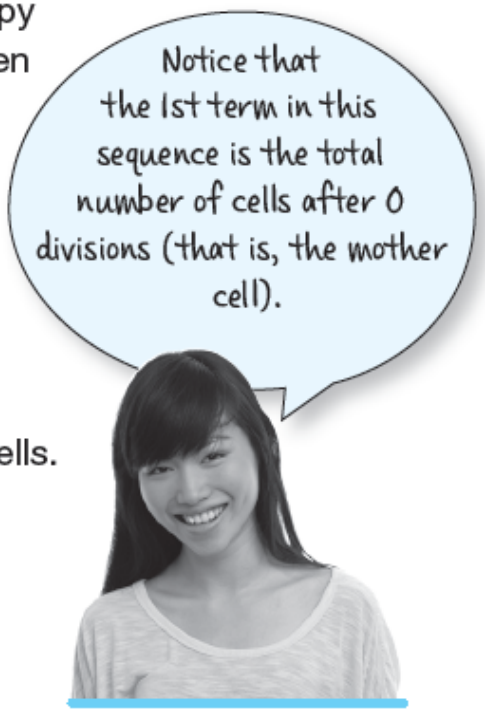
PROBLEM 2 They're Just Out of Control—But That's A Good Thing!

When it comes to bugs, bats, spiders, and—ugh, any other creepy crawlers—finding one in your house is finding *one* too many! Then again, when it comes to cells, the more the better! Animals, plants, fungi, slime, molds, and other living creatures consist of eukaryotic cells. During growth, generally there is a cell called a "mother cell" that divides itself into two "daughter cells." Each of those daughter cells then divides into two more daughter cells, and so on.



1. The sequence shown represents the growth of eukaryotic cells.

1, 2, 4, 8, 16, . . .

a. Describe why this sequence is geometric.

$\frac{2}{1} = 2$ and $\frac{4}{2} = 2$

You multiply by 2 each time.

b. Determine the common ratio for the given sequence.

The **common ratio**, $r = 2$.

c. Complete the table of values. Use the number of cell divisions to identify the term number, and the total number of cells after each division.

Number of Cell Divisions	Term Number (n)	Total Number of Cells
0	1	1
1	2	2
2	3	4
3	4	8
4	5	16
5	6	32
6	7	64
7	8	128
8	9	256
9	10	512

Compare the Number of Cell Divisions to the Term Number. What's the difference?

Starting point

×2

×2

Is there another way to generate these numbers?

Do you notice any patterns in the data?

d. Explain how you can calculate the tenth term based on the ninth term.

Multiply the 9^{th} term by 2.

e. Determine the 20th term. Explain your calculation. Keep multiplying by 2!

20^{th} term = 524,288.

f. Is there a way to calculate the 20th term without first calculating the 19th term? If so, describe the strategy.

Yes. Use the formula 2^x, where x = the # of cell divisions or the # of terms - 1.

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b. Determine the common ratio for the given sequence.

The **common ratio**, $r = 2$.

c. Complete the table of values. Use the number of cell divisions to identify the term number, and the total number of cells after each division.

Number of Cell Divisions	Term Number (n)	Total Number of Cells
0	1	$1 = 2^0$
1	2	$2 = 2^1$
2	3	$4 = 2^2$
3	4	$8 = 2^3$
4	5	$16 = 2^4$
5	6	$32 = 2^5$
6	7	$64 = 2^6$
7	8	$128 = 2^7$
8	9	$256 = 2^8$
9	10	$512 = 2^9$

Rewrite the total # of cells in exponential form.

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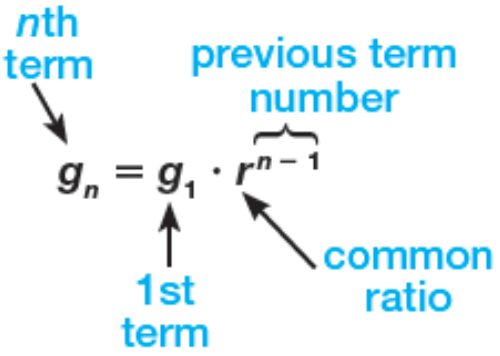
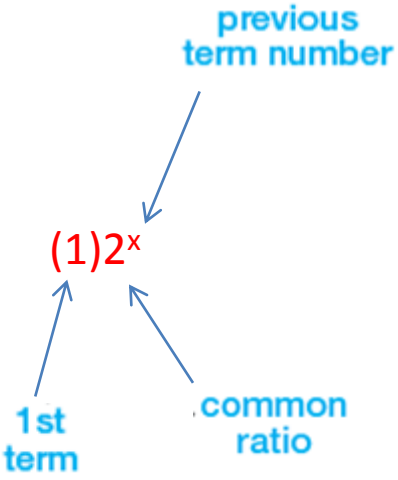
The explicit formula for determining the *n*th term of a geometric sequence is:



Let's Compare!



$$g_n = g_1 \cdot r^{n-1}$$

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3. Use the explicit formula to determine the total number of cells after:

a. 11 divisions. (*12th term!*)

$$g_{12} = 1 \cdot 2^{12-1}$$
$$g_{12} = 1 \cdot 2^{11}$$
$$g_{12} = 2^{11}$$
$$g_{12} = 2048$$

b. 14 divisions.

$$g_{15} = 1 \cdot 2^{15-1}$$
$$g_{15} = 1 \cdot 2^{14}$$
$$g_{15} = 2^{14}$$
$$g_{15} = 16,384$$

c. 18 divisions.

d. 22 divisions.

$g_n = g_1 \bullet r^{n-1}$ ⟶ $1st\ Term = 5$, $r = 3$ ⟶ $g_n = 5 \bullet 3^{n-1}$

4. Suppose that a scientist has 5 eukaryotic cells in a petri dish. She wonders how the growth pattern would change if each mother cell divided into 3 daughter cells. For this situation, determine the total number of cells in the petri dish after:

a. 4 divisions. (*5th term!*)

$g_5 = 5 \bullet 3^{5-1}$

$g_5 = 5 \bullet 3^4$

$g_5 = 5 \bullet 81$

$g_5 = 405$

b. 7 divisions.

$g_8 = 5 \bullet 3^{8-1}$

$g_8 = 5 \bullet 3^7$

$g_8 = 5 \bullet 2187$

$g_8 = 10,935$

~~**c.** 13 divisions.~~

~~**d.** 16 divisions.~~

Let's Practice!