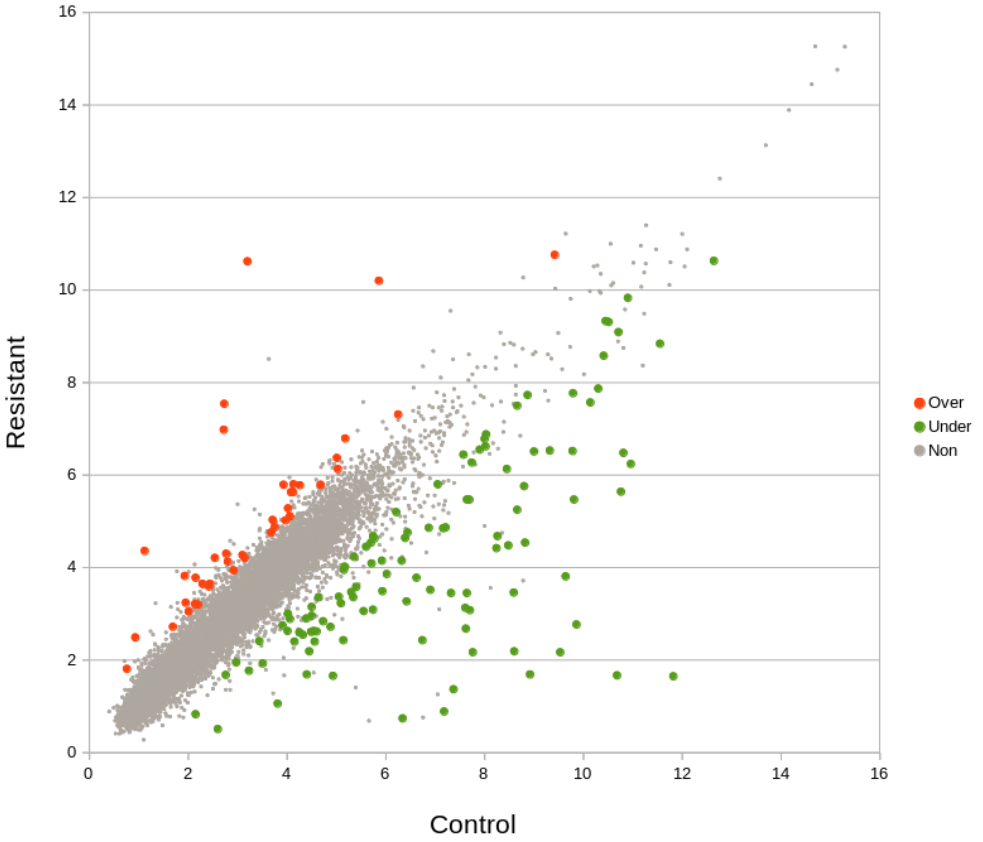
Kong *et al*. 2012

BIOL 375L Genetics Lab (Fall, Reed)

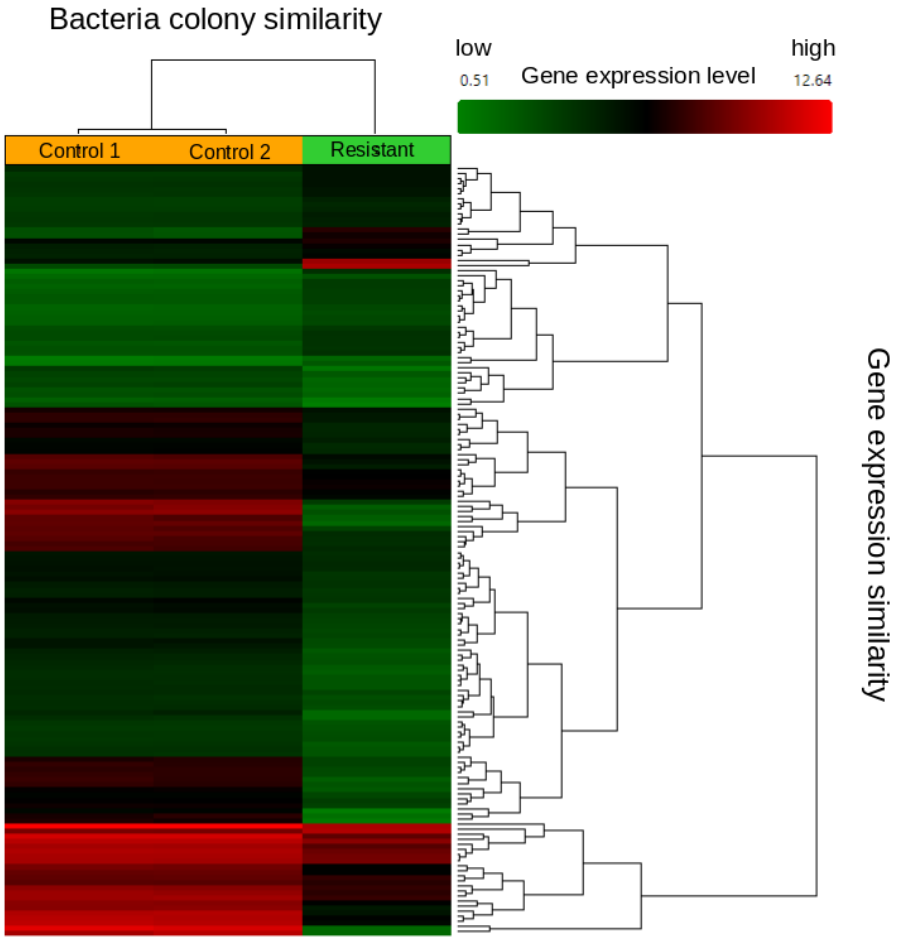
Two examples from the genetics lab



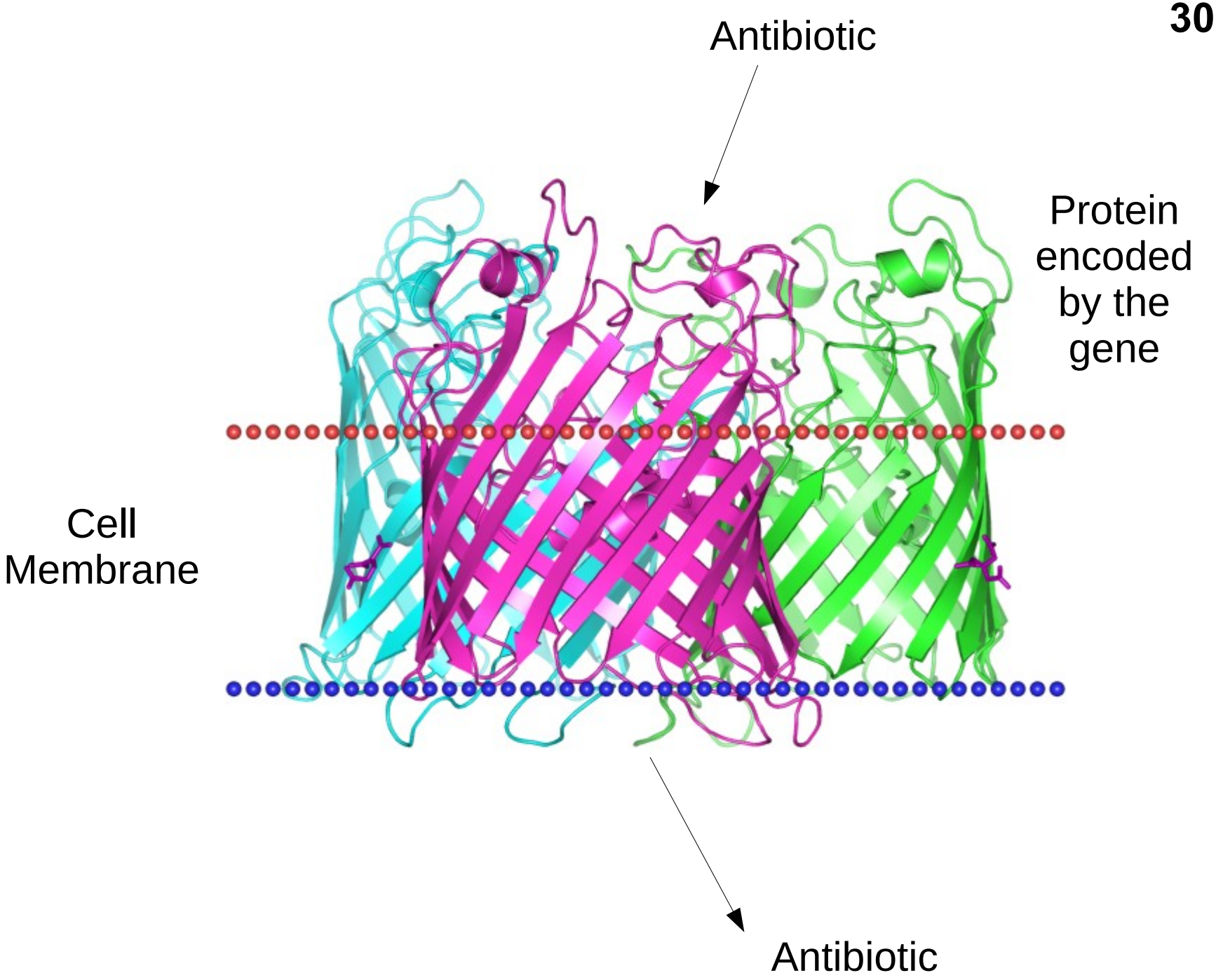
Evolution of antibiotic resistance in *E. coli*



A comparison of the gene expression levels of the antibiotic resistant clone to the controls. Genes with significantly (ANOVA P<0.05) higher (Over, 40 genes) or lower (Under, 110 genes) expression in the resistant line compared to the controls are indicated with red or green points respectively. The genes without significant differences in expression are indicated by small gray points.

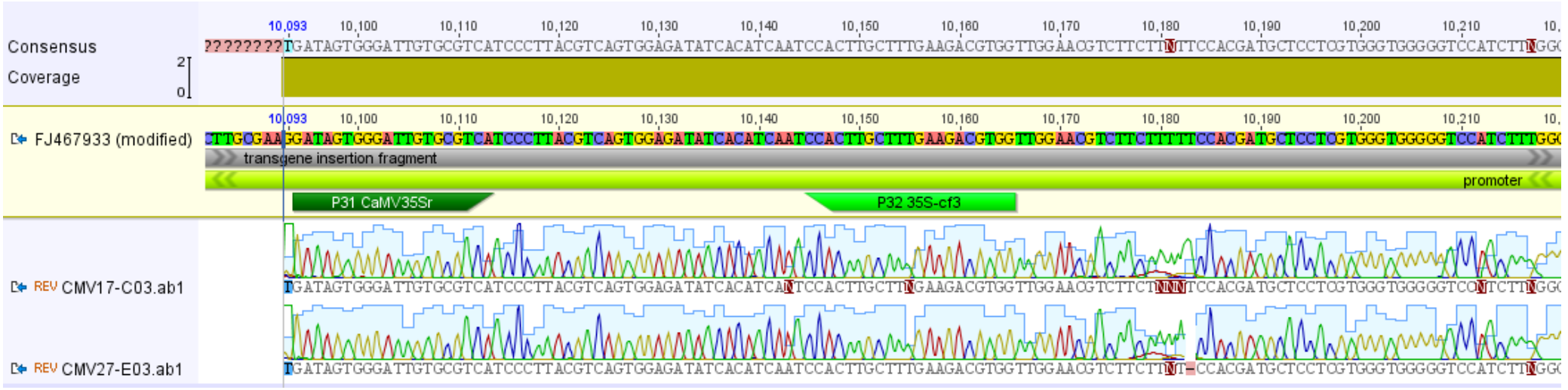


Hierarchical clustering of three clones and the 150 genes with significant differences in expression. The two control lines are nearly identical in their gene expression profile compared to the line that evolved resistance. Several different clusters of genes with similar gene expression profiles across the colonies can also be identified.

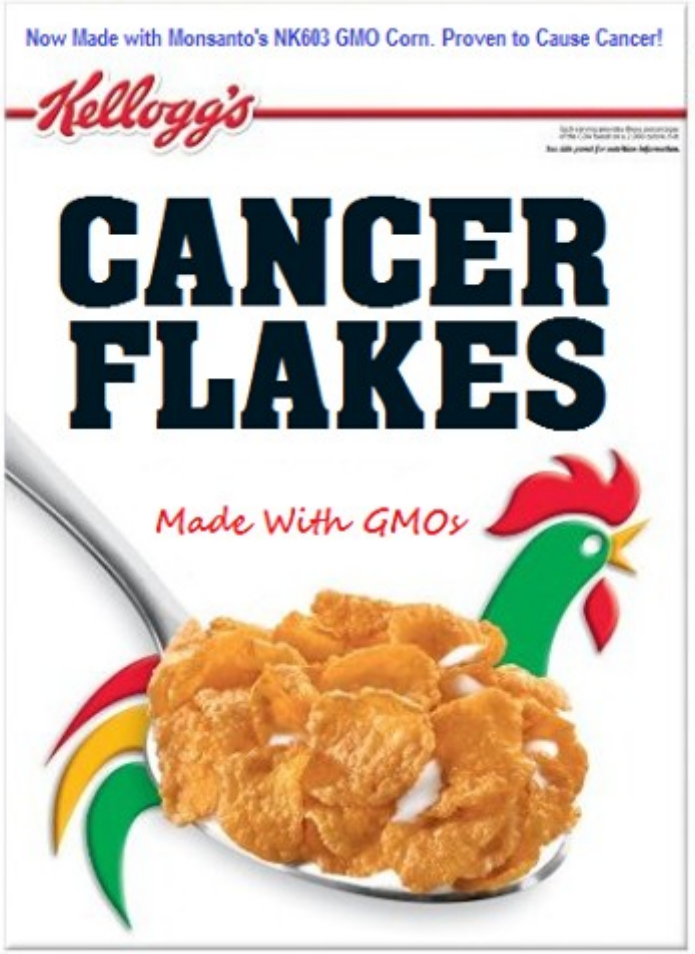

Antibiotic
Protein encoded by the gene
Cell Membrane
Antibiotic

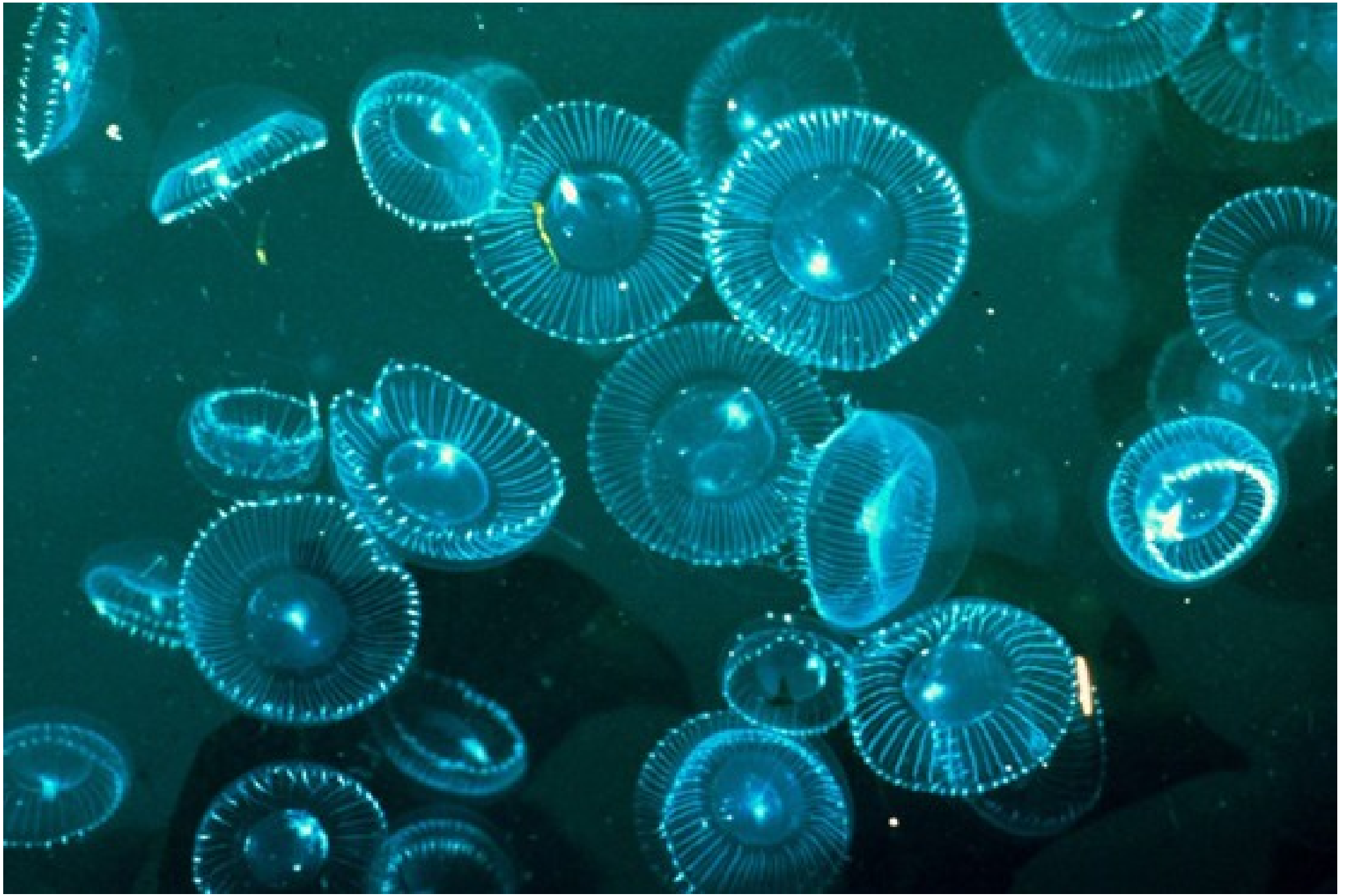
GMO Papaya

Determine GMO status by DNA sequencing



Perception that GMO's cause cancer.





Bioluminescent *Aequorea victoria*

The flourescent protein can be inserted in the fruitfly genome and expressed in certain genetically controlled patterns.


Metastasis

1) Identify GMO and non-GMO papaya by extracting, amplifying, and sequencing DNA.

2) Raise the larvae on food containing GMO papaya and non-GMO papaya.

3) Count the rate of metastasis and compare the results.

(This could also be done with other compounds that are though to prevent or promote tumor formation.)

ZOOL 420 Developmental Biology (Spring, cap 50, Yoshizawa)

The genetics of development are included: how genes are turned on and off and how gene products guide the development of a multicellular organism

ZOOL 480 Evolution (Spring, cap 60, Thomson)

Learn about the effects of selection, drift, etc. and modeling of evolutionary processes.

ZOOL 490 GMO's: Science and Society (“Special Topics,” Ethics Focus, Reed and De Couet)

Discuss aspects of the GMO debate by focusing on a series of case studies in genetically modified plants and animals.

BIOL 650 Population Genetics (Spring, Reed)

The interactions and predictions of mutation, genetic drift, migration, recombination, and selection.

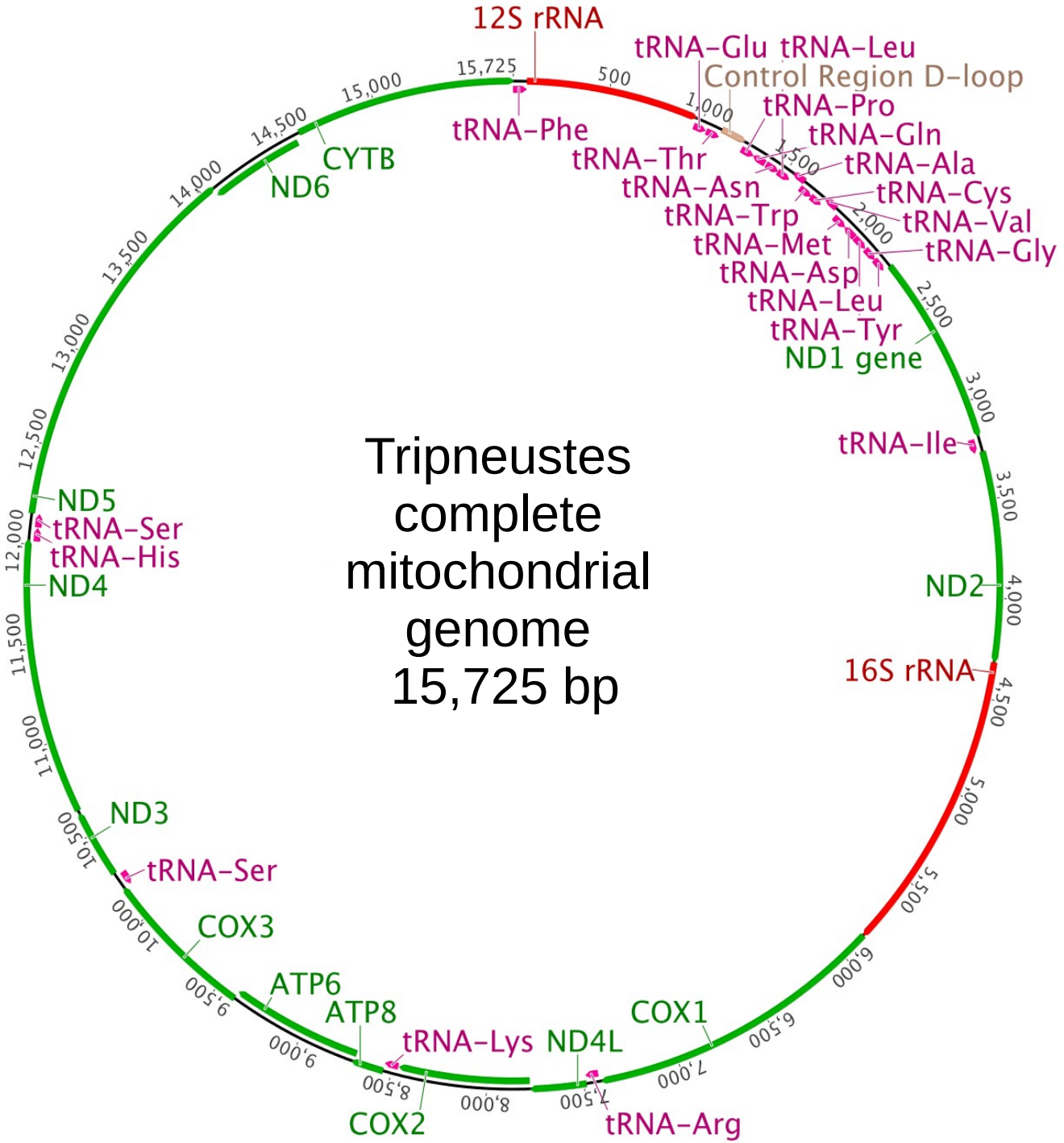
ZOOL 780/781 Foundations of Ecology and Evolution
(Fall-Spring, Reed, Wright, Thomson)

A two semester course that covers three modules

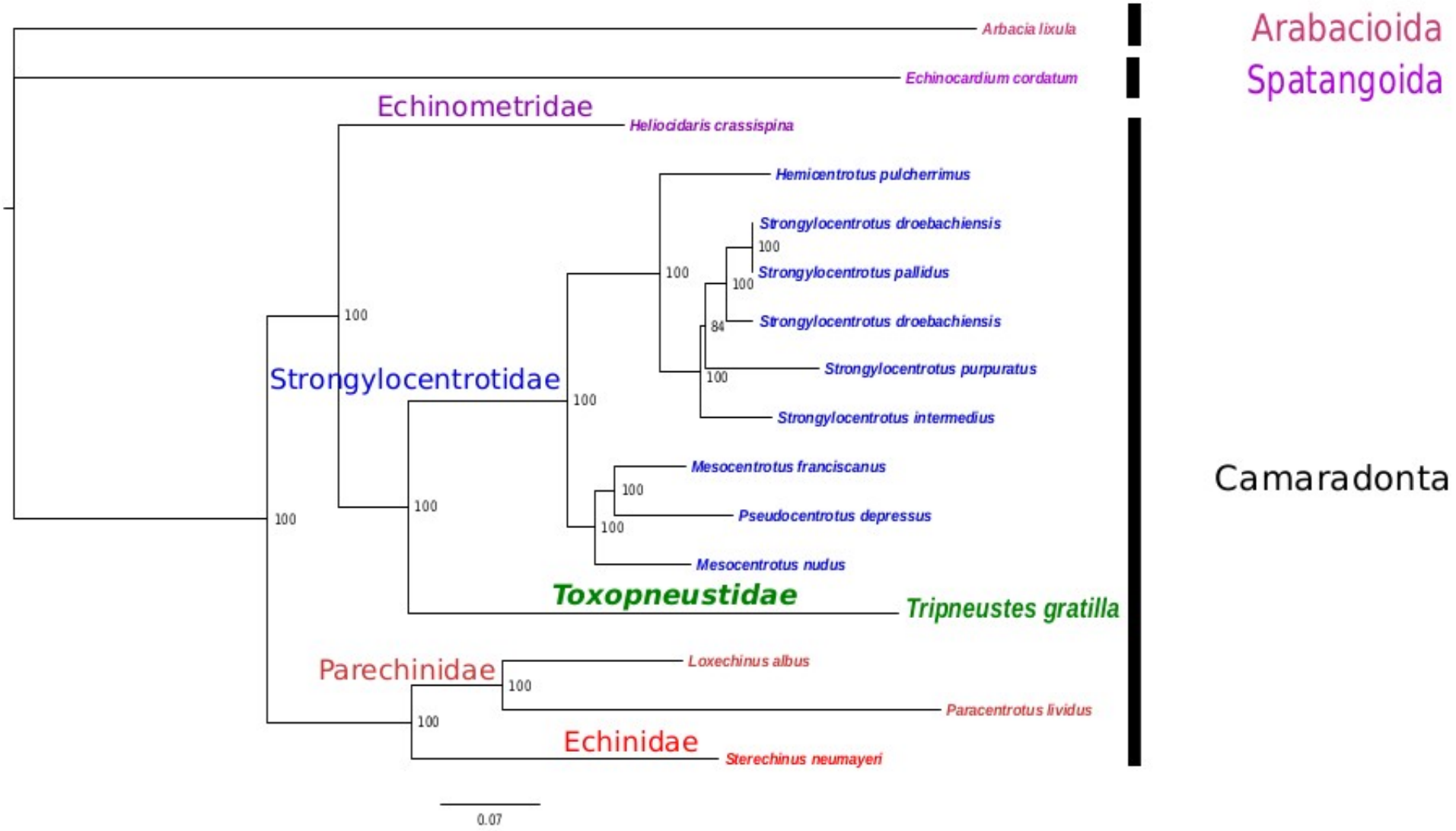
1) Population Genetics

2) Ecology

3) Evolution



Tripneustes complete mitochondrial genome 15,725 bp


Arbacia lixula
Echinocardium cordatum
Echinometridae
Heliocidaris crassispina
Hemicentrotus pulcherrimus
Strongylocentrotus droebachiensis
Strongylocentrotus pallidus
Strongylocentrotus droebachiensis
Strongylocentrotus purpuratus
Strongylocentrotus intermedius
Strongylocentrotidae
Mesocentrotus franciscanus
Pseudocentrotus depressus
Mesocentrotus nudus
Toxopneustidae
Tripneustes gratilla
Parechinidae
Loxechinus albus
Paracentrotus lividus
Echinidae
Sterechinus neumayeri
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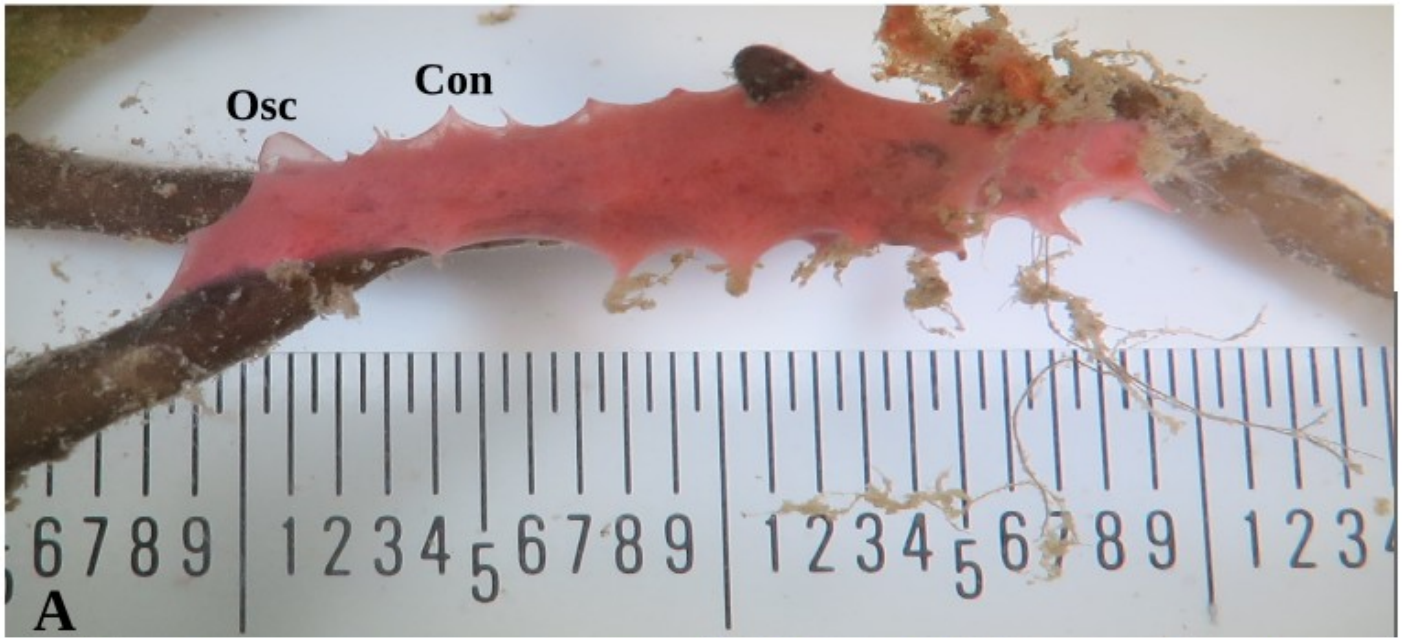
Spatangoida
Camaradonta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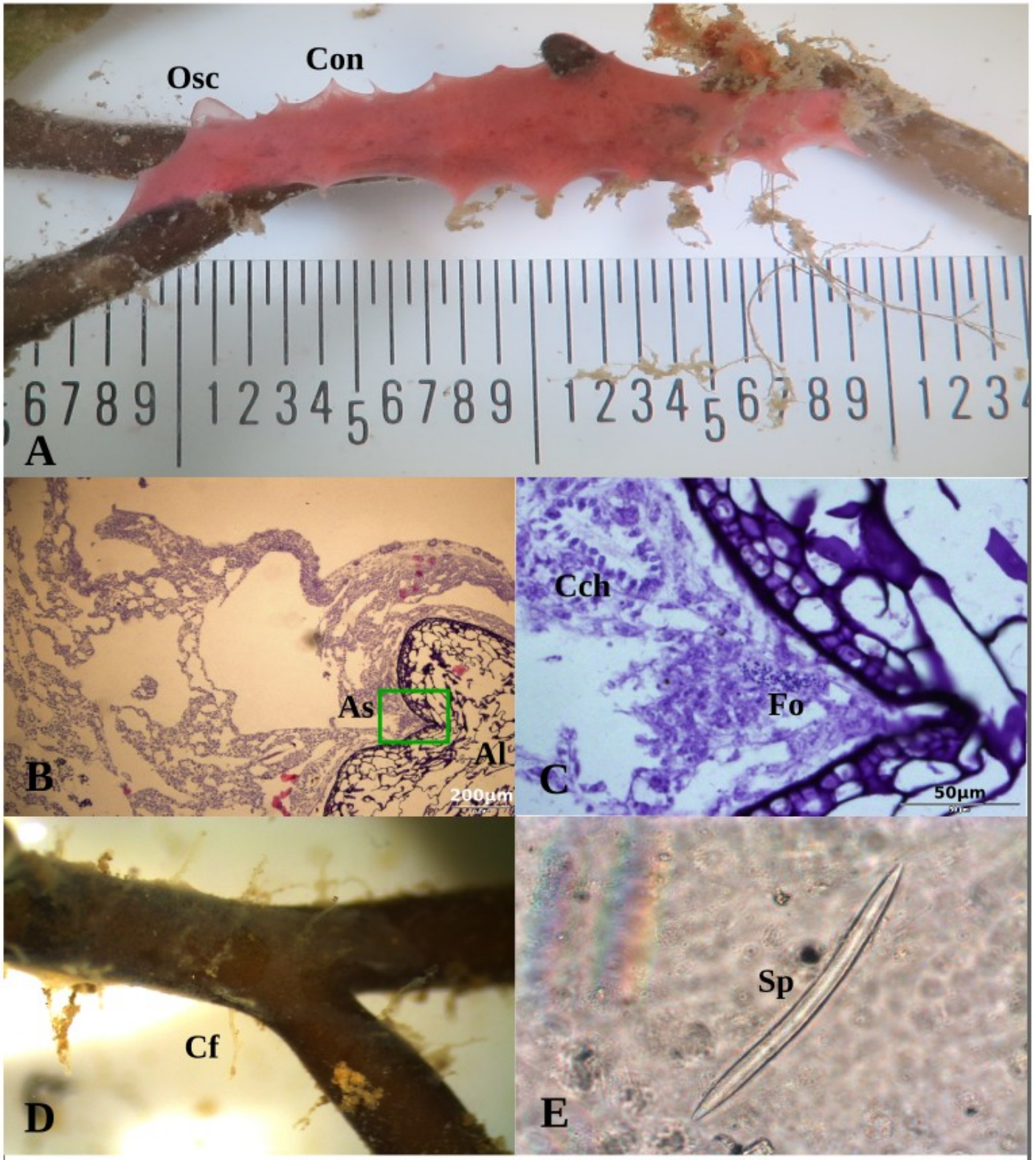
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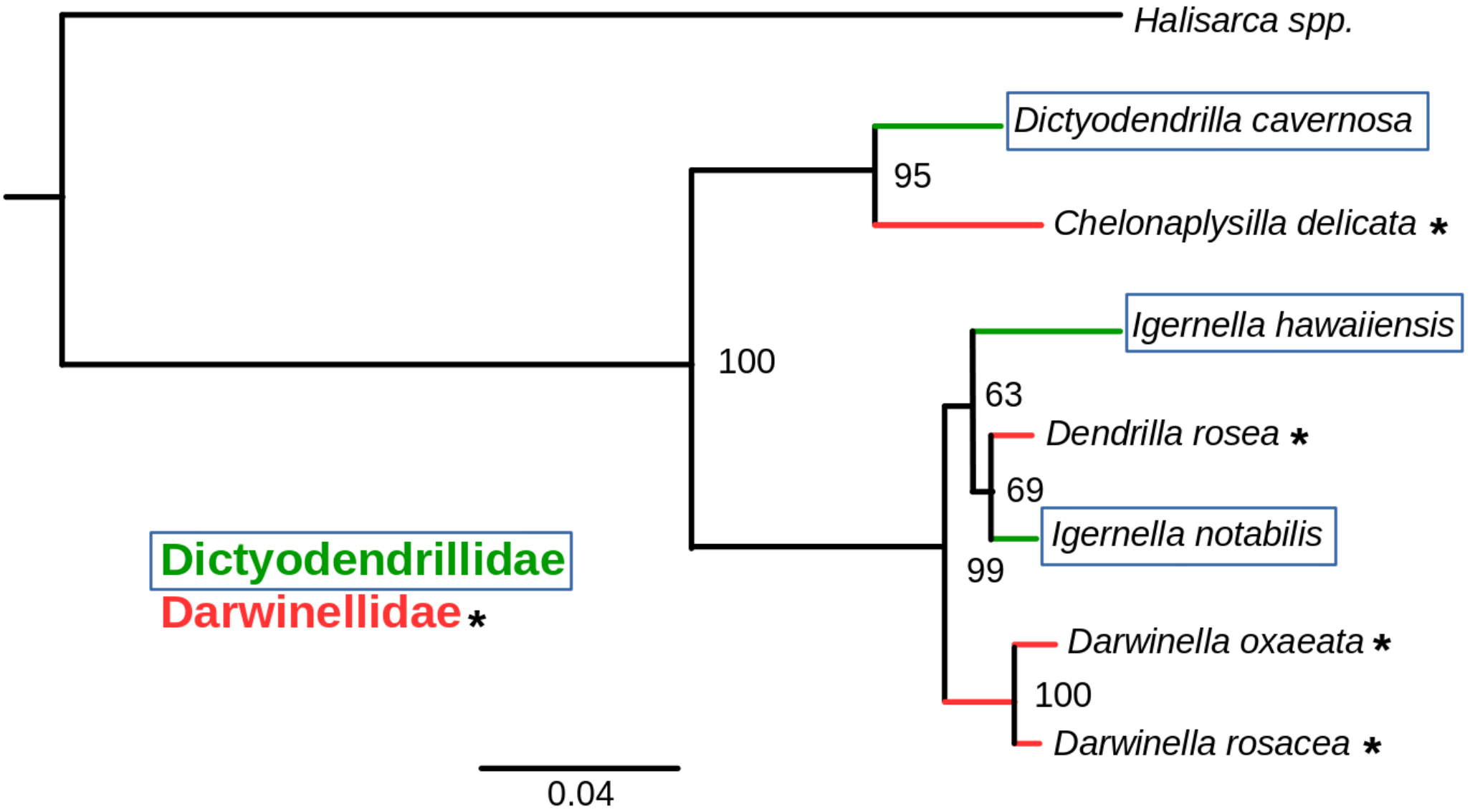
Halisarca spp.
Dictyodendrilla cavernosa
95
Chelonaplysilla delicata *
Igernella hawaiiensis
100
63
Dendrilla rosea *
69
Igernella notabilis
99
Dictyodendrillidae
Darwinellidae *
Darwinella oxaeata *
100
Darwinella rosacea *
0.04

Antibiotics: Sachie Etherton

Fly metastasis: Gert de Couet

Sea urchin: Áki Láruson

Sponge: Michael Wallstrom