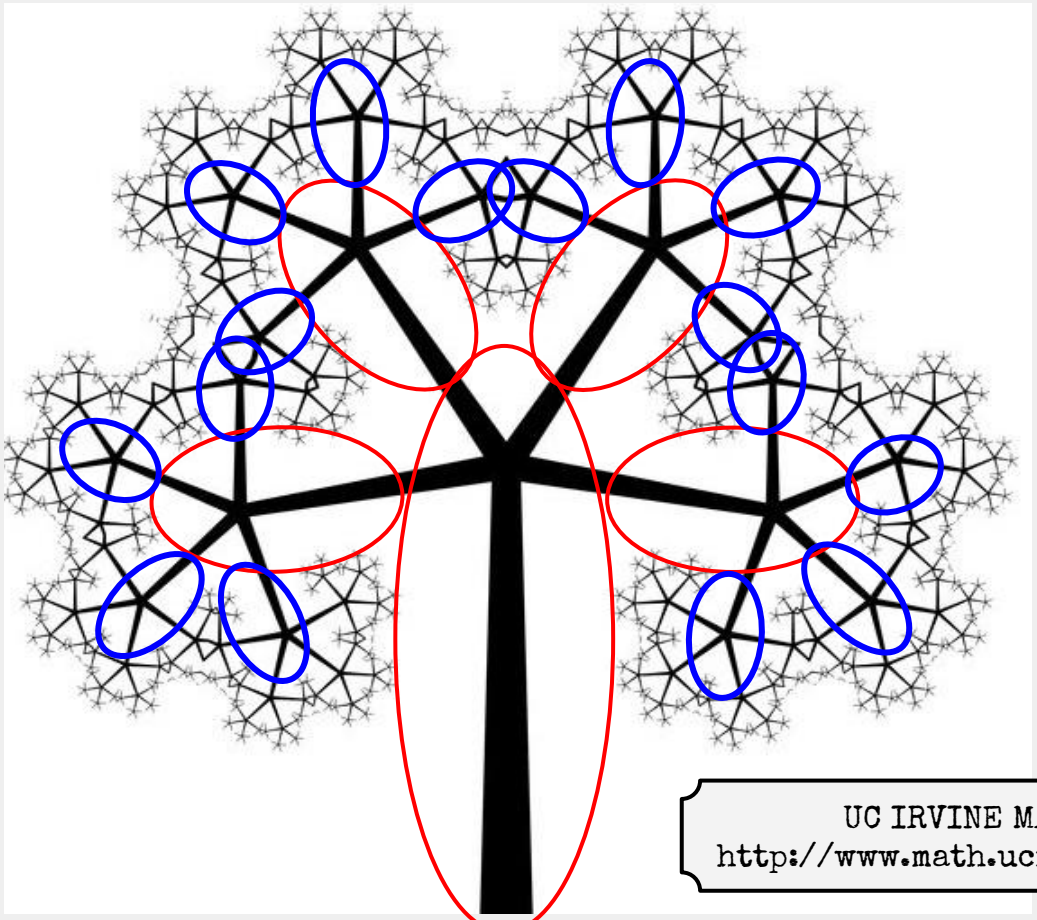
UC IRVINE MATH CEO

Community Educational Outreach

Meeting 11 Student's Booklet

Cells and fractal trees

January 20 2016 @ UCI



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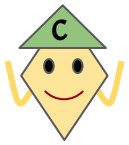
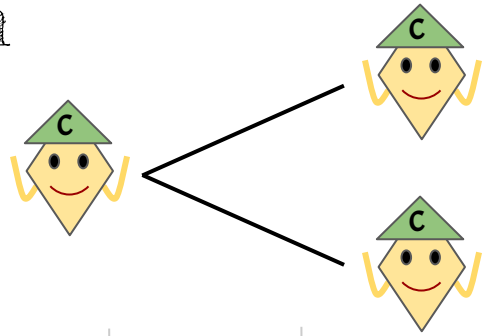


1 Cellular growth

Cellulin is an endothelial cell. An endothelial cell is a cells that is lining the blood vessels. If properly fed, a cellulin cell lives for about a day. During her life, she has two daughters. We can represent this growth using a fertility tree as below. The letter **N** in a cell indicates a newborn.

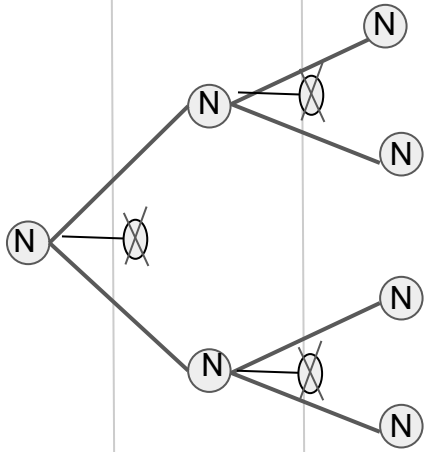


a If there is just one Cellulin cell in **day 0**, how many cells will there be on **day 1**? How many on **day 2**? On **day 3**?

b Draw the cells born in days 3 and 4 on the fertility tree.

c How many times more cells are there on **day 5** compared to **day 2**?

Fertility tree of Cellulin



Day 0	Day 1	Day 2	Day 3	Day 4	Day 5

d Complete the following table, then answer the questions below:

Day	Number of cells	Formula
0		
1		
2		
3		
4		
5		
6		
...	...	...
10		
50		
n		

Find a formula for the number of cells on day 10.

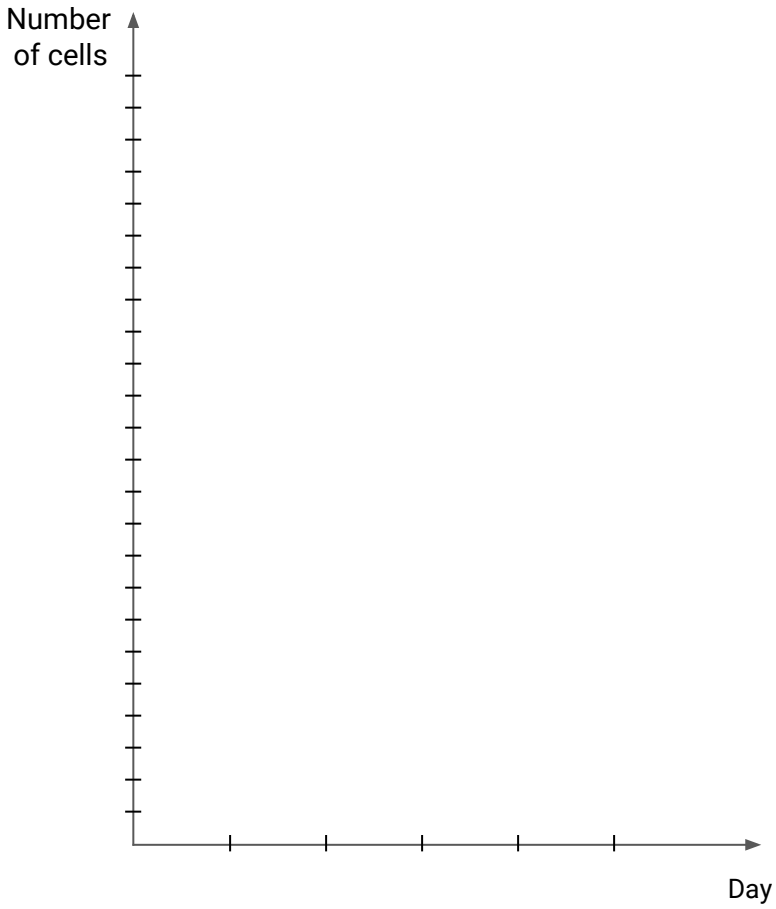
Based on your formula, how many cells do you expect have on day 50?

How many cells would there be on day *n*? Here *n* is any natural number.

If cellulin had 3 daughters in its one-day life, instead of 2, what would be the formula for the amount of cells on any day *n*?

What if cellulin had *m* daughters every day instead?

e Draw a graph of the growth of the total number of cells from day 0 to day 4. Choose an appropriate unit on each axis.



2 Mutation No. 1

Cellulin had a mutation! She now has two daughters every 48 hours (2 days) and she lives for 3 days instead of just 1 day.

a How many *newborn* cells do we have on **day 4?**

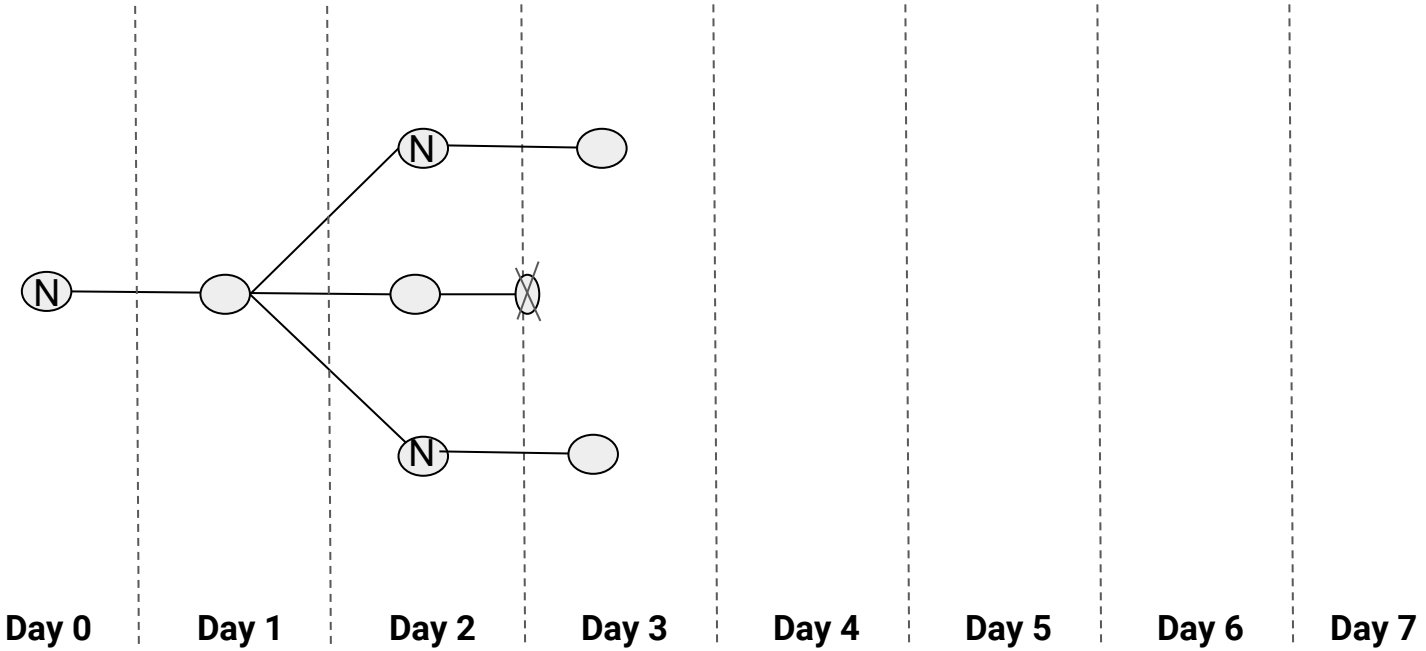
How many *newborn* cells do we have on **day 5?**

b What is the *total* number of cells on day 4?

What about on day 5?

c Complete the fertility tree for the first 7 days.

Fertility tree



d Fill out the second column of this table. That is, find the number of *newborn* cells born on each day (from day 1 to day 8).

e Find a formula for the number of *newborn* cells on **even** days.

_____

f Find a formula for the number of *newborn* cells on **odd** days.

_____

g Fill out the fourth column of this table. That is, find the *total* number of cells on each day (from day 1 to day 8).

_____

h Find a formula for the *total* number of cells on **odd** days.

_____

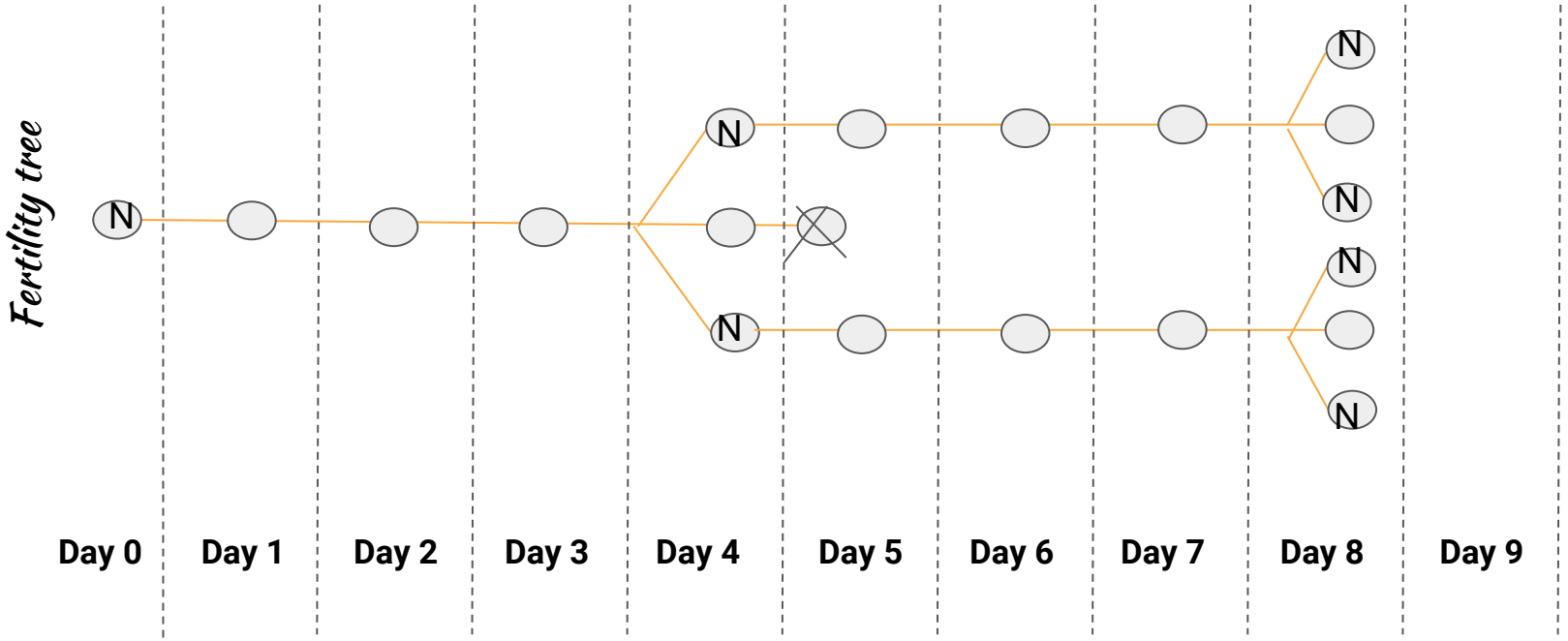
i Find a formula for the *total* number of cells on **odd** days.

_____

Day	Newborn cells	Formula *newborn* **even day**	Formula *newborn* **odd day**	Total cells	Formula *total* **odd day**	Formula *total* **even day**
0						
1						
2						
3						
4						
5						
6						
7						
8						
...	...	...	...	...	...	...
2n						
2n+1						

3 Mutation No. 2

A cellulin cell has had a different mutation! This has changed its lifespan and offspring dynamic. Look at the tree below and answer the questions on the following page:



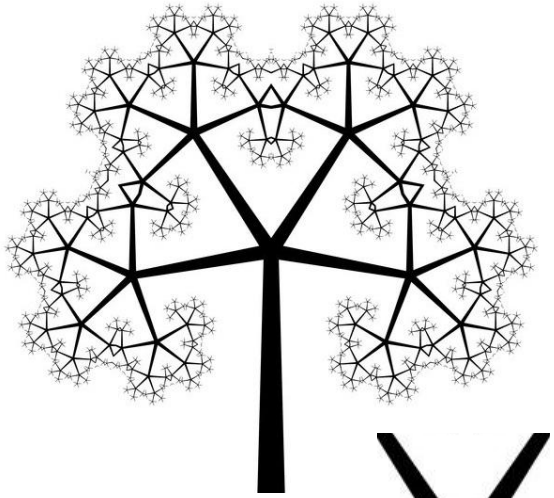
a What is the span life of a cell? _____

b How often does a cell have daughters? _____

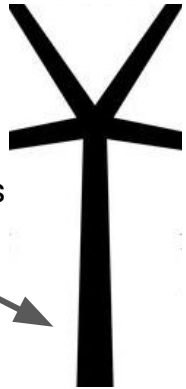
c How many daughters does a cell have? _____

4 Fractals

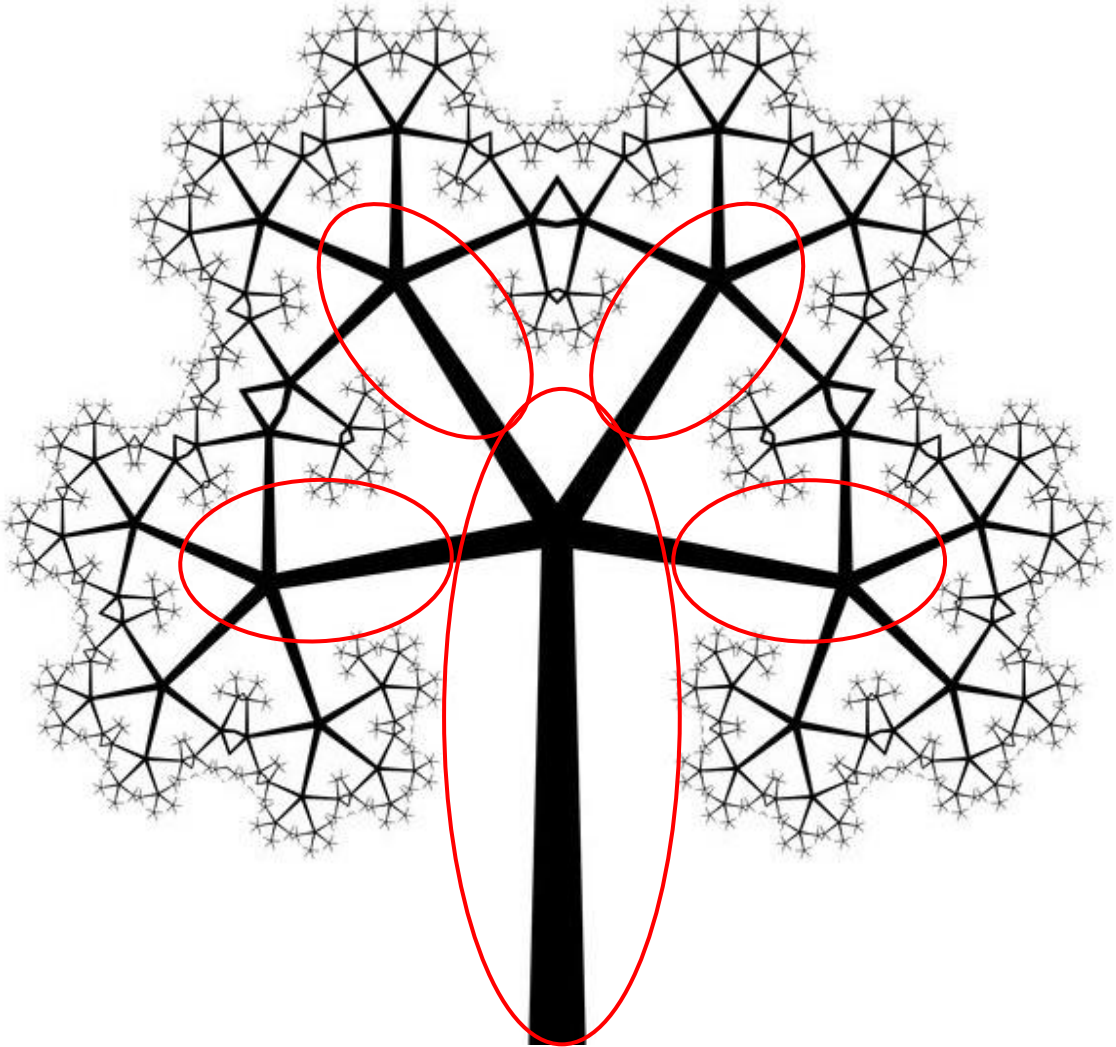
Many objects in nature are formed by repeating a unit piece over and over again. We call this piece **the basic structure** of the object.
For this tree,



the **basic structure** consists of a branch opening up into 4 smaller branches.

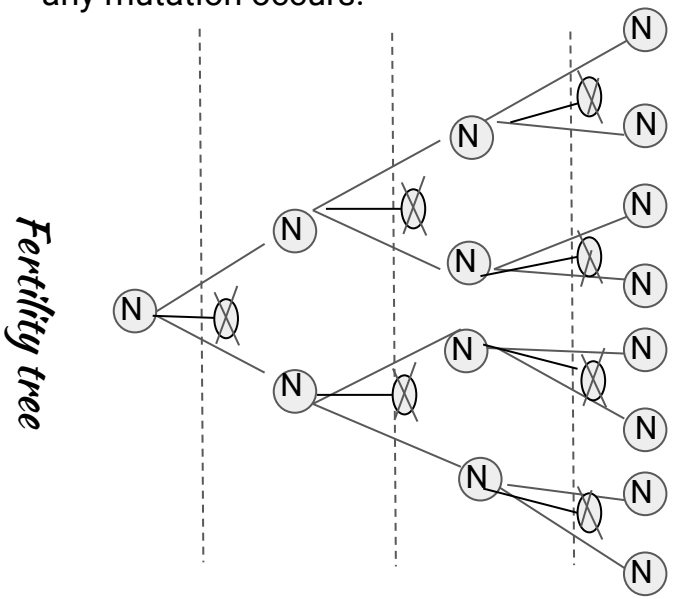


a The basic structure repeats several times. The basic structure in the 1st and 2nd iteration are circled. **Circle the basic structure in the next cycle** (3rd iteration)**.**
How many circles will you draw in the *n*th iteration?



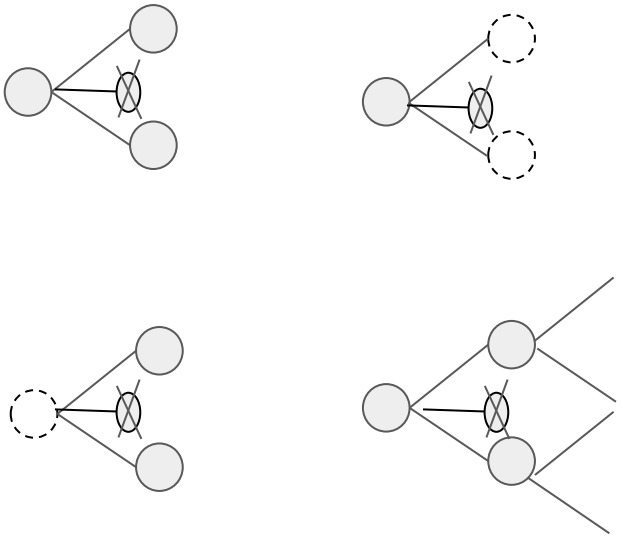
Many trees and leaves are formed by repeating a **basic structure** over and over again. The same is true for the fertility trees we constructed before.

b Look back at the fertility tree of Cellulin, before any mutation occurs.



The entire fertility tree can be generated by adding a basic structure to a single cell (the root of the fertility tree).

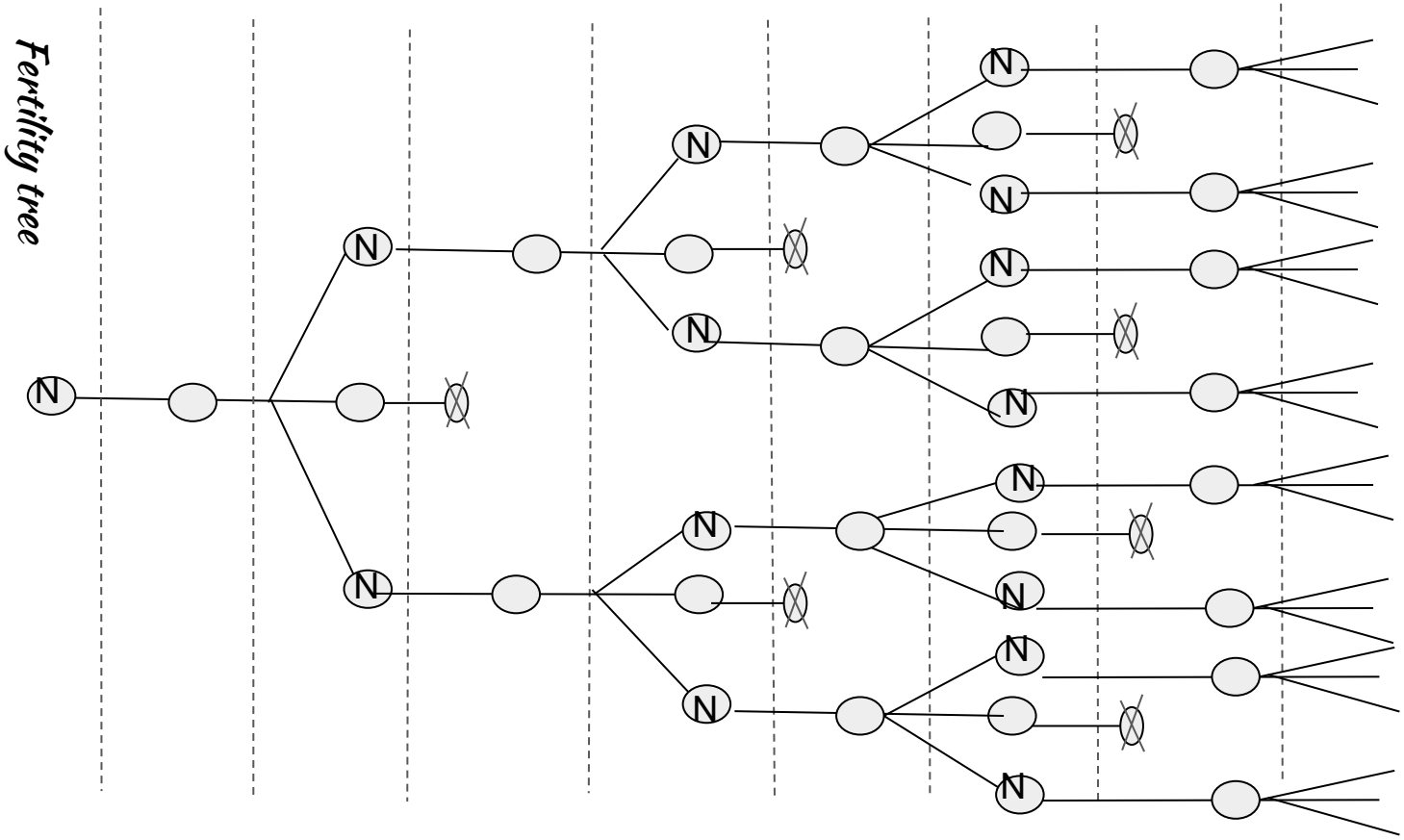
Which of the following is the basic structure for Cellulin's fertility tree? Circle it.



Note: A dotted circle indicates that the figure was already in the fertility tree during the previous day.

c After the first mutation, the fertility tree of Cellulin looks like this:

Can you identify the basic structures of this tree?



d Help us draw a fractal tree, by adding 2 new branches at each step.