Name _____

Class _____

A ***binomial distribution*** is a random distribution with the following properties:

- There are *n* repeated trials that are identical and independent.
- Each trial has two possible outcomes, in general known as a success or failure.
- *P*(success) = *p* and *P*(failure) = 1 – *p*

The following is an example of a binomial distribution.

> ***The survival rate for Emperor penguin eggs is 19%. If there are 100 penguins in a waddle that lay an egg this year, what is the probability that 25 eggs will hatch and live?***

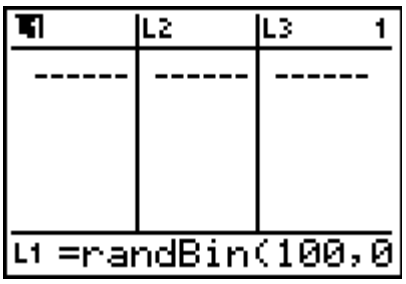
Let's first investigate this problem simulating 100 penguins laying eggs 50 times.

**Problem 1 – Simulation**

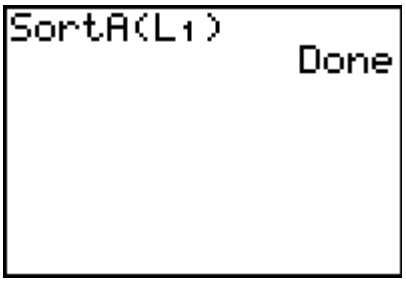
**Step 1:** Use list L1 for the simulation. Press [STAT] [ENTER]. Use the arrow keys to highlight **L1**.

**Step 2:** Enter **randbin(100, 0.19, 50)**. Each entry in the list represents the number of penguin eggs that live out of 100 born.

To enter randbin, press [MATH], arrow to the PRB menu and select **randBin(**.




**Step 3:** Sort list L1. From the Home screen, press [STAT] and select **SortA(**. Then enter L1 and press [ENTER].




**Step 4:** Return to the List Editor and count the number of 25s.

- What is the experimental probability that 25 penguins will hatch and survive? How do your results compare with your classmates?

- If you were a scientist, would you be concerned about this survival rate? Explain your reasoning.

**Problem 2 – Theoretical Probability**

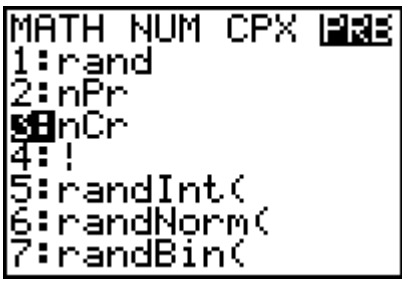
Now, let's find the theoretical probability. In general, the probability of *r* successes in *n* trials where *p* is the *P*(success) is:

$$\binom{n}{r} p^r (1-p)^{n-r}$$

**Step 5:** Use the **nCr** command and the formula to find the theoretical probability.

To access the **nCr** command press [MATH], arrow to the PRB menu and choose **nCr.**

(**Hint:** Enter the value for *n*, select the command, and then enter the value for *r*.)




**Step 6:** The theoretical probabilitiy can also be calculated using the **binompdf** command. Press [2nd] [DISTR] and select **binompdf(**. Enter the number of trials, the probability of success, and the *x*-value (the number of successes).


- How does your experimental probability compare to the theoretical probability? Is the value of your experimental probability reasonable? Explain your reasoning.

**What is the probability that at least 25 eggs hatch?**

- How could this be calculated? Discuss your idea with a classmate.

**Step 7:** Use the **binomcdf** command to calculate the probability that *at least* 25 eggs hatch. Press [2nd] [DISTR] and select **binomcdf(**. Then enter the number of trials and the probability of success. Subtract this value from 1 to determine the probability.


- What is this probability?

- **What is the mean number of eggs expected to hatch and survive?** Calculate this by finding the expected value of the binomial distribution. $\mu = np$

**Homework**

1. Of all the turkeys sold in the US, 1 out of 6 is eaten on Thanksgiving. A certain packing plant processes 2,000 turkeys in November.
    a. What is the probability that 25% of them will be eaten on Thanksgiving?
    b. What is the probability that less than 300 of the turkeys grown will be eaten on Thanksgiving?
    c. What is the expected number of turkeys to be eaten on Thanksgiving?

2. A professional basketball player is an 81% free throw shooter. In a game against Milwaukee, he made 12 free throw attempts.
    a. Is it possible that he missed all 12 shots? Explain why or why not.
    b. What is the probability that he made 9 free throws?
    c. What is the probability that he made at least 9 free throws?

3. Suppose a recent study showed that 35% of women in the United States were overweight. A large company has 400 women employees. Assume that they are a random selection of the US population.
    a. What is the probability that 140 of the women employed are overweight?
    b. What is the probability that at least 140 of the women are overweight?
    c. What is the probability that less than 20% of the women are overweight?