SUPPLEMENTARY REVIEWER

BY VICTORIA CHAN
vebchan@gmail.com

BIOLOGY	PHYSICS
Photosynthesis	Parallel Circuits
Respiration and Citric Acid Cycle	Series Circuits
Dihybrid Cross	The Toll Booth Analogy
Monohybrid Cross (Review)	
General Classification of Plants	
Parts of a Flower	
Pollination	
Monocots vs. Dicots	

NOTE: This reviewer is only for my students ☺ This is meant to supplement what you have learned in class (a.k.a. additional only). Please review all your notes for the exams ☺ You can do it!

REFERENCES:

Reece, J.B., et al. 2014. Campbell Biology, 10th Edition. Pearson Education, Inc.
Bueche, F.J., and Hecht, E. 1997. Schaum's Outline of Theory and Problems of College Physics, 9th Ed. McGraw-Hill Companies

PHOTOSYNTHESIS

- Conversion of light energy (from the sun) to chemical energy
- Occurs in **autotrophs** (review: what are autotrophs?)
- Site of photosynthesis in plants is the **chloroplast**

MUST-KNOW: SUMMARY OF REACTIONS
Don't forget the reactants and the products!

$$CO_2 + H_2O + \text{Light energy} \rightarrow CH_2O + O_2$$

Carbon Dioxide + Water + Light → Sugar + Oxygen

- The complete, balanced equation is
  $6\ CO_2 + 6\ H_2O + \text{Light energy} \rightarrow C_6H_{12}O_6 + 6\ O_2$
    - $C_6H_{12}O_6$ is glucose
    - It takes 6 rounds of photosynthesis to produce glucose
- There are two stages in photosynthesis: the **Light Reaction** and the **Calvin Cycle**

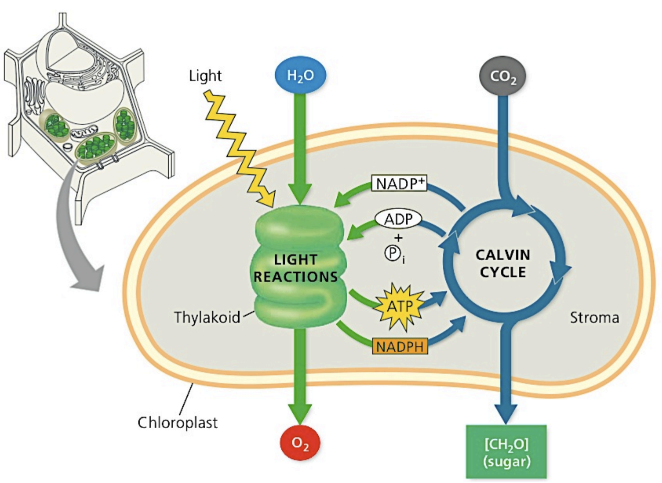


Figure 1. Summary of photosynthesis (Reece, et al., 2014)

MUST-KNOW: IMPORTANT EVENTS PER STAGE

	Light Reaction	Calvin Cycle
Location in chloroplast	Thylakoid membrane	Stroma
Occurring reactions	Light energy is converted to chemical energy (ATP and NADPH)	ATP and NADPH is used to convert CO_2 to sugar
	H_2O is split and O_2 is released	NADP+ and ADP is returned to light reaction
Reactants	H_2O, light	CO_2
Products	O_2, ATP, NADPH	Sugar

CELLULAR RESPIRATION AND THE CITRIC ACID CYCLE

- Cellular respiration is the process of **breaking down** of food molecules to produce more **ATP**
- The waste products of respiration are **carbon dioxide and water**, which are the raw materials of photosynthesis
- Site of respiration is the **mitochondria** (review: what is the function of the mitochondria? What is produced in the mitochondria?)
- **The Citric Acid Cycle** (a.k.a. Krebs Cycle) is one part of the respiration process
    1. **Pyruvate*** enters the mitochondrion
    2. Pyruvate is oxidized into **acetyl CoA**
    3. Acetyl CoA enters the **Citric Acid Cycle** as a raw material/reactant
    4. In the Citric Acid Cycle, further **oxidation** of Acetyl CoA occurs
    5. **ATP** is produced as a main product, and **CO_2** is a waste product. **NADH** and **$FADH_2$** undergoes electron transport to produce more ATP.

***Pyruvate** is a product of the breakdown of glucose (which came from photosynthesis in plants, or eating of food in animals)

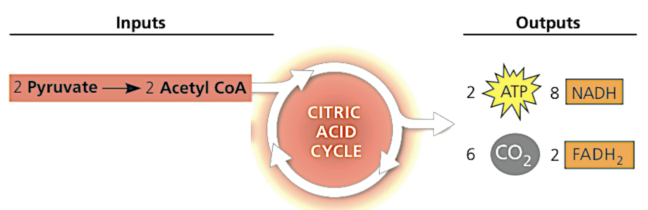
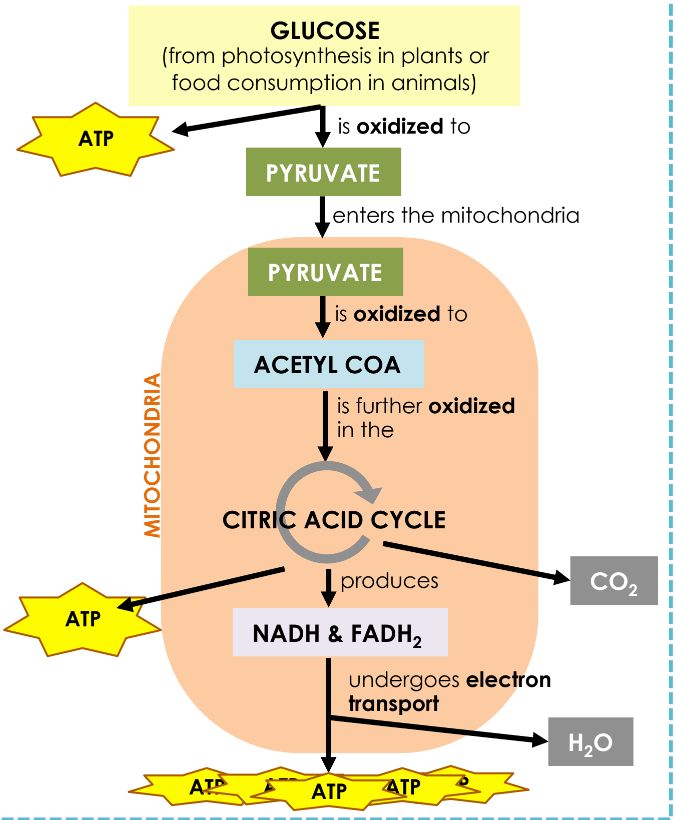


Figure 2. Summary of the Citric Acid Cycle (Reece, et al., 2014)

MUST-KNOW: SUMMARY OF RESPIRATION



DIHYBRID CROSS

Dihybrid cross is a cross between **two** traits.
(Review: the prefix "di-" means "two")

Consider the following traits in a plant: seed color and seed size:

	DOMINANT		RECESSIVE
Seed color	Yellow 	×	Green 
Seed shape	Round 	×	Wrinkled 

QUESTION: What is the genotype and phenotype of the offspring of a plant with the following traits?

YYRR 

Yellow and round seed

 *yyrr*

Green and wrinkled seed

ANSWER: Because one parent has both dominant traits and the other has both recessive traits, the offspring will be **100% heterozygous:**

 *YyRr*

Yellow and round seed

HOW DID WE GET THIS ANSWER?

Old-school way: 4x4 Punnett Square!

Step 1: Get the possible gametes using FOIL method (**F**irst, **O**utside, **I**nside, **L**ast)

F → YR
O → YR
I → YR
L → YR

F → yr
O → yr
I → yr
L → yr

Step 2: Set up a 4x4 Punnett Square using the gametes and fill up the Punnett Square.

	YR	YR	YR	YR
yr	YyRr	YyRr	YyRr	YyRr
yr	YyRr	YyRr	YyRr	YyRr
yr	YyRr	YyRr	YyRr	YyRr
yr	YyRr	YyRr	YyRr	YyRr

All offspring are YyRr! Therefore, all seeds are **yellow and round (phenotype) and YyRr (genotype)**.

Faster way: 2x2 Punnett Square and Probability

Step 1: Construct a 2x2 Punnet Square **PER TRAIT:**

SEED COLOR:

	Y	Y
y	Yy	Yy
y	Yy	Yy

Genotype: 100% Yy
Phenotype: 100% Yellow

SEED SHAPE:

	R	R
r	Rr	Rr
r	Rr	Rr

Genotype: 100% Rr
Phenotype: 100% Round

Step 2: Get the probability of the traits by **multiplying**. Remember that **independent events** must be multiplied. The segregation of traits is **independent (Law of Independent Assortment).**

Yellow x Round = Yellow and Round

$$\frac{4}{4} \times \frac{4}{4} = 1$$

 *YyRr*

Yellow and round seed

Note from Teacher Vicky: *Use whatever method you are comfortable with. However, the second method has more benefits. First, you do not have to do FOIL method. Second, you do not need to make a 4x4 Punnett Square!*

LET'S PRACTICE!

QUESTION: Consider the offspring of the previous problem. What is the probability of getting a plant with **green and round seeds** when the said plant is **self-pollinated?**

 *YyRr*

Yellow and round seed

X

 *YyRr*

Yellow and round seed

Review: Self-pollination means crossing the organism's genotype with itself! It's like multiplying the genotype by itself.

FAST METHOD:
Step 1: 2x2 Punnett Square PER TRAIT

SEED COLOR:

	Y	y
Y	YY	Yy
y	Yy	yy

Genotype:
¼ YY
2/4 Yy
¼ yy

Phenotype:
3/4 Yellow
¼ Green

SEED SHAPE:

	R	r
R	RR	Rr
r	Rr	rr

Genotype:
¼ RR
2/4 Rr
¼ rr

Phenotype:
3/4 Round
¼ Wrinkled

Step 2: Multiply Probabilities

Since we want to find the probability of a **green** and **round** seed, we multiply the probability of getting a **green** seed with the probability of getting a **round** seed.

$$\frac{1}{4} \times \frac{3}{4} = \boxed{\frac{3}{16}}$$

LET'S PRACTICE!
QUESTION: What is the probability of getting:
1. Round and yellow seeds
2. Wrinkled and yellow seeds
3. Wrinkled and green seeds

if the following cross is made?

YyRr
Yellow and round seed

X

YyRr
Yellow and round seed

ANSWER:
1. 9/16
2. 3/16
3. 1/16

SOLUTIONS:
Step 1: 2x2 Punnett Square

SEED COLOR:

	Y	y
Y	YY	Yy
y	Yy	yy

Genotype:
¼ YY
2/4 Yy
¼ yy

Phenotype:
3/4 Yellow
¼ Green

SEED SHAPE:

	R	r
R	RR	Rr
r	Rr	rr

Genotype:
¼ RR
2/4 Rr
¼ rr

Phenotype:
3/4 Round
¼ Wrinkled

Step 2: Multiply the probabilities

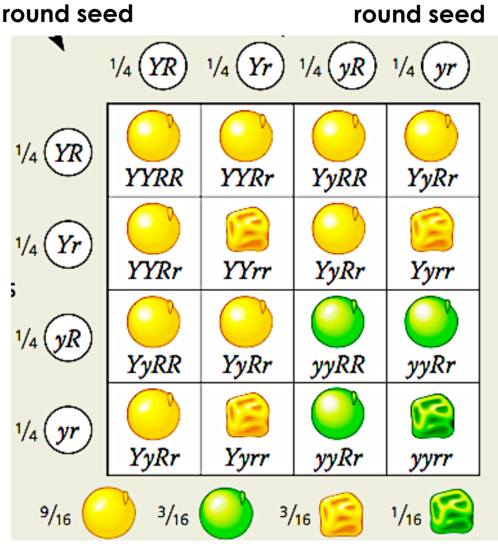
1. Round and yellow $\frac{3}{4} \times \frac{3}{4} = \frac{9}{16}$
2. Wrinkled and yellow $\frac{1}{4} \times \frac{3}{4} = \frac{3}{16}$
3. Wrinkled and green $\frac{1}{4} \times \frac{1}{4} = \frac{1}{16}$

Here is the alternate solution if you want to do it the old-school way:

YyRr
Yellow and round seed

X

YyRr
Yellow and round seed



MONOHYBRID CROSS

REVIEW!
Figure 3 shows a **monohybrid** cross (one trait only) between a plant with purple flowers and a plant with white flowers, which produced all purple flowers.

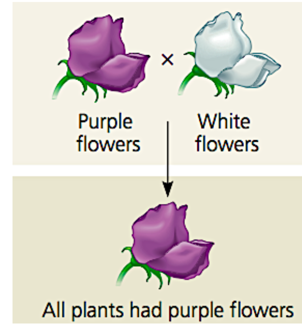
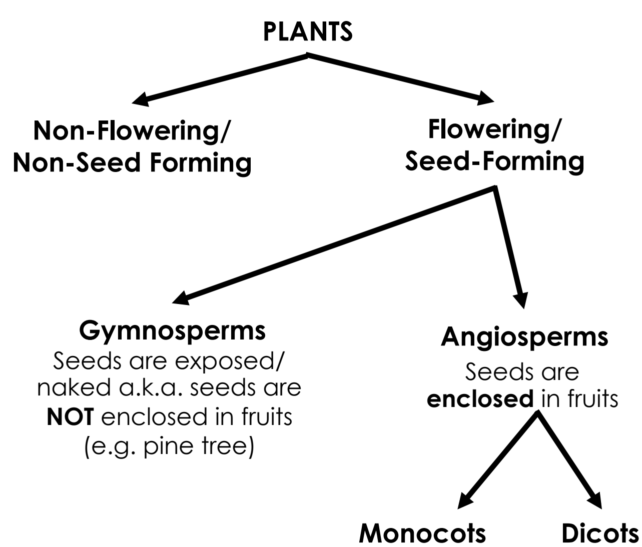


Figure 3. Monohybrid Cross (Reece, et al., 2014)

1. Which trait is dominant, purple or white?
2. What are the possible genotypes of the parents?
3. What is the genotype of the offspring?

ANSWERS:
1. Since all offspring are color purple, **purple** is the dominant trait.
2. Since we have established that all offspring are purple, we must look for the genotypes that will give out 100% purple offspring. This is only possible if both parents are homozygous for purple, or if one is homozygous for purple and the other homozygous for white. Because one parent is purple and the other is white, the genotypes of the parents are **homozygous dominant (purple) and homozygous recessive (white)**.
3. The offspring is **heterozygous**, since we have established that the parents are both homozygous – one is dominant, and the other is recessive.

GENERAL CLASSIFICATION OF PLANTS



PARTS OF A FLOWER

A **complete flower** has all four basic floral organs, namely:

- **Carpels –** contains the ovary, style, and stigma; sort of like the **female parts** of a flower
- **Stamens –** contains the anther and filament; sort of like the **male parts** of a flower
- **Petals** – brightly-colored to attract pollinators
- **Sepals** – encloses and protects unopened floral buds

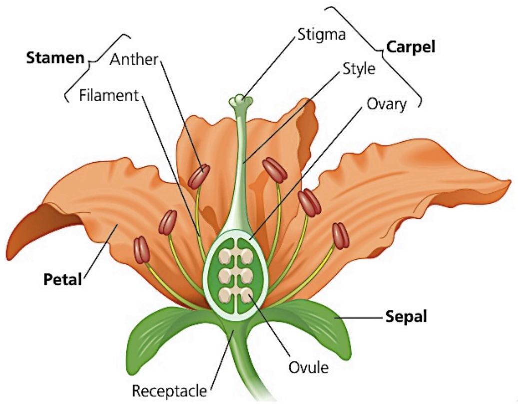


Figure 4 Structure of a complete flower. (Reece, et al., 2014)

POLLINATION

- Transfer of pollen from the **anther** to the **stigma**, which leads to fertilization and plant reproduction
- Occurs only in **angiosperms** (a.k.a. plants with protected seeds)
- Steps:
  - Pollen from the anther (or carried by an agent) sticks to the stigma
  - A pollen tube is formed and elongates until the ovary to deliver the sperm (from the pollen) to the ovule
  - Fertilization occurs

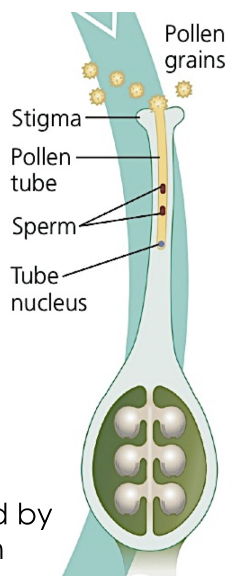


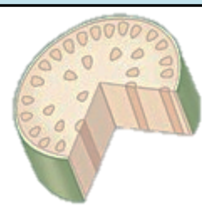
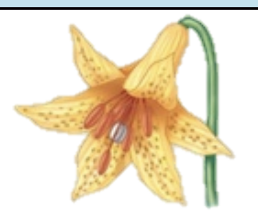
Figure 5 Pollination (Reece, et al., 2014)

- Types of Pollination
  - **Abiotic** (pollen carried by wind) vs. **Biotic** (pollen carried by insects of animals)
  - **Self-pollination** (pollen from same plant or same flower) vs. **Cross-pollination** (pollen from another flower)

MUST-KNOW: FATES OF FLORAL STRUCTURES
(a.k.a. what happens to the parts after fertilization?)

Ovary → Fruit
Ovule → Seed

MONOCOTS vs. DICOTS

MONOCOTS	DICOTS
SEEDS	
 One cotyledon	 Two cotyledons
LEAVES	
 Veins parallel	 Veins branched
STEMS	
 Complex arrangement of xylem and phloem	 Circular arrangement of xylem and phloem
FLOWERS	
 Floral parts usually in multiples of three	 Floral parts usually in multiples of four/five
ROOTS	
 Fibrous root system	 Taproot system
EXAMPLES	
Corn Bamboo Wheat	*Monggo* Sunflower Mango

SERIES CIRCUITS

- Current (***I***) flows in only one path
- One end of a resistor (***R***) is connected to another end

Figure 6. Series circuit (Bueche & Hecht, 1997)

To get the **total resistance**, just add the individual measurements per resistor.

$$R_{TOTAL} = R_1 + R_2 + R_3 + \cdots$$

This implies that the equivalent resistance in a **series** circuit is greater than the largest of the individual resistances.

It also means that the resistance in a **series** circuit **increases** the equivalent resistance.

PARALLEL CIRCUITS

- One end of a resistor (***R***) is connected to one node, and the other ends is connected to the other node.
- Look like **parallel** lines

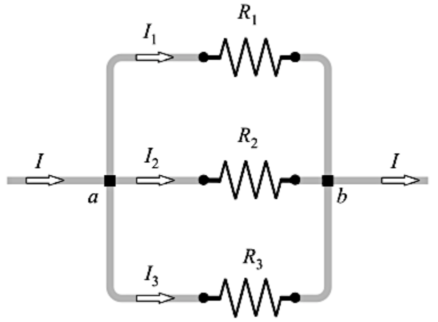


Figure 7 Parallel circuit (Bueche & Hecht, 1997)

To get the **total resistance**, the following formula is used:

$$\frac{1}{R_{TOTAL}} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \cdots$$

The formula above implies that the equivalent resistance in parallel circuits is **less than the smallest of the individual resistances.**

It also means that if you **add more resistance** to a **parallel** circuit, the resistance gets **smaller.**

THE TOLL BOOTH ANALOGY

Imagine that:

Circuit → SLEX
Toll Booth → Resistor

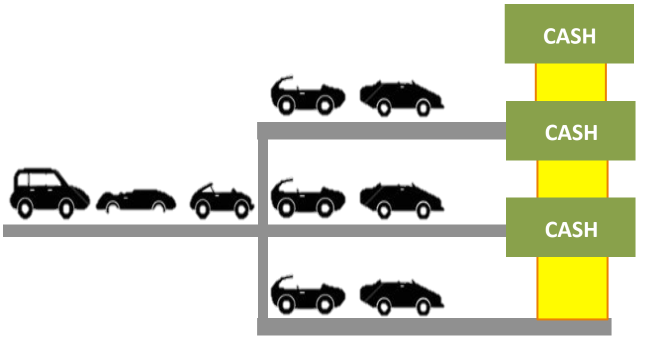
If you add one tollgate in SLEX, it will create a bottleneck and cause traffic.

If you add more toll booths, it will cause even more traffic.

More toll booths mean more obstruction/ **resistance**, therefore causing more **traffic.**

In a **series** circuit, if you add **more resistance**, total resistance **increases.**

However, if you add more **parallel** roads before a toll booth, traffic goes on smoothly.



Toll booths arranged in **parallel** will create less traffic.

In a **parallel** circuit, if you add **more resistance,** total resistance **decreases.**

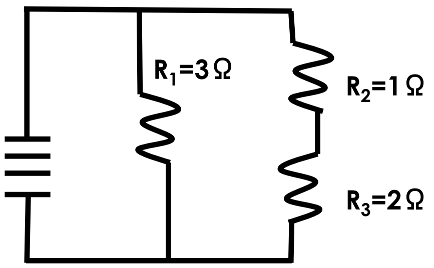
MUST-KNOW: RESISTANCE IN SERIES AND PARALLEL

Adding resistance in a **series** circuit **increases total resistance.**

Adding resistance in a **parallel** circuit **decreases total resistance.**

LET'S PRACTICE!

QUESTION: Find the total resistance of this circuit:



SOLUTION:

Observe that Resistors 2 and 3 are connected in **series**. Simply add the resistances to get the total resistance for the two:

$$\mathbf{R_{2,3}} = R_2 + R_3 = 1\,\Omega + 2\,\Omega = \mathbf{3\,\Omega}$$

Since $R_{2,3}$ and R_1 are connected in parallel, we use the equation to find the total resistance of the entire circuit:

$$\frac{1}{R_{TOTAL}} = \frac{1}{R_1} + \frac{1}{R_{2,3}} = \frac{1}{3} + \frac{1}{3} = \frac{2}{3}$$

$$R_{TOTAL} = \boxed{\frac{3}{2}\Omega}$$