# Matrix Stiffness and Cell Proliferation

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**Subject:** Intermediate Level Science  
**Grade Level:** Middle School (Grade 5-8)

**Standards:**  
- From NYS Intermediate Science Core Curriculum  
1-Scientific Inquiry: S2.1b, S2.3b-c, S3.1a-b, S3.2, S3.2a-e, g  
4-Living Environment: 1.1a-e, 1.2j, 4.4a-b,d

**Schedule:** 2 days, 40 min periods

## Description:

This activity introduces students to cell biology, the study of biology at the cellular level, and the research question of the role of matrix stiffness on cell responses. The accompanying laboratory activity allows students to explore the role of matrix stiffness on cell proliferation.

## Objectives:

- Students will be introduced to the hierarchy of body systems: system > organ > tissue > cell  
- Students will be introduced to the how and why biological research is conducted  
- Students will investigate the role of matrix stiffness as a mediator of cellular proliferation  
- Students will communicate their findings to group mates and the class

## Vocabulary:

- Organ  
- Tissue  
- Cell  
- Matrix  
- Protein  
- In vitro  
- In vivo  
- Cell area  
- Cell Proliferation

## Materials:

- "Cell Biology Notes" worksheet  
- "Cell Proliferation Lab" Activity sheet

## Safety:

N/A
Science Content for the Teacher:

Organ systems are organized with a hierarchy of structure and functions. Starting at the largest length scale and working down, the body is organized into systems, organs, tissues, and cells. The most basic functional units of body systems are cells and matrix. Matrix are usually proteins that may be made by cells and are used to glue cells together and create mechanical integrity and stiffness in a tissue.

Biological research can be divided into two classes—*in vitro* and *in vivo*. *In vitro* work is done "on the benchtop" and may use cells from animals. *In vivo* describes work within living animals. Biological research is necessary to help understand disease states and to ultimately develop treatments for disease.

Matrix stiffness plays a role in mediating cell responses. For example, cow heart blood vessel cells (bovine aortic endothelial cells) increase in area when grown on matrices of increasing stiffness. Cellular proliferation is the process of cell division where one cell becomes two. Matrix stiffness may also play a role in mediating cellular proliferation in some cells. Current work in cancer research incorporates the role of matrix stiffness on cell proliferation. Tumors are identified by physicians as a lump or mass that is usually stiffer than the surrounding tissue. This increase in stiffness may promote a cancerous phenotype.

Classroom Procedure:

**Pre-lab lecture**
Before the lab activity, the teacher should introduce students to body systems and cellular biology. The role of the complexity of biology and the role of matrix stiffness in mediating cell responses should be emphasized. See lecture slides (Cell Biology Lecture) and accompanying notes pages (Cell Biology Notes and Key). The purpose of this activity is to determine the role of matrix stiffness in mediating cellular proliferation.

**Cellular Proliferation Lab**

**Engage (5 min)**
Students are provided with and instructed to read the “Cell Proliferation Lab” activity sheet prior to the lab day, and again before the lab activity.

**Explore (60 min)**
Allow students to work through the “Cell Proliferation Lab” activity. Encourage students to hypothesize how matrix stiffness will alter cellular proliferation.
Note: This activity depicts increasing proliferation with increasing matrix stiffness, a response found in actual preliminary data gathered by our lab (Dr. Reinhart-King, BME Cornell University).

**Explain (15 min)**
Allow each group of students to report their findings to the class. Compare and contrast anomalies in findings. Asks students how matrix stiffness may be important in disease. Connections to disease states include increased matrix stiffness during tumor growth and blood vessel stiffness during atherosclerosis (hardening of the arteries).

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