

### 5.2.D2 Exponential Functions

❖ What is an exponential function?

An **exponential function** is a nonlinear function of the form  $y = ab^x$ , where  $a \neq 0$ ,  $b \neq 1$ , and  $b > 0$ . As the independent variable  $x$  changes by a constant amount, the dependent variable  $y$  is multiplied by a constant factor, which means consecutive  $y$ -values form a constant ratio.

❖ Writing Exponential Functions

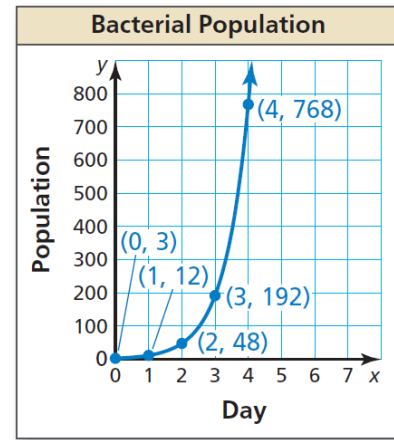
For an exponential function of the form  $y = ab^x$ , the  $y$ -values change by a factor of  $b$  as  $x$  increases by 1. You can use this fact to write an exponential function when you know the  $y$ -intercept,  $a$ . The table represents the exponential function  $y = 2(5)^x$ .

$x$	0	1	2	3	4
$y$	2	10	50	250	1250

$\xrightarrow{+1}$   $\xrightarrow{+1}$   $\xrightarrow{+1}$   $\xrightarrow{+1}$   
 $\xleftarrow{\times 5}$   $\xleftarrow{\times 5}$   $\xleftarrow{\times 5}$   $\xleftarrow{\times 5}$

➤ **EXAMPLE:** The graph represents a bacterial population  $y$  after  $x$  days.

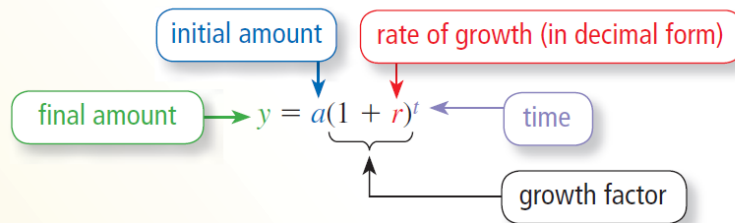
- Write an exponential function that represents the population after  $x$  days.
- Find the population after 5 days.



❖ Exponential Growth Functions

➤ Exponential growth occurs when a quantity increases by the same factor over equal intervals of time.

A function of the form  $y = a(1 + r)^t$ , where  $a > 0$  and  $r > 0$ , is an **exponential growth function**.



For exponential growth, the value inside the parentheses is greater than 1 because  $r$  is added to 1.

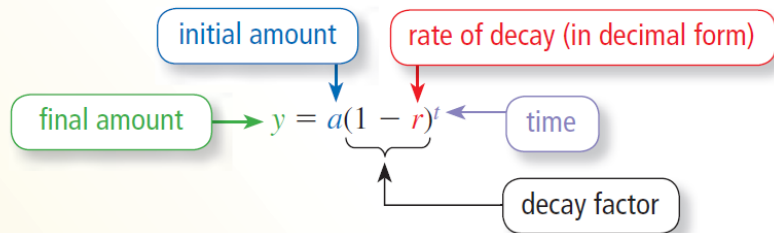
➤ **EXAMPLE:** The attendance of an annual music festival is 150,000. The attendance,  $A$ , increases by 8% each year.

- Write an exponential growth function that represents the attendance after  $t$  years.
- How many people will attend the festival in the fifth year?

## ❖ Exponential Decay Functions

- Exponential decay occurs when a quantity decreases by the same factor over equal intervals of time.

A function of the form  $y = a(1 - r)^t$ , where  $a > 0$  and  $0 < r < 1$ , is an **exponential decay function**.



For exponential decay, the value inside the parentheses is less than 1 because  $r$  is subtracted from 1.

- **EXAMPLE:** You purchase a car in 2010 for \$25,000. The value of the car decreases by 14% annually.
  - Write an exponential decay function that represents the value of the car after  $t$  years.
  - What is the value of the car in 2015?
- **EXAMPLE:** Determine whether the table represents an exponential growth function, an exponential decay function, or neither. If exponential, write an equation of the form  $y = a(b)^x$ .

a.

$x$	$y$
0	270
1	90
2	30
3	10

b.

$x$	0	1	2	3
$y$	5	10	20	40

- **EXAMPLE:** Determine whether each function represents exponential growth or exponential decay. Identify  $a$ , the initial value,  $b$  the growth factor or decay factor, and  $r$ , the percent rate of change.
  - $y = 5(1.07)^t$
  - $f(t) = 0.2(0.98)^t$