The Forces That Bind

Engineer Andrés García:

Studying the Mechanics of Cell Adhesion

Andrés García Sizes Up Sticky Cells

Engineer García wants to create biomaterials to heal broken bones.

Adhesion enables cells to

- Change shape
- Move around the body
- Repair a wound

Question:

What happens when human cells become too sticky?

Answer: Cells cannot move

Cell adhesion: a delicate balance between too little and too much

Too little adhesion

↓

No traction

↓

No forward movement

Too much adhesion

↓

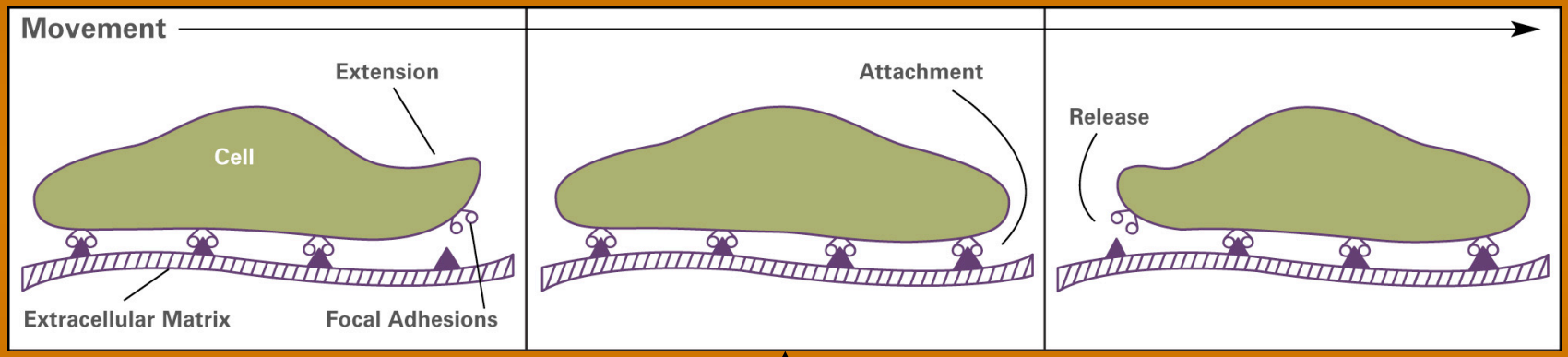
Flypaper effect

↓

No forward movement

How Cells Move

Cells walk along body surfaces via tiny "feet," called focal adhesions, which connect with the extracellular matrix.



To move (extend, attach, release), what must cells exert?

Forces Are With You

Types of force:

- Applied_one object exerts energy on another object

Give an example of applied force.

- Gravitational_massive celestial bodies pull on objects

What non-planetary objects might this type of force affect?

- Frictional_an object slides across a surface

Give an example of frictional force.

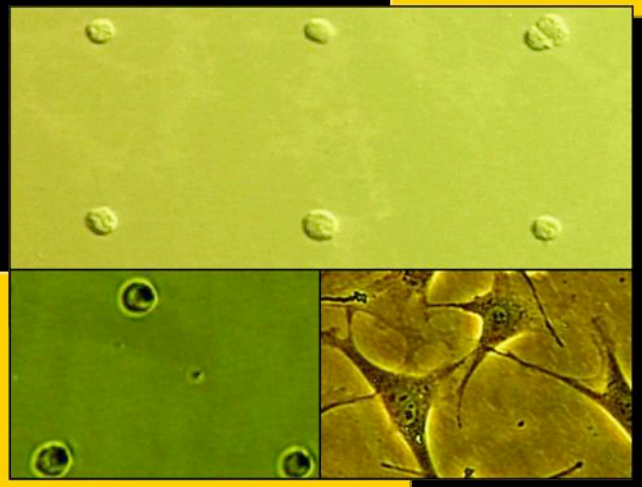
García's "One Size Fits All" Solution

Research question #1

How tightly do cells stick to a surface?

Technical solution:

Plates (surfaced with gold and a blend of chemicals) with indentations that hold just one cell each to provide control over where and how strongly cells stick



Technical obstacle:

Without a patterned surface to adhere to, cells stretch out any which way when growing on a glass slide

New tool needed:

A patterned surface to prevent cells from changing shape and shifting the position of their focal adhesions

García Gains Momentum

Research question #2

What can change adhesion force?

Technical obstacle:

No way to measure how much force kept cells stuck to the surface of the plates

Technical solution:

Create a cell-spinner

How Tightly Do Cells Stick to a Surface?

Answering research question #1

Inside the cell spinner

1. Plate containing cells sits on a disk holder
2. Disk holder spins inside a chamber filled with liquid
3. Spinning disk generates a 3-dimensional flow pattern that applies precise pressure detachment forces to the cells

Adhesion strength is calculated by counting cells remaining adhered after spinning stops.

What Can Change Adhesion Force?

Answering research question #2

Cellular stickiness depends on

- How many “feet” a cell has in one spot
- Whether cells have certain proteins

Question:

Do more “feet” mean stronger or weaker adhesion?

Why?

Interdisciplinary Discovery

García's discoveries are the result of mixing concepts from two disciplines: cell biology and engineering.

Biologists study the complexities of living systems

Engineers take systems apart to measure them

Research Applications

In what ways might the knowledge that García has gained about focal adhesion mechanics be applied in human medicine?