Maintenance of Cell Shape

# Introduction

Fibrous elements of the cytoskeleton, including microtubules and filaments, help maintain cell shape. For example, amoeba movement involves interactions of myosin and actin in the microfilaments in the cell cytoskeleton. Myosin is normally dispersed throughout the cell, but locally assembles and disassembles as necessary to drive movement.

# Importance

The importance of myosin to cell translocation can be assessed by studying shape differences between normal amoeba cells which assemble and disassemble myosin and mutant cells which overassemble myosin.

# Questions

How does the assembly of myosin contribute to cell shape?

# Methods

One way to quantify cell shape is by measuring the roundness of cells. For cells with unusual shapes, it may be difficult to visually compare cell shape. Roundness can be quantified from two dimensional pictures of cells by comparing the area of a cell to its perimeter:

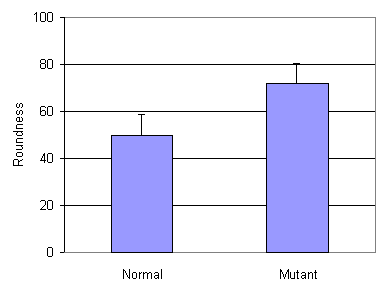
|  |  |
| --- | --- |
|  | LaTeX Code: \[ roundness = (4 \pi) \Bigg( \frac{area}{perimeter^2} \Bigg) (100\%) \] |

For a perfect sphere, the area and perimeter for a two-dimensional picture of the cell are given by the usual formulas r2 and 2r. Therefore, for a spherical cell, roundness equals 100%. A straight line, which has no area, would have a roundness of 0%.

We can quantify the roundness of normal and mutant cells to assess how the overassembly of myosin affects cell shape. Two dimensional pictures of normal and mutant cells can be taken, and the area and perimeter of cells measured.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | Normal 1 | Normal 2 | Normal 3 | Mutant 1 | Mutant 2 | Mutant 3 |
| Area (micrometers2) | 96 | 111 | 89 | 66 | 57 | 60 |
| Perimeter (micrometers) | 53 | 49 | 48 | 34 | 32 | 32 |

We can then calculate and graph the mean roundness for normal and mutant cells in order to compare them.



# Interpretation

Normal cells, which assemble myosin normally, are somewhat elongate and have roundness values averaging 49.8%. Mutant cells, which overassemble myosin, were found to have significantly higher roundness at approximately 71.7%.

# Conclusion

The abnormally round shape of mutant cells may be due to the high level of tension in the cell due to the overassembly of myosin. In normal cells, moderate levels of myosin help maintain the elongate shape. By quantifying cell roundness, we can assess the effects of myosin assembly on cell shape.

# Additional Questions

1. Calculate the roundness for each of the 6 cells given in the table.

2. What would the roundness be for a cell that was shaped like a cube?

# Source

Stites, J., D. Wessels, A. Uhl, T. Egelhoff, D. Shutt, and D. R. Soll. 1998. Phosphorylation of the Dictyostelium myosin II heavy chain is necessary for maintaining cellular polarity and suppressing turning during chemotaxis. *Cell Motility and the Cytoskeleton 39*:31-51

# About this Resource

This material was originally distributed as part of “Alternative Routes to Quantitative Literacy for the Life Sciences[[1]](#endnote-1)” - National Science Foundation Award DUE-9752339 to the University of Tennessee, Knoxville for August 1, 1998 - July 31, 2000. Principal Investigator: Louis J. Gross. Co-Principal Investigators: Beth C. Mullin and Susan E. Riechert.

This material is now being revised as part of the “Resources for Improving Quantitative Skills in Community College Biology[[2]](#endnote-2)” project. As part of that project is also aligned with the OpenStax Biology Textbook[[3]](#endnote-3).

It is published using the QUBES Open Education Resources publishing platform[[4]](#endnote-4).

1. http://www.tiem.utk.edu/~gross/bioed/ [↑](#endnote-ref-1)
2. https://qubeshub.org/community/groups/quantbioatcc/ [↑](#endnote-ref-2)
3. https://openstax.org/details/books/biology-2e [↑](#endnote-ref-3)
4. https://qubeshub.org/qubesresources/publications/1032/ [↑](#endnote-ref-4)