

An Introduction to Probability

Basic Counting Rule

A student takes two coins, a nickel and a quarter, and tosses them at the same time. What is the probability of obtaining two heads?

If you answered $\frac{1}{4}$, you may recall that the probability of two independent events occurring is the product of their individual probabilities. The probability of tossing a coin and getting a head is $\frac{1}{2}$; thus, the probability of obtaining 2 heads is $\frac{1}{2} \times \frac{1}{2} = \frac{1}{4}$.

Do you understand this logic?

		<u>Quarter</u>	
		H	T
	H	HH	HT
<u>Nickel</u>	T	TH	TT

There are two coins, each of which has two possible outcomes $2 \times 2 = 4$

Perform the following exercises using the logic above.

1. Suppose that you toss a quarter and a six-sided dice (each side showing a different number, 1-6). How many different outcomes are possible?

Number of possible outcomes: quarter_____ Die_____

Total Number of possible outcomes: _____

2. A small protein contains two amino acids, I & II. Each amino acid could be any one of the 20 known amino acids. How many different possible proteins (two amino acids long) can we make? _____

Extension of the Basic Counting Rule:

Suppose 3 students are taking an exam for credit or no-credit (pass or fail). Because each student can either pass or fail, there are 8 possible outcomes for this class:

	<u>Student 1</u>	<u>Student 2</u>	<u>Student 3</u>
1	P	P	P
2	P	P	F
3	P	F	P
4	P	F	F
5	F	P	P
6	F	P	F
7	F	F	P
8	F	F	F

By using the Counting Rule from page one, you can determine this answer without having to make a table as the one shown above. Each student has two possible fates, pass or fail, therefore, the total possible outcomes can be calculated as follows:

	<u>Student 1</u>	<u>Student 2</u>	<u>Student 3</u>	
Number of Outcomes	2	2	2	
Total No. of Outcomes	2	X	2	X 2 = 2 ³ = 8

A general rule:

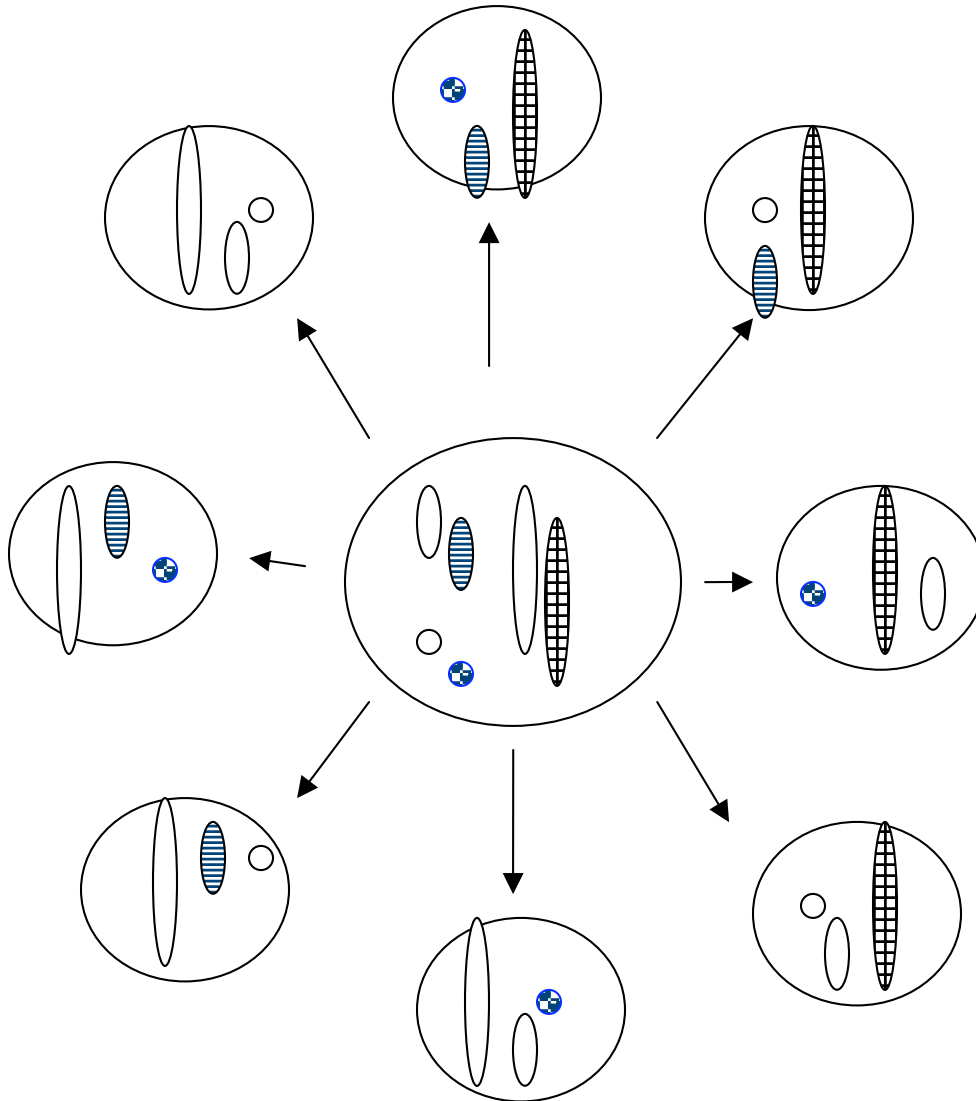
If an event has n_1 possible outcomes, and a second event has n_2 possible outcomes, and a third event has n_3 possible outcomes, then the total number of outcomes is: $n_1 \times n_2 \times n_3$.

3. A molecule of DNA is three bases long and each base can be one of the four bases, A, T, C, or G. How many unique 3-base DNA molecules could be made?_____

4. A protein made of 3 amino acids is discovered. Each amino acid must be one of the 20 known amino acids. How many different proteins made of 3 amino acids are possible?_____

5. How many different proteins made of 10 amino acids are possible?_____

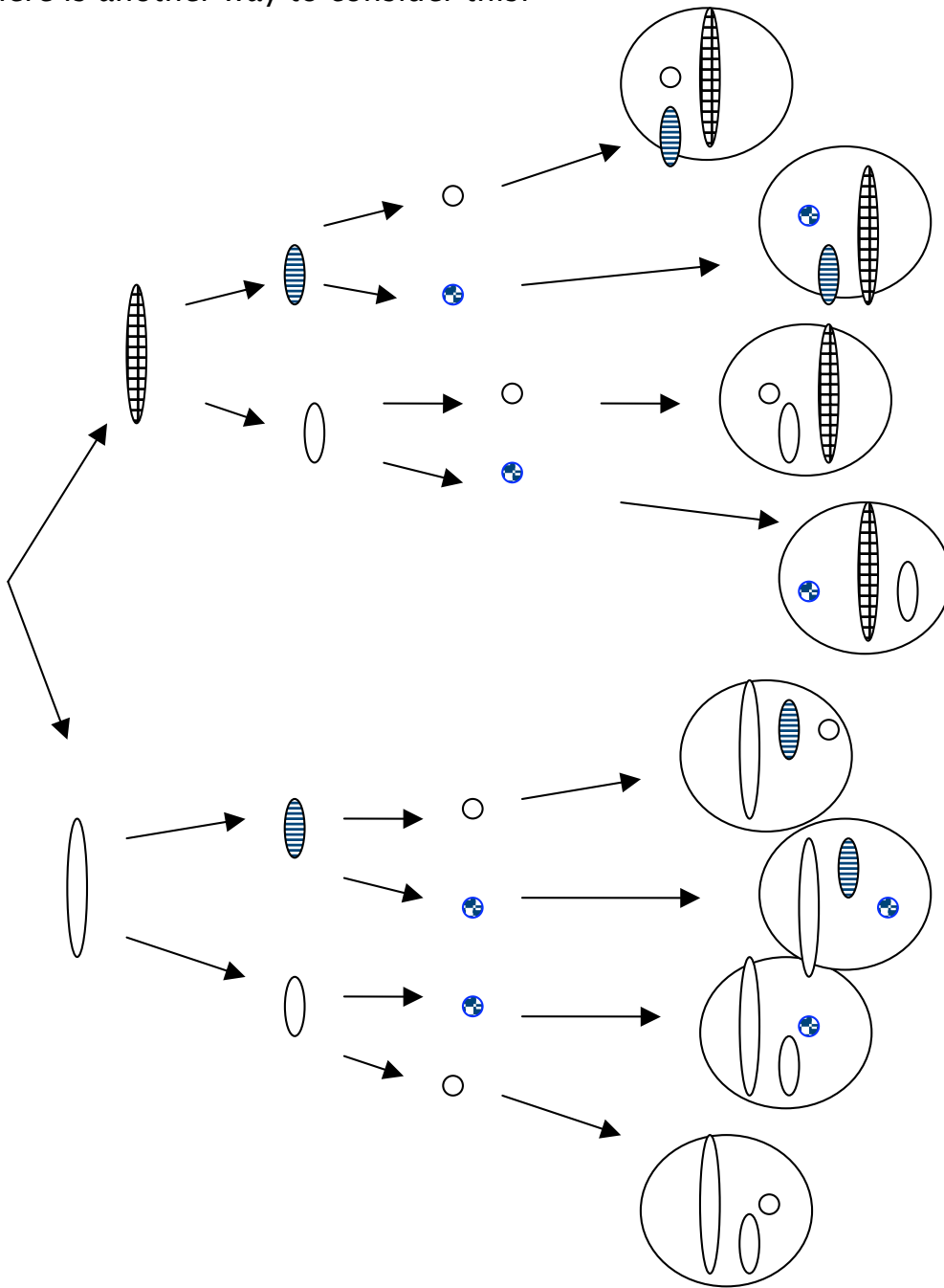
Varieties of Sperm and Eggs



The diagram above depicts a diploid cell (Middle) containing three pairs of chromosomes ($2N = 6$), and the possible chromosome combinations in the resulting gametes surrounding it.

Each pair of Chromosomes is represented in each gamete by one of two possibilities, so the total number of unique gametes equals $2 \times 2 \times 2 = 2^3 = 8$

There is another way to consider this:



$$2 \times 2 \times 2 = 8$$

If no two chromosome pairs carry the same genetic information (alleles), and each gamete receives one of two possible chromosomes from each of the N pairs, then the number of possible unique gametes is 2^N .

If each individual can produce 2^N unique gametes, then two individuals can produce 4^N unique offspring since $2^N \times 2^N = 4^N$

6. The cells of a given organism have 4 pairs of chromosomes.

How many combinations of gametes can an individual produce? _____
How many combinations of offspring can two individuals produce? _____

7. How many combinations of gametes can any human produce? _____
How many combinations of offspring can any two humans produce? _____

8. How many different combinations of *gametes* could be produced by individuals with the following genotype? (imagine that each letter represents a pair of chromosomes)

a. AABbCCddEeFf _____

b. AaBBCcDdEeff _____

c. AABbCCddEeFF _____

9. Two individuals AABbCCDDEE and aabbccdde (two different genotypes) are mated and produce offspring who are then mated together to produce grand-offspring.

a. What is the genotype(s) of the offspring? _____
b. How many different genotypes are possible in the grand-offspring? _____
c. What proportion of the grand-offspring genotypes will be have two little letters for all 5 loci? _____

10. Would you change your answers to (a) and (b) if the original parents were AAbbCCdde x aaBBccDDEE? _____

11. Would you change your answers to (a) and (b) if the original parents were AABbCCDDEE x aabbccddeE? _____

12. Albinism results from a recessive gene. Two parents with normal pigmentation have an albino child.

a. What is the probability that their next child will be albino? _____
b. What is the probability that their next child will be an albino girl? _____
c. What is the probability that their next three children will be albino? _____

13. A large basket of fruit contains 3 oranges, 2 apples and 5 bananas. If a piece of fruit is chosen at random, what is the probability of getting an orange or a banana? _____

14. A pair of dice is rolled. What is the probability of getting a sum of 2? _____

16. In the United States, 43% of people wear a seat belt while driving. If two people are chosen at random, what is the probability that both of them wear a seat belt?_____

17. Three cards are chosen at random from a deck without being replaced. What is the probability of drawing a jack, a ten and a nine in that order? _____

18. A city survey found that 47% of teenagers have a part time job. The same survey found that 78% plan to attend college. If a teenager is chosen at random, what is the probability that the teenager has a part time job and plans to attend college?_____