Welcome to Bio 1030
Biology Today

Powers of 10
Patterns of Inheritance

Instructor for Second Part:
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Here is how a live paramecium looks under the microscope

Here is another: If you scrape your cheek, stain, and place under the scope:

Scientific Notation: Powers:

2^3 = 2X2X2=8

2^4 = 2X2X2X2=16

10^1 = 10

10^3 m= 10X10X10=1,000 m = 1 kilometer

10^6 = 10X10X10X10X10X10=1,000,000 (1 million)

Try to solve: What is 10^9 ?

Scientific Notation: Negative Powers

10^{-1} m = 1/10=0.1 m

10^{-3} m = 1/1000=0.001 m = 1 ml

10^{-6} m = 1/1,000,000=0.000001 m = 1**μm** =1 micrometer

Try to solve: What is 10^{-2} ?

Another way of visualizing this, from small to big:

Viruses: 0.0000001 meter: Life forms?

Bacteria: 0.000001 m, prokaryotes

Euglena, amoeba (single-cell organisms), human heart cells (building blocks of a larger organism): 0.00001 m

A human child: 1 m

Distance to alpha-centauri: 4.3 light years, or 40,000,000,000,000,000 m

Measurement Equivalents

1 meter (m) = 100 cm = 1,000 mm = about 39.4 inches

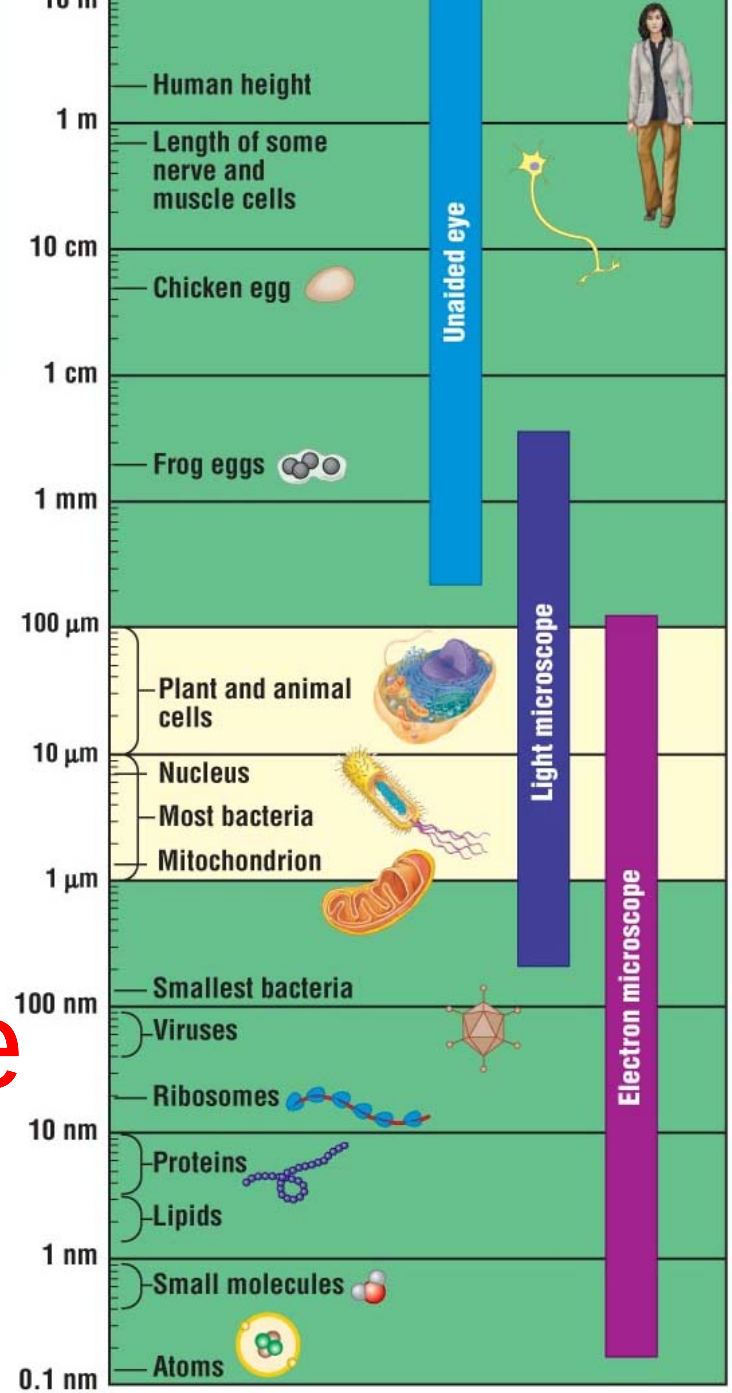
1 centimeter (cm) = 10^{-2} $(\frac{1}{100})$ meter (m) = about 0.4 inch

1 millimeter (mm) = 10^{-3} $(\frac{1}{1,000})$ m = $\frac{1}{10}$ cm

1 micrometer (µm) = 10^{-6} m = 10^{-3} mm

1 nanometer (nm) = 10^{-9} m = 10^{-3} µm

Orders of Magnitude



Now, this question of the **Orders of Magnitude** is of the utmost importance to understanding:

- Biology
- Reality
- Our place in the universe

- So let's take a few minutes to visualize this: ppt / .pdf)

The Birth of Genetics: Gregor Mendel

- Mendel's Abbey, 2005

A Side view of Mendel’s Abbey

Site of Mendel’s experimental plot/garden itself, 1856-1865 :

Gregor Mendel, Brno, Czech Republic

Like the majority of scientists with no networking skills and connections, Mendel the scientist (but not abbot) was totally ignored during his lifetime. Had to be rediscovered 16 years later.

Probability: Random Events

Q1. Let us first examine the results of single random events. Suppose you toss a coin once. What are the chances of getting heads (H)? _____ Tails (T)? _____

Q2. What are the chances that your next child will be a boy? _____ A girl? _____

Q3. Now toss a coin 10 times and record the number of heads (Hs) and tails (Ts) in the space below. (Make sure that the process is indeed random. Flip the coin a few times in your hand before each toss; examine it only after it lands on the floor).

H ____ T ____

For the class as a whole, the results were:

H ____ T ____

Q4. Most likely, some of your classmates' observations are not in line with the expected 50/50 distribution? Why?

Q5. Are class totals more or less in line with the expected distribution? Why?

Q6. What are a couple's chances of having a girl?

Q7. Assuming that either type of sperm is as likely as the other to fertilize an egg (reality is a bit more complicated), what is the expected distribution of boys and girls in a small village of 100 souls? ____
In a city of two million? ____

Probability: Two Independent Events

Imagine that you simultaneously tossed a nickel and a dime. Each coin alone, we know already, has an equal chance of yielding H or T, but what can we expect when the 2 are flipped at the same time?

Please divide into pairs, and construct the following table (a penny or a quarter will be just as good). Simultaneously, one person should toss a nickel and the other person should toss a quarter. For each toss of the two coins, 4 outcomes are possible. Please record each outcome with one vertical line in the table below, and then summarize the total of 10 simultaneous tossed for your pair. Next, summarize the totals for your entire row. We shall then summarize, on board, the results for the entire class.

Q8. Our prediction: ??? Our actual results for the class as a whole?

		Dime	
		H	**T**
Nickel	**H**		
	T		

Similar probabilities prevail in a large population of two-child families:

- Total sample: 100,000

		Dad	
		Boy	**Girl**
Mom	**Boy**		
	Girl		

Q9. In this population of 100, 000, what are the chances of having a boy and a girl, irrespective of their order of birth? ____

Q10. What are the chances for two girls? ____

Q11. Let's divide these 100,000 two-child families into 2 categories. The first consists of families with 2 girls. The second consists of all other two-child families. How many families would belong to the first group (the one with 2 girls)? ______ How many to the second (all the other combinations)? If you divide the second number by the first, the expected ratio between them would be ____ to 1.

Q12. Imagine that a philanthropist came up with a $1000 prize to any family in your community that meets the following conditions: it has 2, and only 2, natural born daughters. Imagine that all qualified families applied for the bonus, and that after being checked for accuracy, 100,000 received the prize. The philanthropist now comes up with an even more curious announcement: He will give a $1,000,000 prize to the first person who would tell him, and then properly explain his deductions, the approximate number of two-child families in this community who do not have two girls. How would you go about getting this prize?

		Dad	
		Boy	Girl
Mom	Boy		
	Girl		

Imagine yourself a banker. To save money, you devised an ingenious scheme of monitoring the vigilance of your bank's night watchman. At the opposite ends of the building, there are 2 light switches. Every hour during his 10-hour shift, the guard must approach one switch and flip a coin. If it's Heads, he is to turn the switch on, if it's Tails, he is to turn it off. He then must approach the second switch and repeat the same procedure. If both switches are on, the light is on. If either one is off, or if both are off, the light is off. You have installed a special machine that tells you, for every hour, whether the light has been on or off. Four months and 1000 hours later, you examine the lighting record to determine whether the guard should receive a raise or be fired. You observe that during that time, the light has been on 570 hours and off 430 hours.

Q13. What are your theoretical expectations for the number of hours the lights should have been on and off? Why? Should the guard be promoted or sacked?

		Switch II	
		ON	OFF
Switch I	ON		
	OFF		

Mendel's Observations

Worked with peas.

True-breeding varieties, e.g., tall (6 ft) and short (1 ft)

The Cross

Tall Peas X Short Peas (Parents)

What kind of offspring will they have?

Surprising answer: children: ALL TALL

Mendel then crossed these new tall plants (the offspring of the Tall X Short cross) to themselves or to each other. Can you guess the outcome?

Grandchildren: 787 tall / 277 short.

So,

- Short: reappeared (so it must have still been there, somehow, out of sight!)
- Tall / Short ratio: 2.84 to 1 (approximately 3 to 1).

Similar observations with other characters, e.g., smooth vs. wrinkled seeds

Smooth X Wrinkled

P generation: Smooth vs. Wrinkled seeds

F1 generation: All smooth

F2 gen: 3 smooth for every 1 wrinkled

Mendel gave to lectures on the subject. In the first he described the results you have just seen. In the second, he explained them.

Take home Q: (Don’t read text) Imagine you found yourself in Mendel's shoes. What would you tell your audience?