

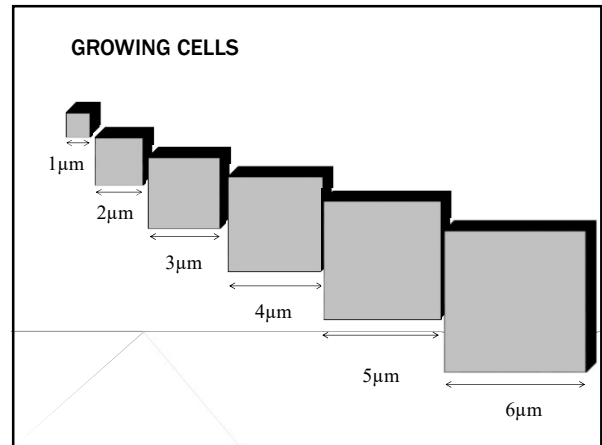
LIMITS TO SIZE

VOLUME

Volume determines the amount of metabolism in the cytoplasm
 Metabolism will require import of precursors
 Metabolism will result in the export of secretions
 And the export of excretory products.

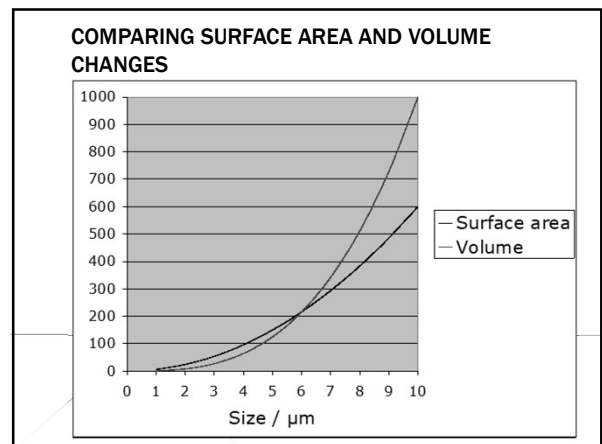
SURFACE AREA

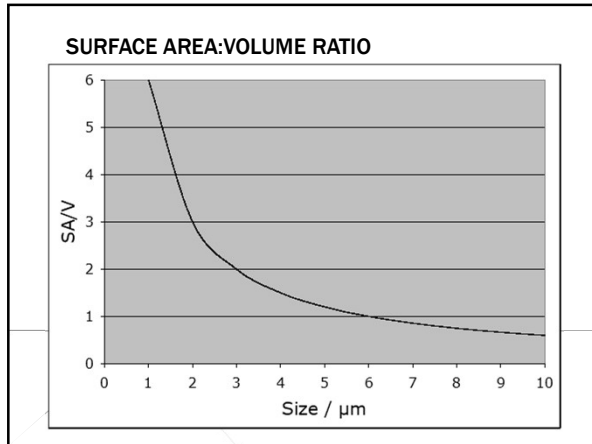
Surface area determines the exchange of materials between the cell and its environment
 Bigger cells will metabolize more
 But they will need more surface to support that metabolism
 And the sites of metabolism inside bigger cells will be further from the surface of the cell.



HOW ARE SURFACE AREA AND VOLUME AFFECTED BY GROWTH?

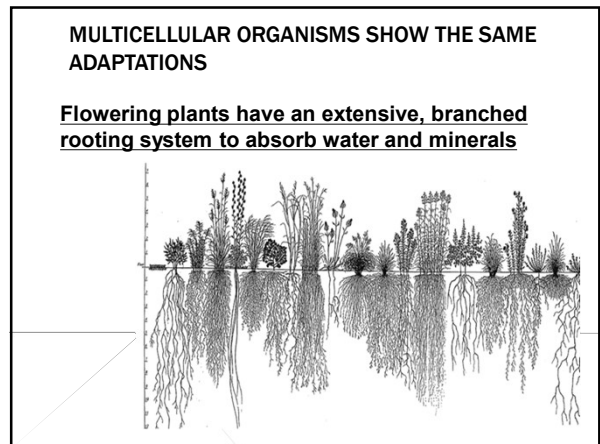
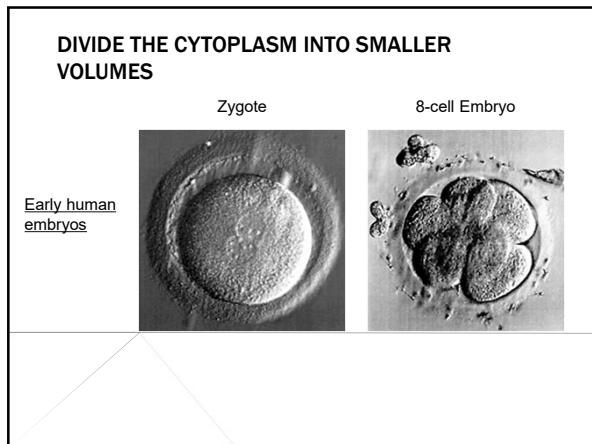
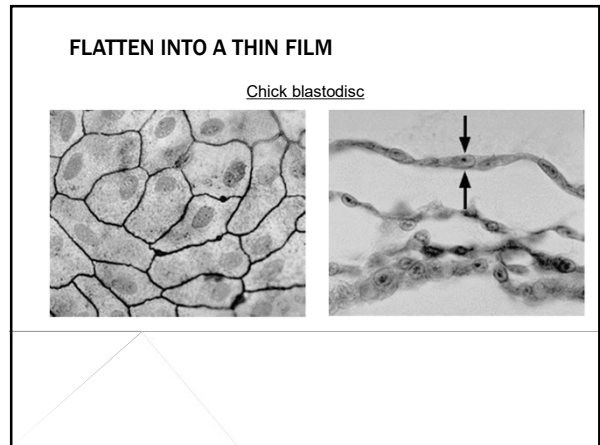
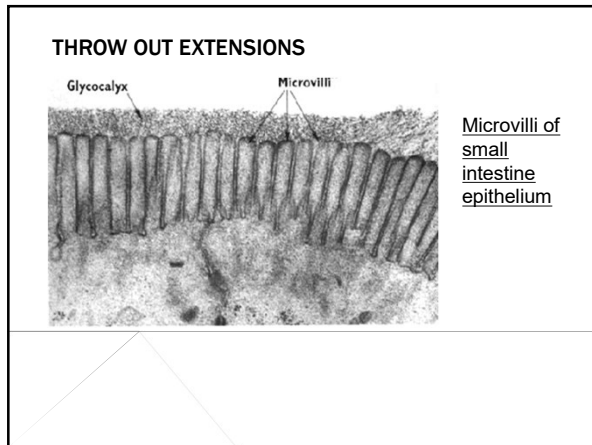
Size / μm	1	2	3	4	5	6
Surface area / μm^2	6	24	54	96	150	216
Volume / μm^3	1	8	27	64	125	216
SA/V	6	3	2	1.5	1.2	1





THE PROBLEM

Bigger cells have a greater metabolism than smaller cells
BUT bigger cells have a proportionally less surface for exchange
 How to increase surface area without increasing volume still further?



MULTICELLULAR ORGANISMS SHOW THE SAME ADAPTATIONS

Mammals have a long small intestine with internal folding to absorb digested food



C. Smith, PSERM