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**Population Growth Equations Tutorial and Practice**

Addition for U10P1, AP Biology

**Formulas:**

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| --- | --- | --- | --- |
| **Rate** | **Population Growth** | **Exponential Growth** | **Logistic Growth** |
| dY/dt | dN/dt = B – D  |   |  |

**Key:**

|  |  |  |  |
| --- | --- | --- | --- |
| **Row** | **Term** | **Meaning** | **Typical Values**  |
| 1 | dY | This is a generic term meaning a change (d) in some variable (Y). Another way to write this is ΔY (delta Y), where the Δ (delta) stands for change. **Example #1:** dY could represent a change in the number of organisms in a population. **Example #2:** dY could represent a change in the number of inches of snow on the ground as it melts.  | dY is typically a whole number**Example #1:** If dY = 40, then 40 organisms have been added to the population. **Example #2:** If dY = -6, then 6 inches of snow have melted. In other words, the depth of snow on the ground has decreased by 6 inches. |
| 2 | dt | This term means a change (d) in time (t). Just like with the previous term, another way to write this is Δt (delta t), where the Δ (delta) stands for change. | dt is typically a whole number. **Example #1:** dt could be measured in units of years (the typical unit of measurement when discussing population growth)**Example #2:** dt could be measured in units of days*Note: dt is typically given a value of 1 when it is used in a rate equation (see row 3 and row 5).* |
| 3 | dY/dt | This is a generic equation for rate, which is a change in some variable (dY) over a change in time (dt).  | dY/dt is typically a whole number. **Example #1:** If dY/dt = 10 organisms/year, then 10 organisms have been added to the population over a period of one year. **Example #2:** If dY/dt = -2 inches/day, then the depth of the snow has decreased by two inches over a period of one day.  |
| 4 | dN | This is a more specific term than dY. Rather than a change in some variable (Y), dN represents a change in N, the population size.  | dN is a whole number of organisms. (just like example #1 in row 1).  |
| 5 | dN/dt | This is a specific equation for population growth rate, which is a change in the number of organisms in the population over a period of time (typically one year).  | If dN/dt = 25, then 25 organisms have been added to the population over a time period of one year. In other words, the population size has increased by 25 organisms. If dN/dt = -25, then 25 organisms have been lost from the population over a time period of one year. In other words, the population size has decreased by 25 organisms.  |
| 6 | B | This is the birth rate for a population, which is the number of organisms born in the population over a period of time (typically one year).  | This a whole number over 0. If B = 56, then 56 organisms have been born over the course of a year.  |
| 7 | D | This is the death rate for a population, which is the number of organisms that die in the population over a period of time (typically one year).  | This is a whole number over 1.If D = 23, then 23 organisms have died over the course of 1 year. |
| 8 | rmax | This is the maximum per capita growth rate for the population. The maximum per capita growth rate is the highest possible growth rate (i.e., when there is an abundance of resources) **per member of the current population**.  | This is a decimal value that is typically between 0 and 1. If rmax = 1.0, this means that for every member of the original population, we are adding another organism to the population over the course of a year. For example, say there were 20 organisms in the population at the beginning of the year. If one organism was added over the course of the year for each of these 20 organisms, then we would be adding 20 organisms for a total population size of 40 organisms at the end of the year. In other words, if rmax = 1.0, then we will double the population size over the course of the year (so long as there are no limiting factors such as resource shortages to limit population growth). If rmax = 0.5, this means that for every member of the original population, we are adding half of an organism (weird, I know!) to the population over the course of a year. Let’s say there were 34 organisms in the population at the beginning of the year. If one half of an organism was added over the course of the year for each of these 34 organisms, then we would be adding 17 organisms for a total population size of 51 at the end of the year.  |
| 9 | N | This is the current population size (i.e., at the beginning of the year before any population growth has occurred).  | This is a whole number of organisms.  |
| 10 | K | This is the carrying capacity for the population. Carrying capacity is the maximum number of organisms that the environment can support for a particular population.  | This is a whole number of organisms.  |

**A few important considerations…**

* Always use the logistic growth equation if you are given a value for the carrying capacity (K) of the population. Remember that the exponential growth equation is only used for populations that have abundant resources and no limiting factors.
* **Question:** If K is higher than N, what does this mean? How does it affect the growth rate of the population (dN/dt)?

**Practice Problems**

1. A population of 265 swans are introduced to Circle Late. The population’s birth rate is 34 swans per year, and the death rate is 27 swans per year. What is the rate of population growth? Express your answer as a whole number.
2. There are 190 green tree frogs in a swamp.
3. If rmax = 0.07, determine the population growth rate. Express your answer to the nearest whole number.
4. What will be the population size at the end of the year? Express your answer as a whole number.
5. There are 240 eastern grey squirrels in Prince William forest.
6. If rmax = -0.09, determine the population growth rate. Express your answer to the nearest whole number.
7. What will be the population size at the end of the year? Express your answer as a whole number.
8. One dandelion plant can produce many seeds, leading to a high growth rate for dandelion populations. If a population of dandelions has a current size of 40 individuals and rmax =0.2, predict dN/dt if this population is growing exponentially. Express your answer to the nearest whole number.
9. Imagine the dandelion population discussed in #4 cannot grow exponentially due to lack of space. The carrying capacity for the population is 56 dandelions. What is the population growth rate in this situation? Express your answer to the nearest whole number.
10. A hypothetical population has a carrying capacity of 300 individuals and rmax is 1.0. What is the population growth rate for a population with a current size of 320 individuals? Express answer to the nearest whole number.
11. There are 130 mice living in a field. If 25 mice are born each month and 18 mice die each month, what is the per capita growth rate of the mouse population over a month? Express your answer to the nearest hundredth.

*Note: This worksheet is adapted from various sources. Thank you!*