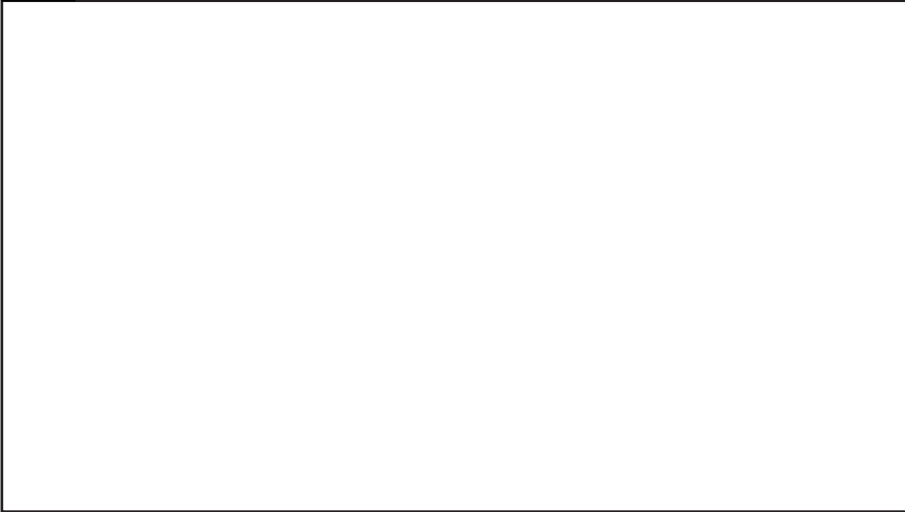
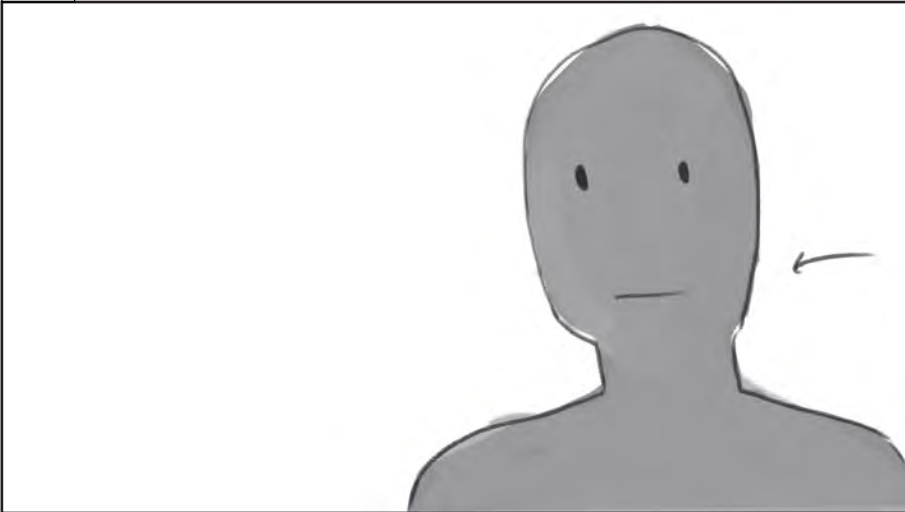


1a



Start with a white screen.

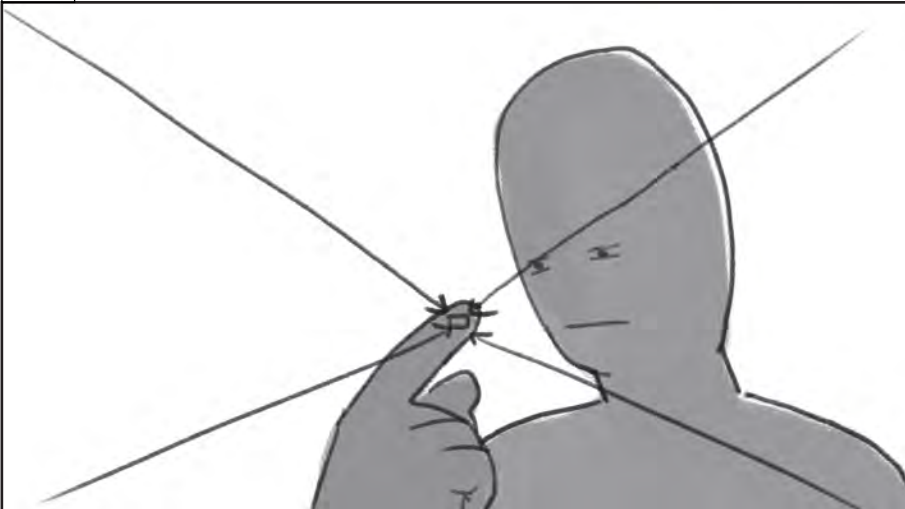
1b



In cell biology, everything we study is too small to be seen with the naked eye. We use diagrams to learn about cells, but it can be hard to judge the sizes of things we've only seen in images.

Human figure steps into view and blinks on "naked eye".

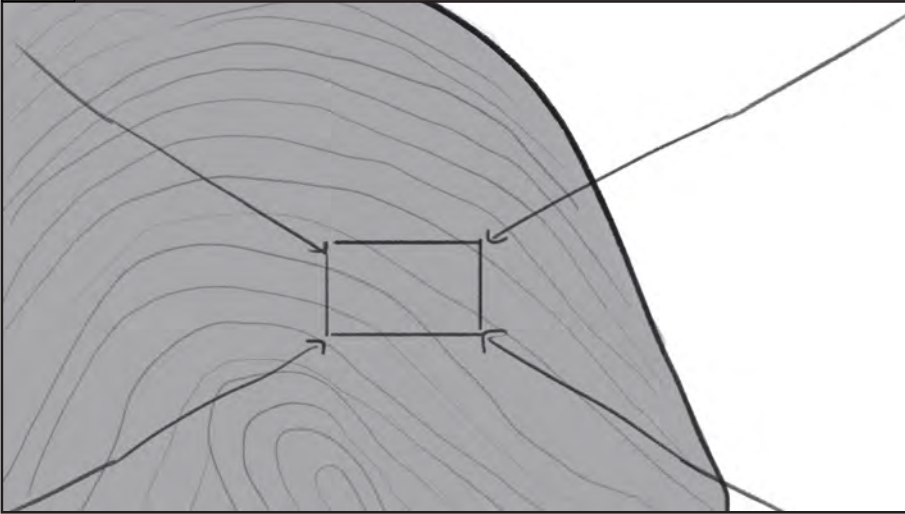
1c



Let's compare cells and their substructures with some structures we are already pretty familiar with. Ourselves!

The human figure looks at their finger. Camera zooms and blurs to reveal a closer view of the fingerprint.

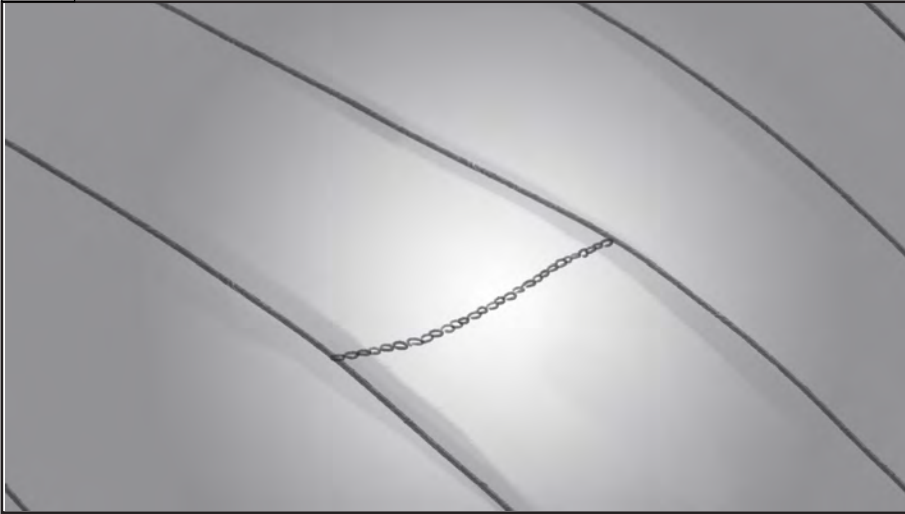
1d



A large fibroblast can be 16.5 microns long, --

Camera continues zooming towards the fingerprint.

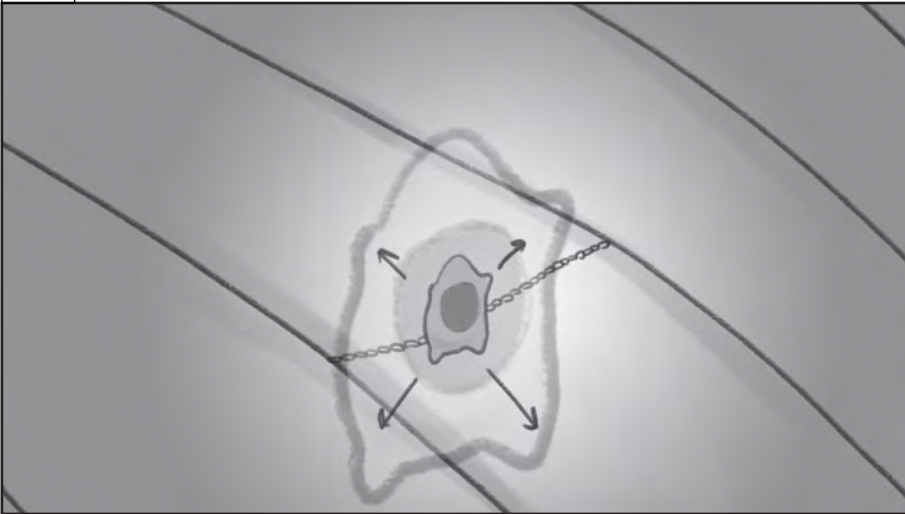
1e



-- small enough for 30 of them to fit in one ridge on a fingerprint.

Camera stops at a close up shot, and the skin turns transparent to reveal 30 fibroblasts lined up.

2a



Now imagine that we could enlarge the fibroblast by 100,000 times.

A single fibroblast in the line rapidly expands.

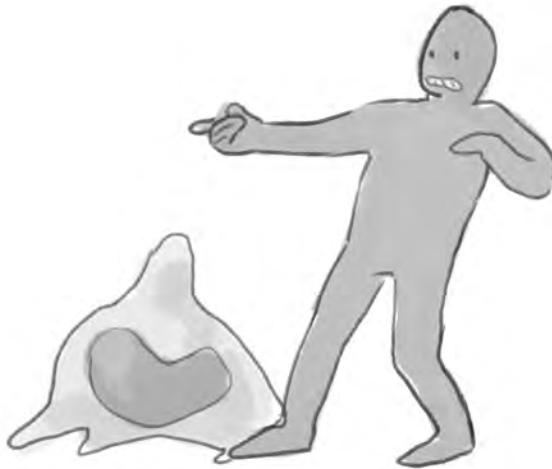
2b



The 16.5 micron fibroblast cell --

The fibroblast expands from the finger with a conical balloon noise.

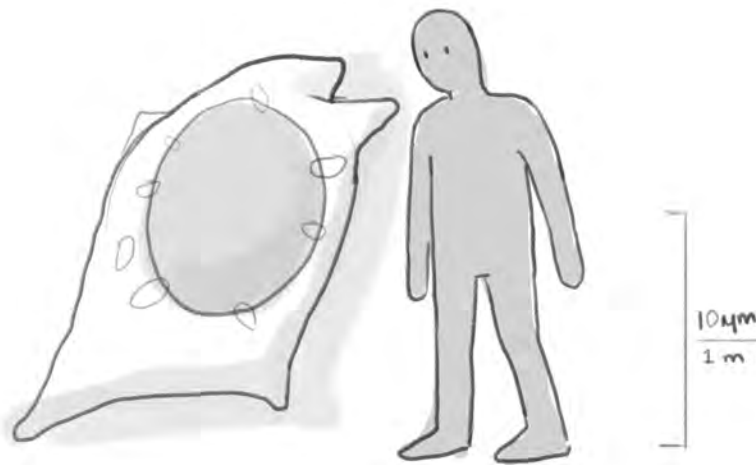
2c



-- would become 165 cm tall, --

The still-expanding fibroblast drops onto the floor.

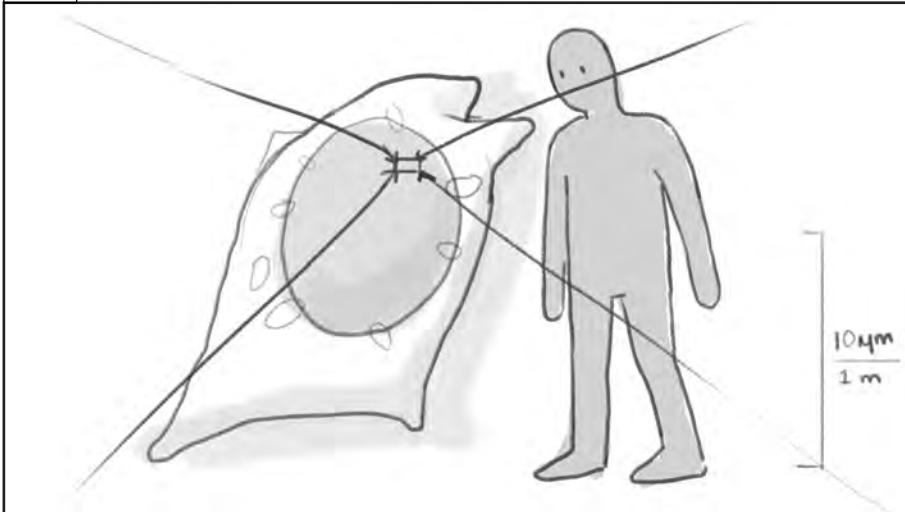
2d



-- roughly the height of an average human.

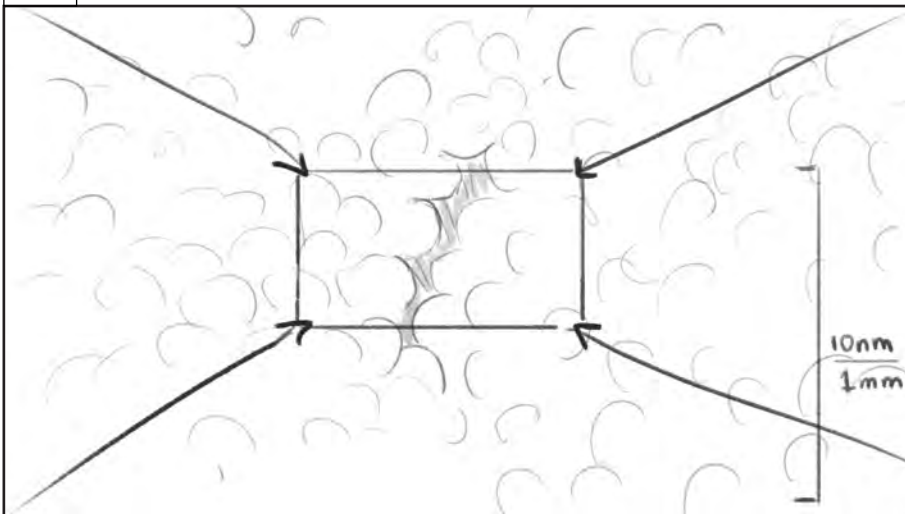
The fibroblast grows and finally stops when it reaches the same height as the person.

2e



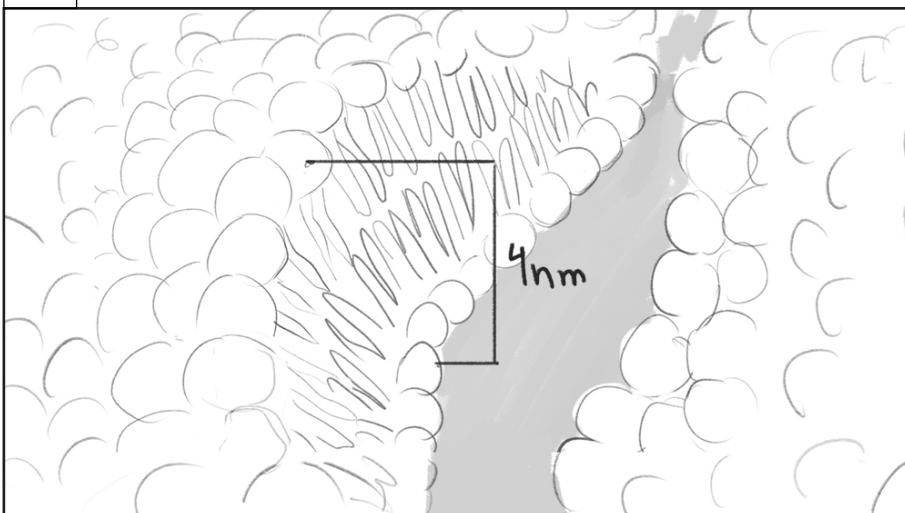
After narration ends, camera dollies and zooms into the cell to focus at the plasma membrane.

3a



Camera zooming and dollying into the plasma membrane as a crack opens, exposing the lipid tails.

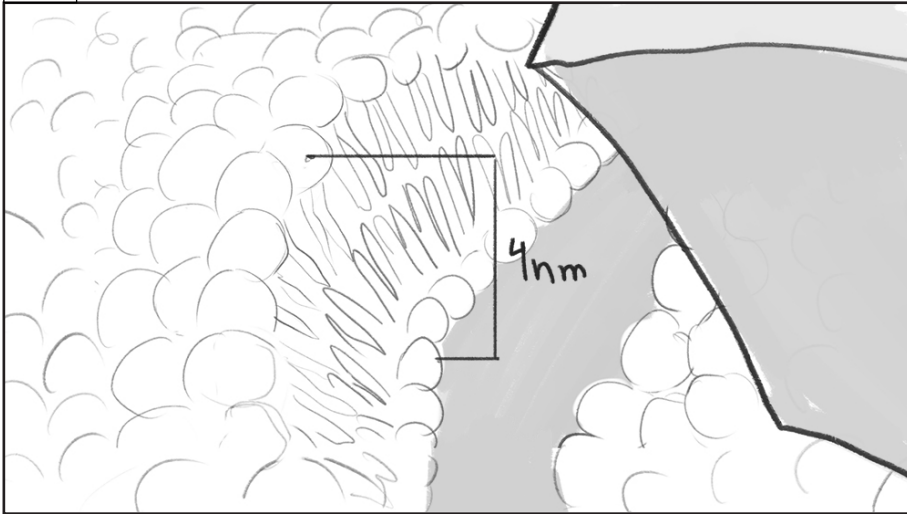
3b



The plasma membrane is 4 nanometres thick. To a person-sized cell, this would be 0.004 centimetres, --

Camera stops and lipids stop moving apart. The "4 nm" measurement moves from the right margin, and tracks with the movement of the bilayer, which jiggles in place

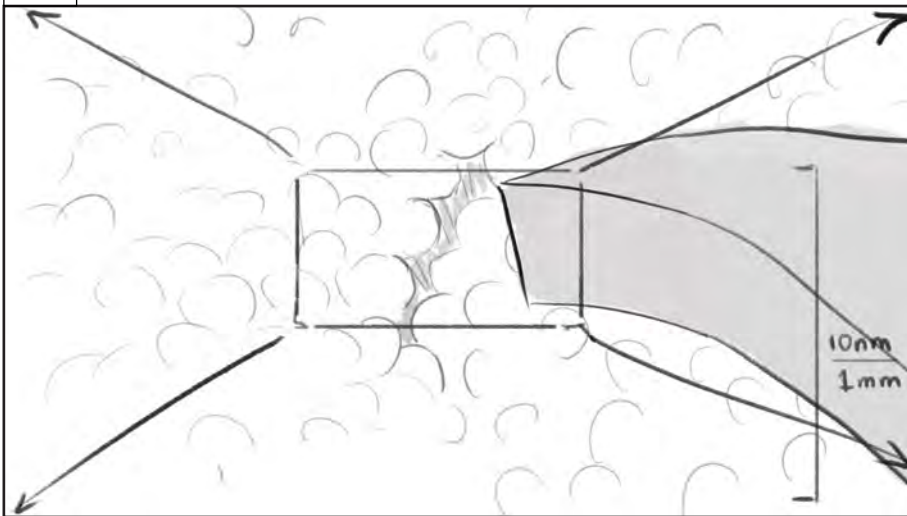
3c



-- or half the thickness of newspaper.

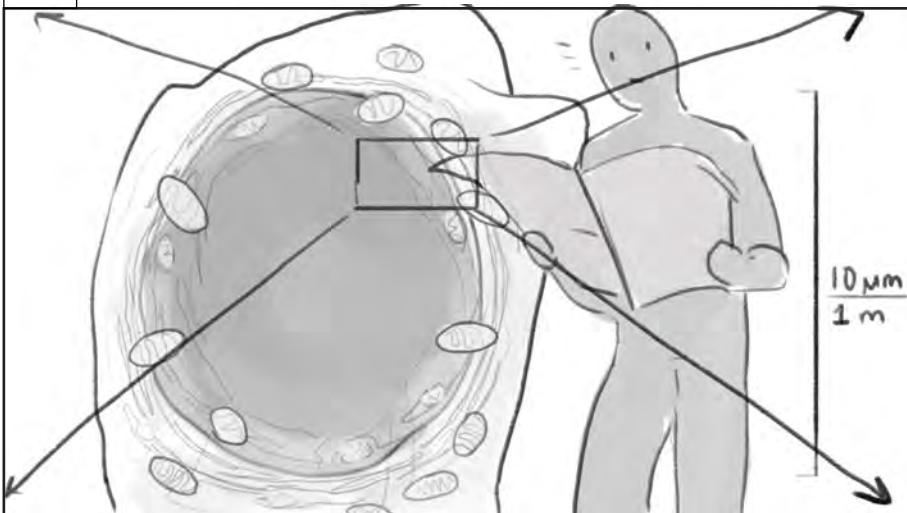
A slowed-down paper ruffling sound is heard as the corner of a huge piece of newspaper comes into view.

4a



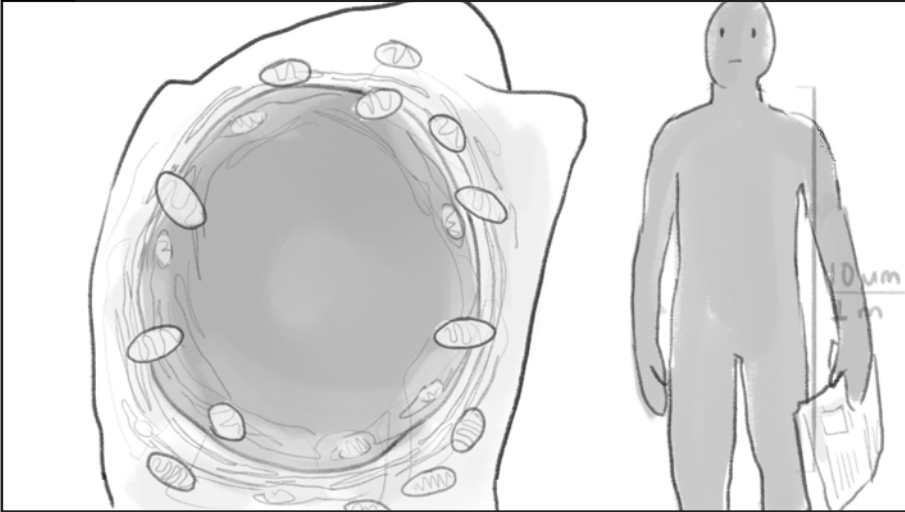
The scale bar returns to the right margin.. Camera dollies and zooms out to view the nucleus and the human figure.

4b



Camera continues zooming out, revealing the human figure reading the newspaper. They notice, and put the newspaper down to one side as the camera continues zooming out.

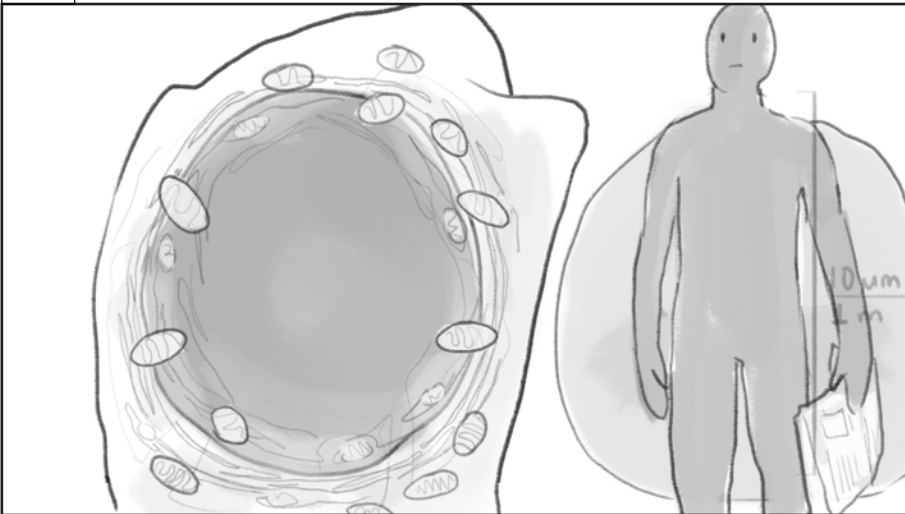
4c



The nucleus itself is 10 microns in diameter. To a person-sized cell, it would be 1 metre across --

The nucleus glows for a moment, for emphasis

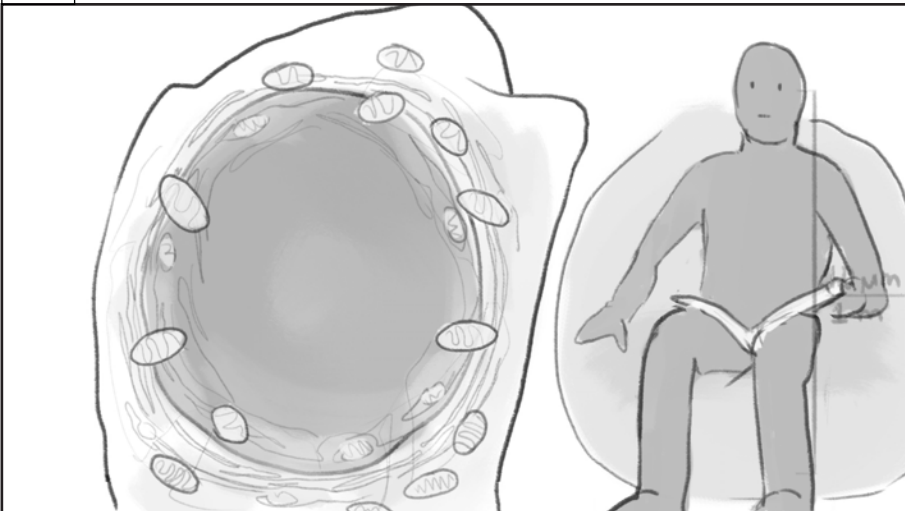
4d



-- about the width of a beanbag chair .

A beanbag chair pops into existence behind the figure. The figure sits down in the beanbag chair, making a fabric-rustling sound, and a newspaper ruffling sound.

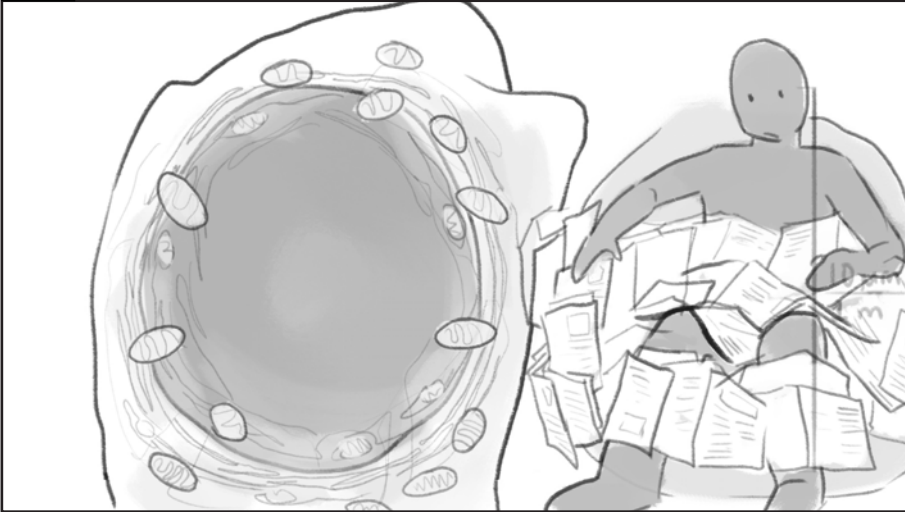
5a



The endoplasmic reticulum is difficult to measure because it is a continuous membrane that spans most of the cell.

The ER glows for a moment when mentioned.

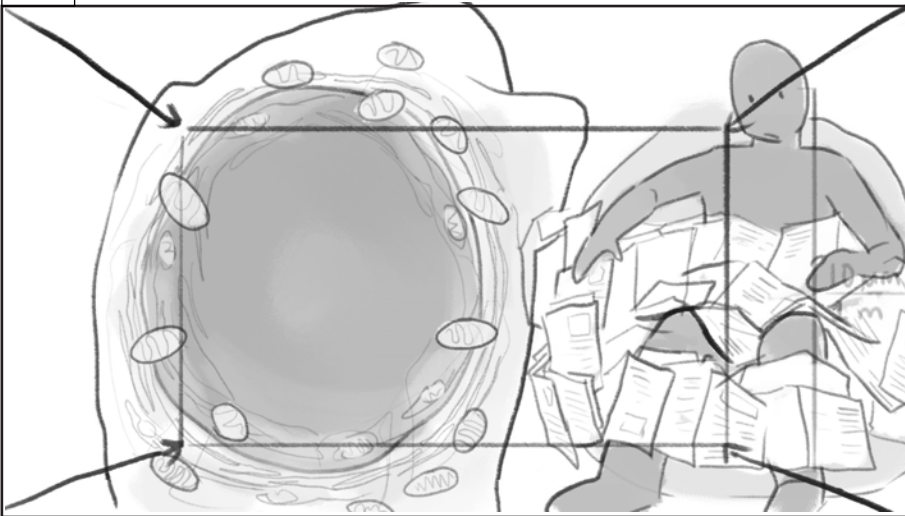
5b



To a person-sized cell, it would be like wrapping the nucleus in a hundred sheets of newspaper.

Newspapers pop into existence, covering the figure and beanbag chair as ruffling sounds are made.

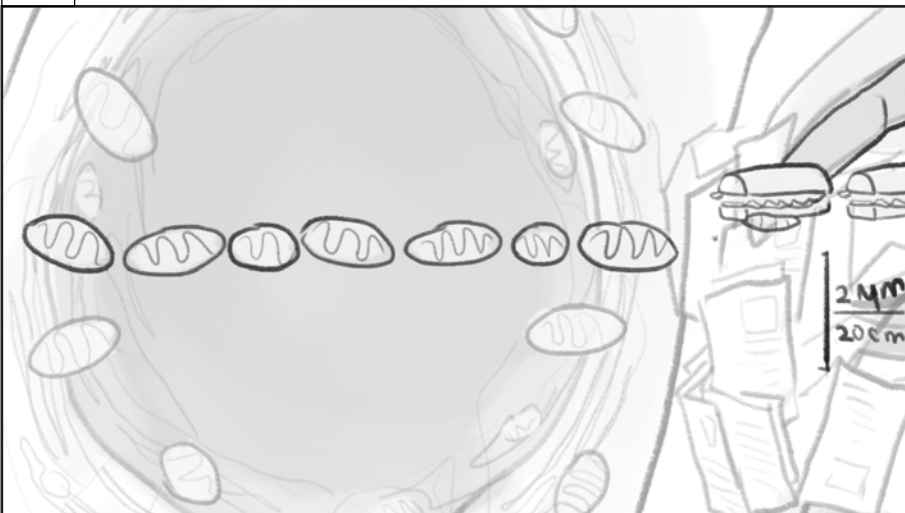
6a



Mitochondria vary in size from 1-2 microns. To a person-sized cell, this would be 10-20 centimetres, --

Zoom to a closer view of mitochondria, with the nucleus mostly in frame for comparison.

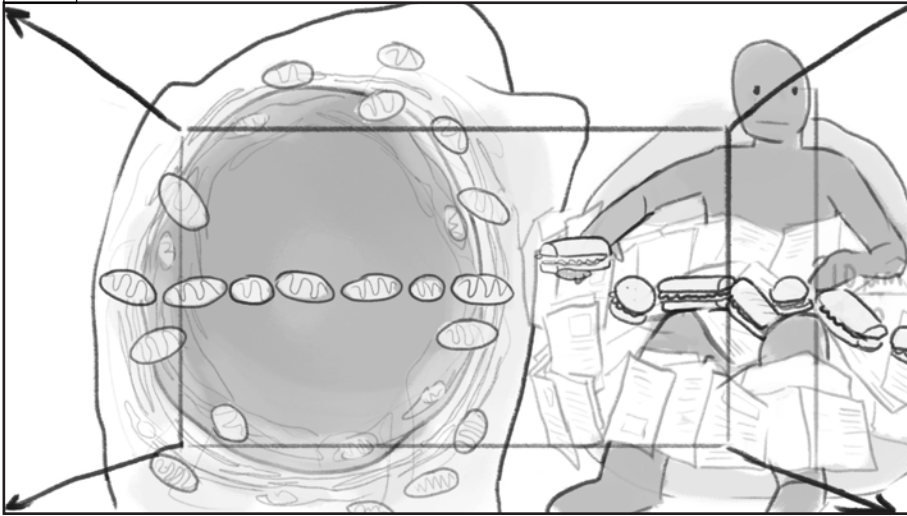
6b



-- between the sizes of a hamburger and a submarine sandwich .
5-10 mitochondria would span the diameter of the nucleus, just like 5-10 sandwiches --

A sub sandwich pops into the figure's hand first, then the mitochondria move into position, then the other sandwiches appear, making popping-in sounds from off-screen.

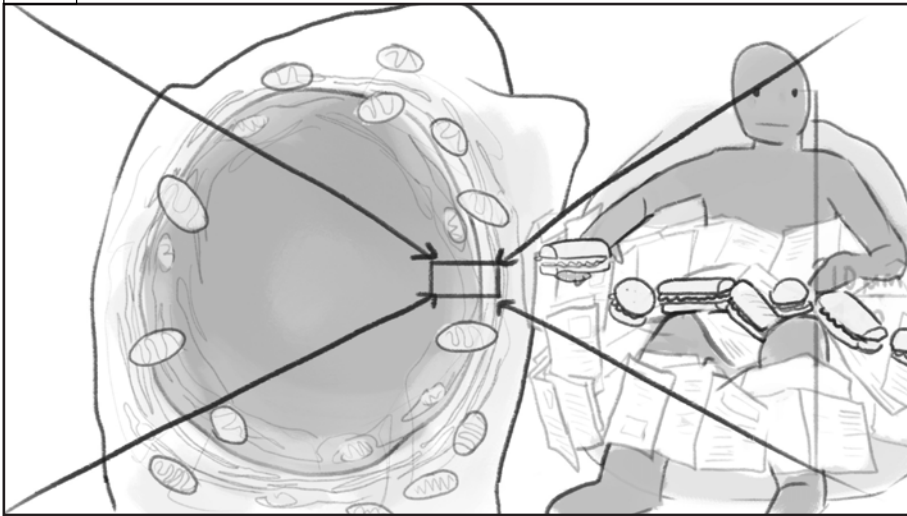
6c



-- would span the length of a beanbag chair.

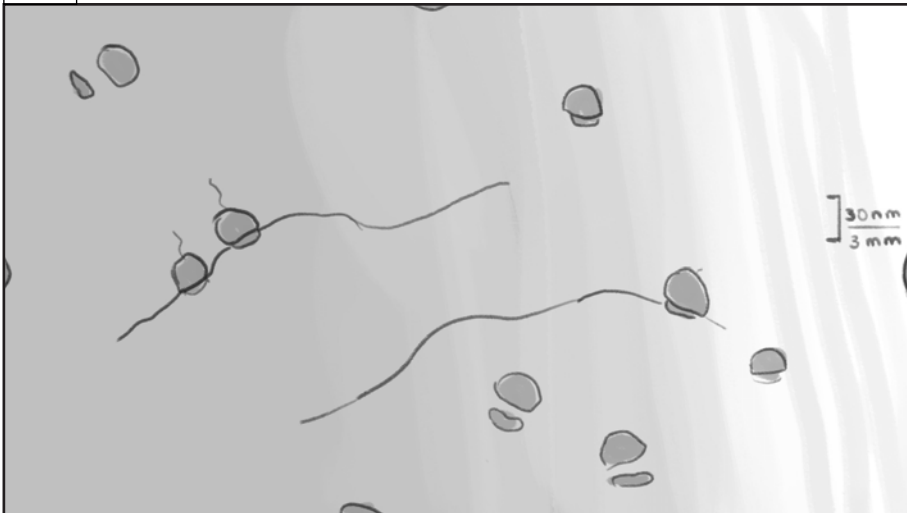
The camera zooms out to reveal the sandwiches spread over the figure's lap as they are mentioned in narration. The mitochondria relax back to their original positions.

7a



Camera extreme zooms to focus on ribosomes and mRNA. The nucleus and ER are extremely defocused in the background.

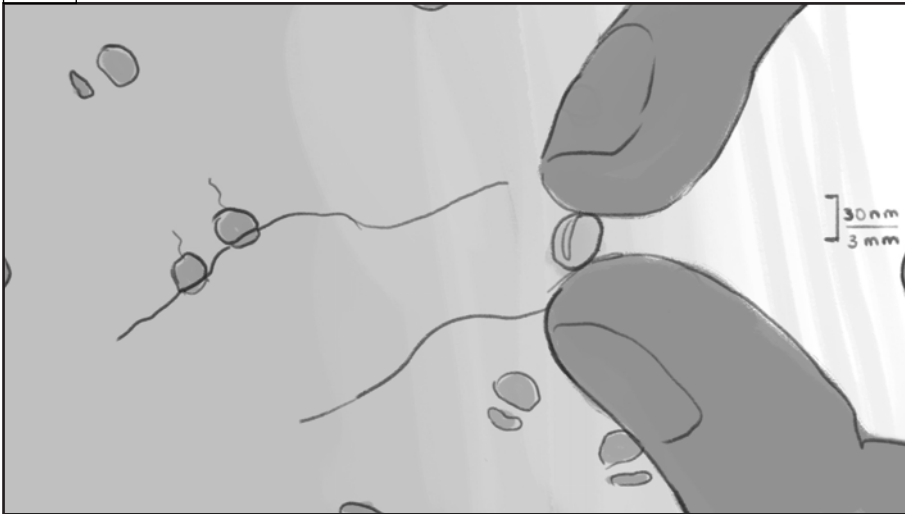
7b



Ribosomes are very small, only 30 nanometres across. To a person-sized cell, they would be 3 millimetres --

Ribosomes float around or move along their mRNA strands.

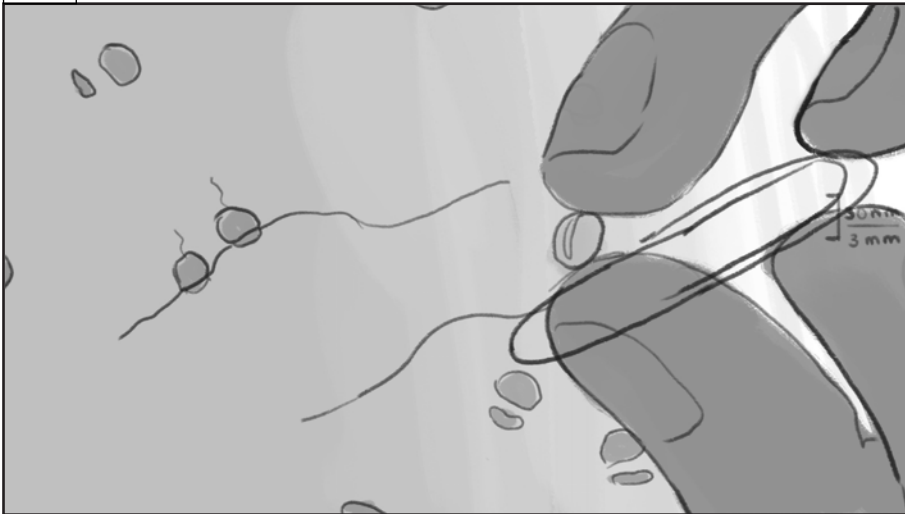
7c



-- or the size of a barley seed.
 mRNA, on the other hand, are much larger.

A right hand brings in a barley seed.

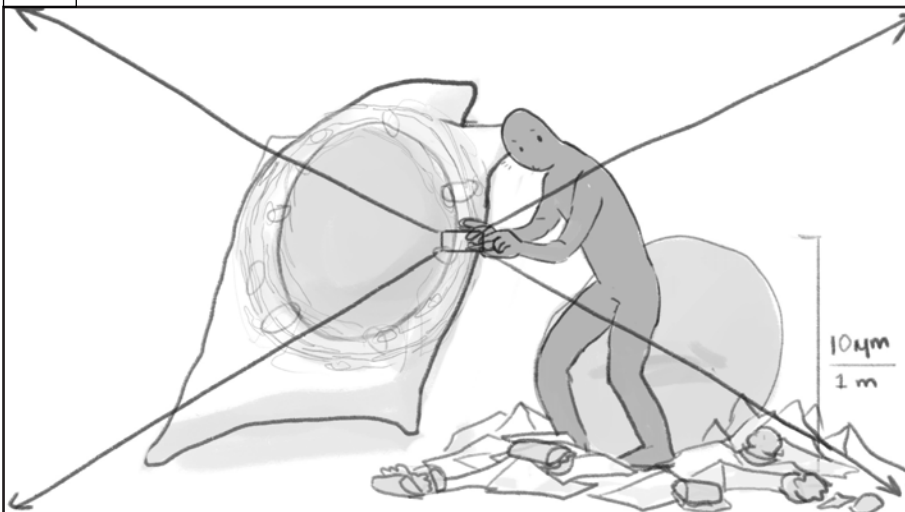
7d



An average mRNA strand is about 300 nanometres long, and would be 30 millime-tres to a person-sized cell. This is about the length of a paperclip.

A left hand brings in a paperclip next to the barley seed.

8a



It's easier to get an idea of the sizes of such tiny structures now that we have seen them in a more familiar scale.

Camera zooms out to reveal the figure holding the barley and paperclip in frame. The sandwiches and newspapers are strewn across the floor. The figure notices and returns to original position for the summary.

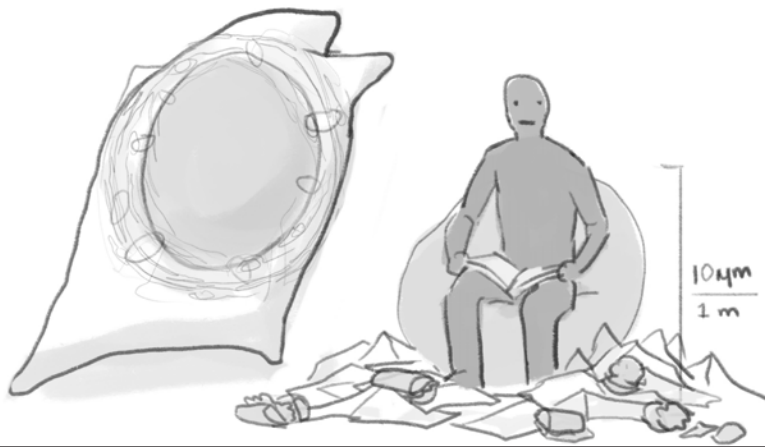
8b



If a fibroblast were the size of a person, the plasma membrane would be half as thick as newspaper, --

The figure takes a piece of newspaper from the floor as a ruffling sound is made. They look anxiously at the camera.

8c



-- the nucleus would be the width of a beanbag chair, --

The figure sits in the beanbag chair as a fabric ruffling sound is made.

8d



-- endoplasmic reticulum would be like layers of newspaper, --

The figure frantically gathers more sheets of newspaper from the ground.

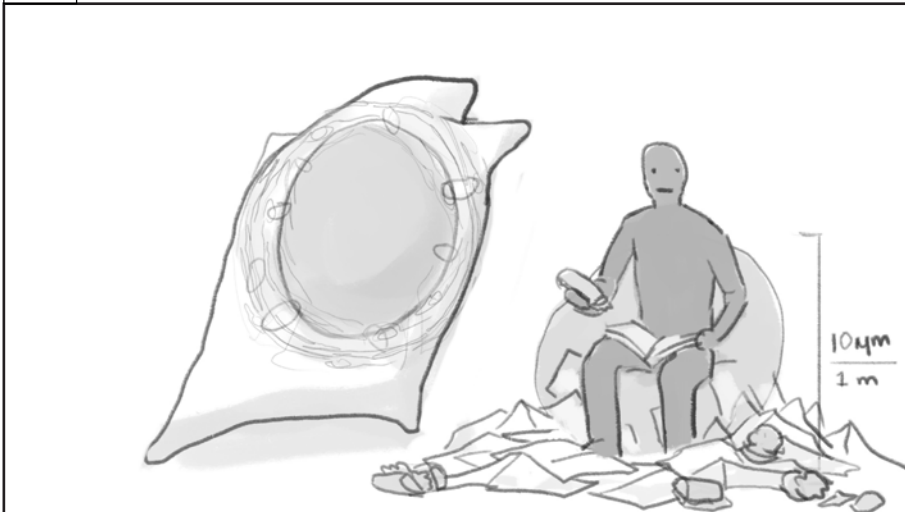
8e



-- mitochondria would be the size --

The figure reaches for a sub sandwich from the ground.

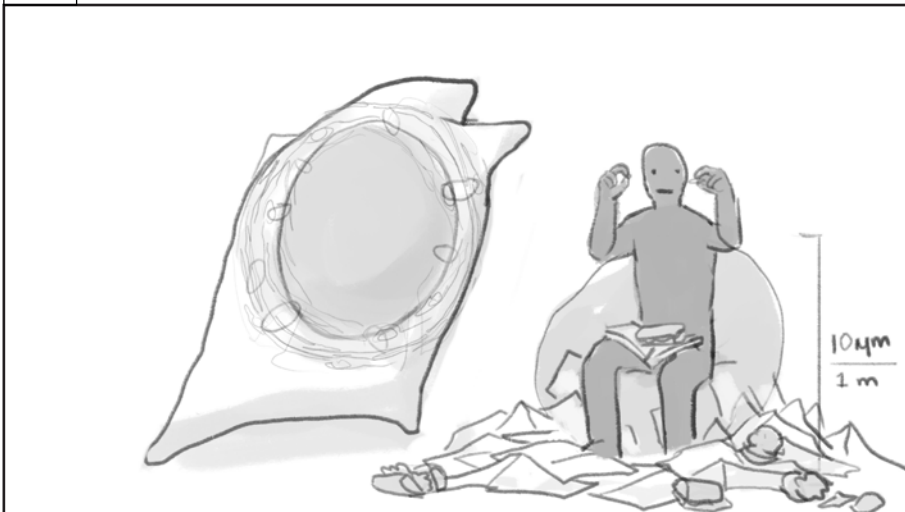
8f



-- of sub sandwiches, --

The figure holds the sandwich while it is mentioned, then places it in their lap.

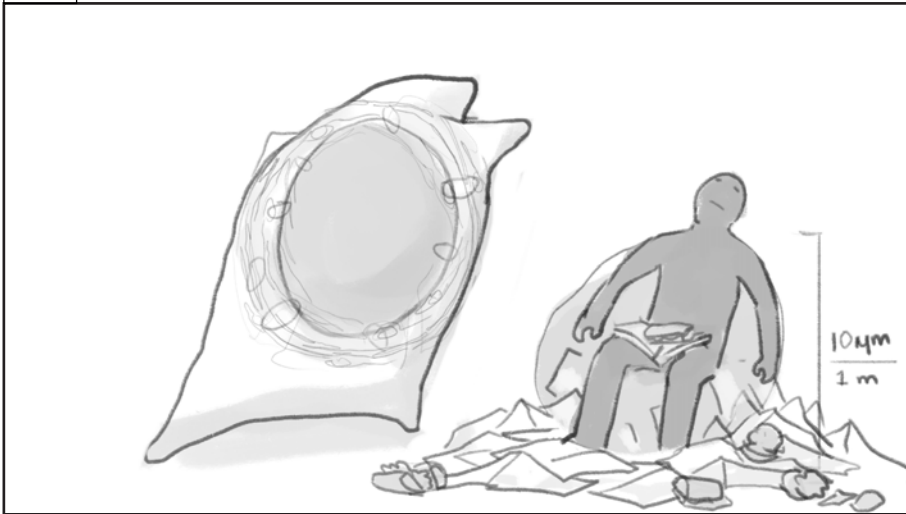
8g



-- mRNA would be as long as paperclips and ribosomes would be as small as barley seeds.

The figure takes the barley and paperclip up from their lap and holds them at eye level.

8h



The figure can finally relax in their seat. The scene fades to white.

9a



Credits roll over a white background.