Robustness of tissue growth to cell mechanics

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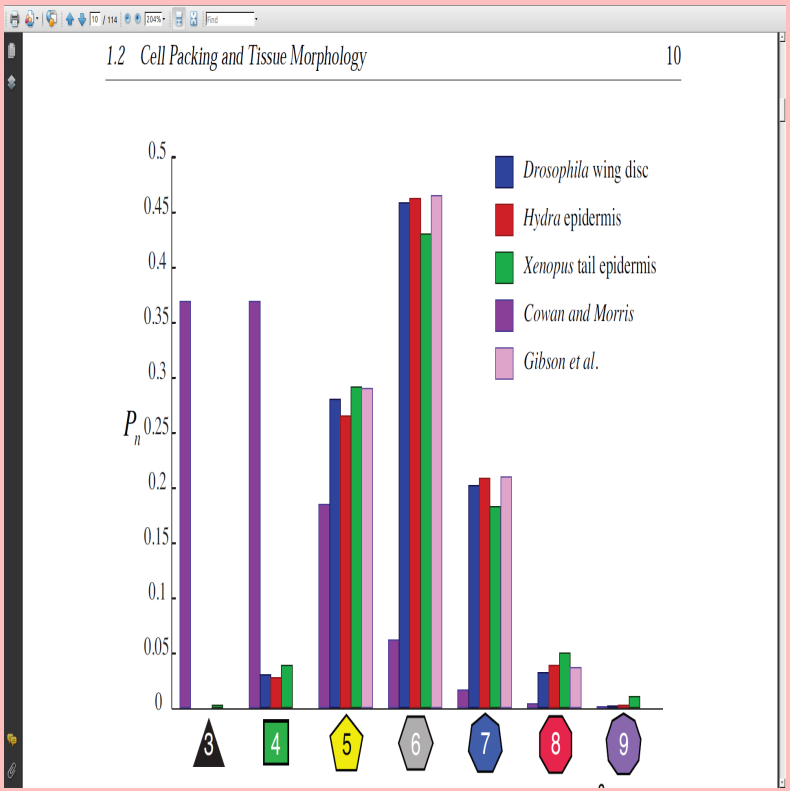
Robustness of tissue growth to cell mechanics,
22 October 2015, IEU/UZH, Switzerland.

Tissue growth: cells as polygons, tissues as networks

Different kind of tissues



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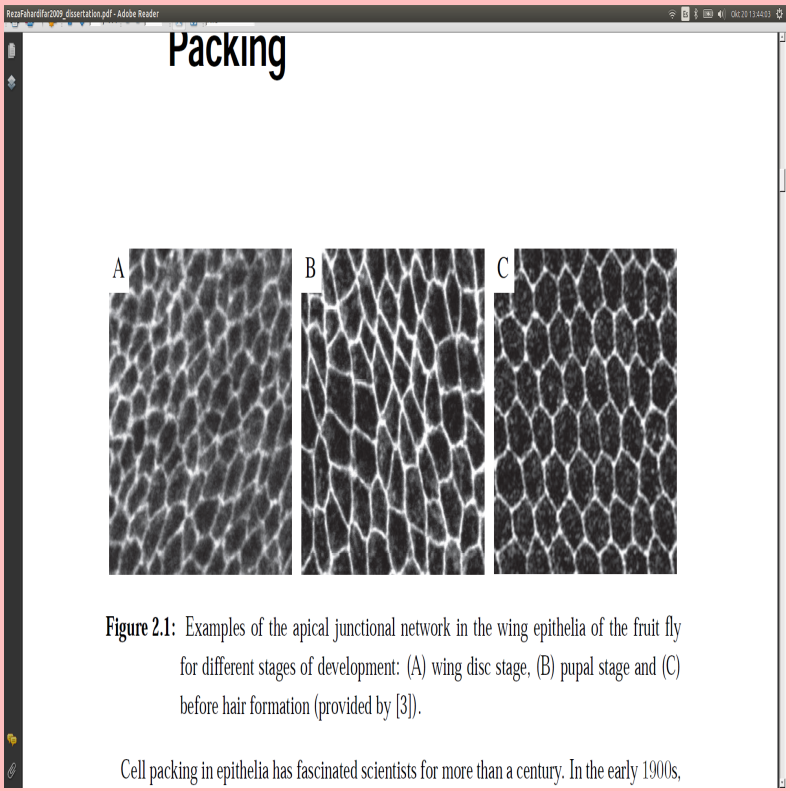
- Different cells *shapes* distributions are related to **different kind** of tissues[1].

Developmental stages of tissues



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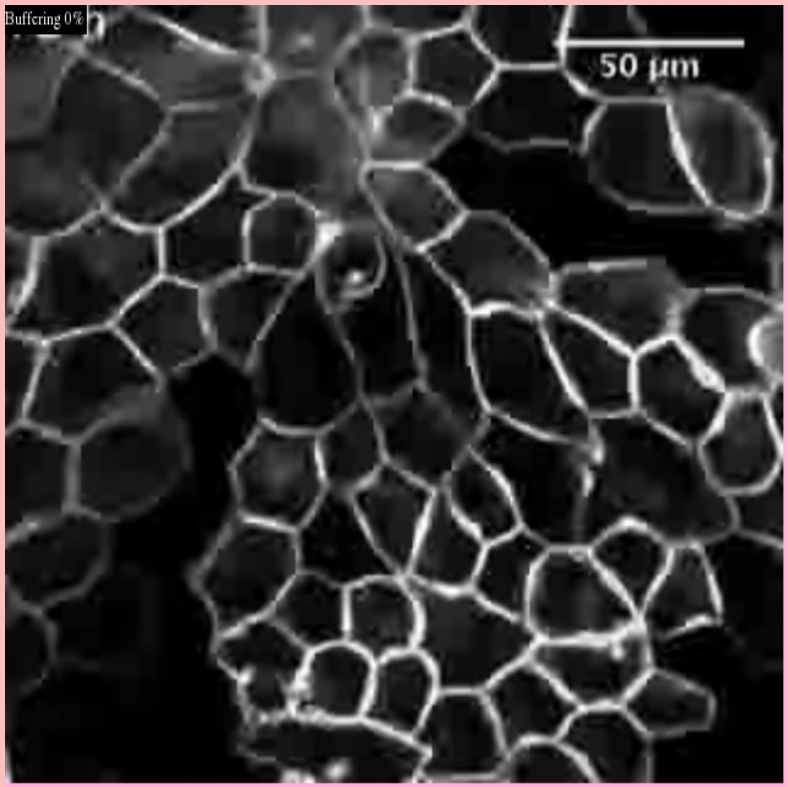
- Different cells *shapes* distributions are related to different **developmental stages** of a same tissue[2].

Tissue, cells, Edges, and Vertices



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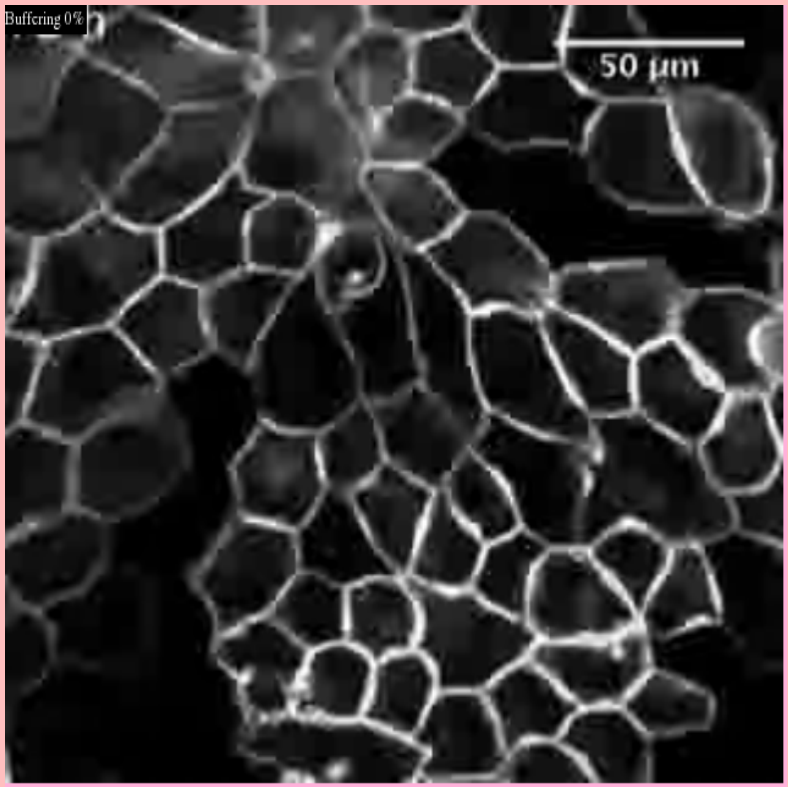
1. Tissue as a network of cells.

Tissue, cells, Edges, and Vertices



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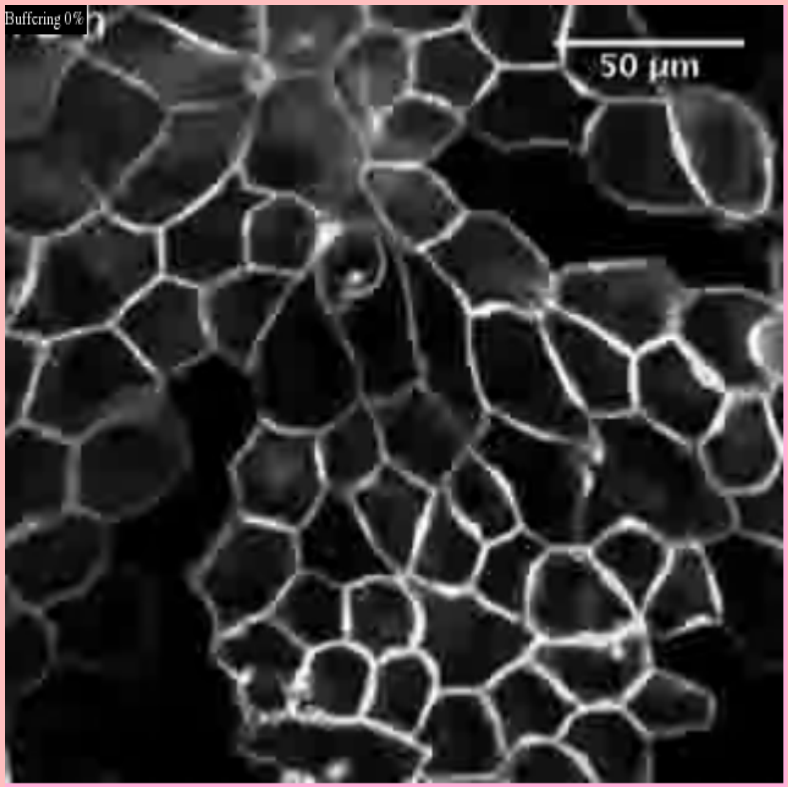
1. Tissue as a network of cells.
2. Cells as polygons.

Tissue, cells, Edges, and Vertices



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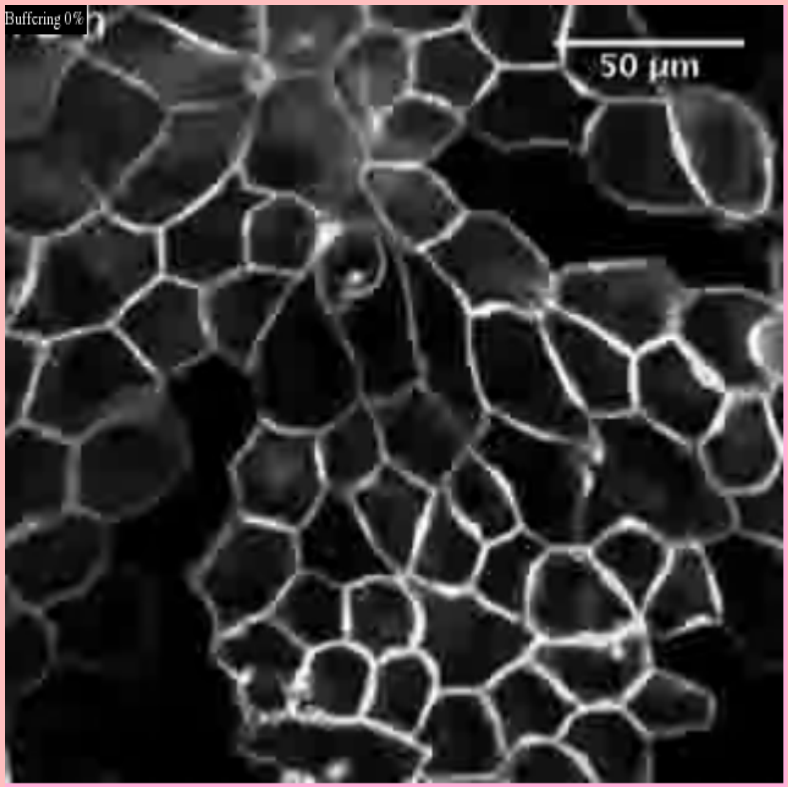
1. Tissue as a network of cells.
2. Cells as polygons.
3. Each 2 Cells share 1 Edge.

Tissue, cells, Edges, and Vertices



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1. Tissue as a network of cells.
2. Cells as polygons.
3. Each 2 Cells share 1 Edge.
4. Each Edge is composed by 2 Vertices.

Edge's Line Tension

Include figure of a cell from Farhadifar

- Edge's Line tension (Λ) is associated to Edge's length.

Cell's Contractility

Include figure of a cell from Farhadifar

- Cell's Contractility (Γ) is associated to Cell's Perimeter.

Cell's Elasticity

Include figure of a cell from Farhadifar

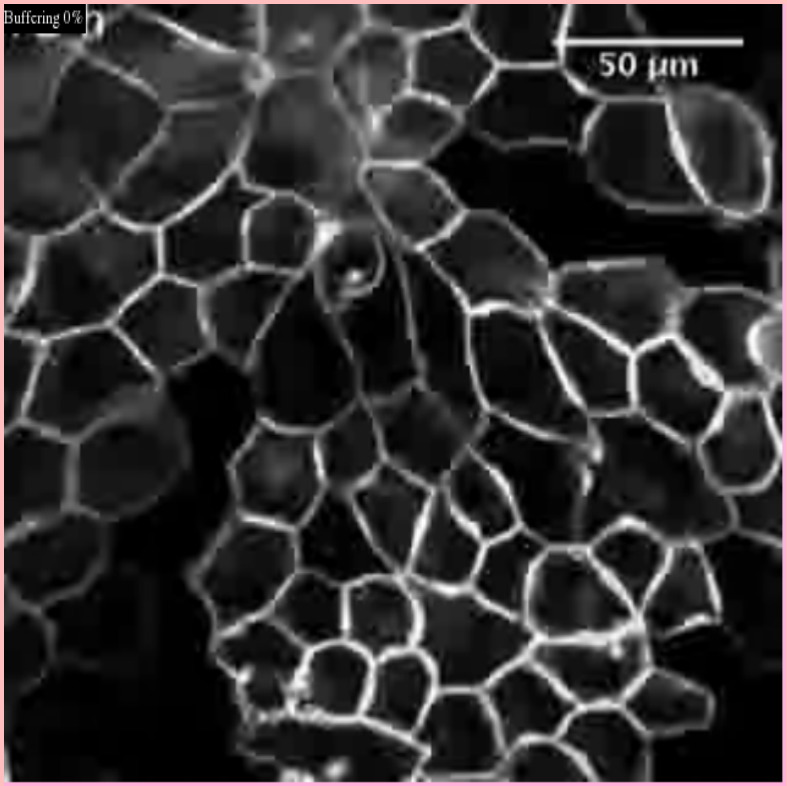
- Cell's Elasticity (K) is associated to Cell's Area.

Force Balance Energy Function

$$F = \sum_\alpha \frac{K_\alpha}{2}(A_\alpha - A_\alpha^{(0)})^2 + \sum_{(i,j)} \Lambda_{ij} L_{ij} + \sum_\alpha \frac{\Gamma_\alpha}{2} L_\alpha^2$$

Force Balance Energy Function

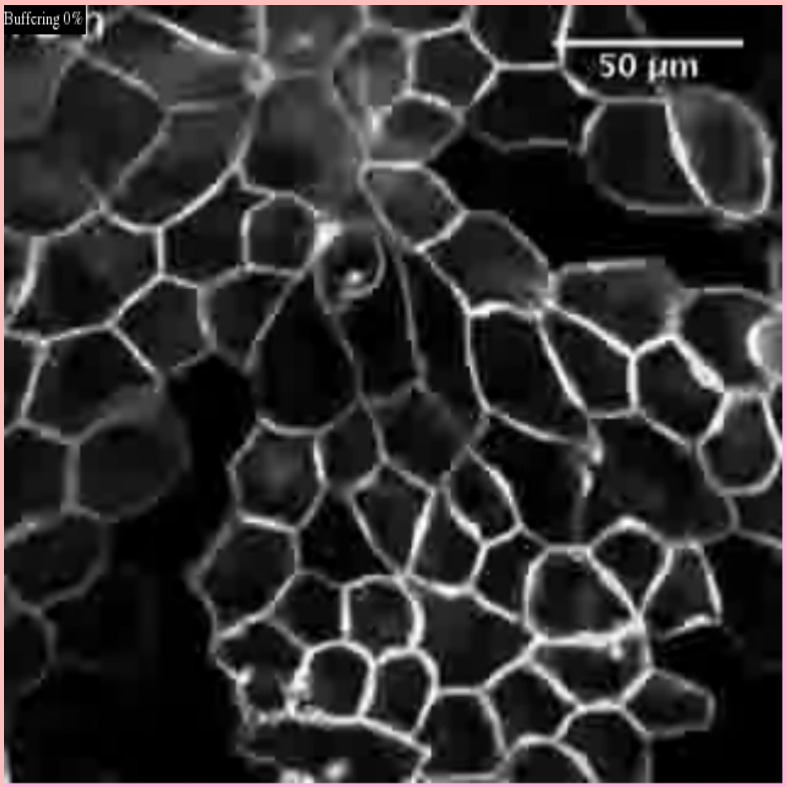
$$F = \sum_\alpha \frac{K_\alpha}{2}(A_\alpha - A_\alpha^{(0)})^2 \; + \; \sum_{(i,j)} \Lambda_{ij} L_{ij} \; + \; \sum_\alpha \frac{\Gamma_\alpha}{2} L_\alpha^2$$



We keep the physical properties of the cells fixed during the simulation. So, in order to satisfy the **Minimal Energy's Assumption** theh positions of the vertices need to change.

Preferred Cell's Area $A_\alpha^{(0)}$

$$F = \sum_\alpha \frac{K_\alpha}{2}(A_\alpha - A_\alpha^{(0)})^2 \; + \; \sum_{(i,j)} \Lambda_{ij} L_{ij} \; + \; \sum_\alpha \frac{\Gamma_\alpha}{2} L_\alpha^2$$



$A_\alpha^{(0)}$ is the preferred area of cell α which is related to the volume, V_α and height, h_α of the cell: $A_\alpha^{(0)} = \frac{V_\alpha}{h_\alpha}$

Thank you!

- SystemsX Initiative.
- ***EpiphysX*** members: Andreas Wagner (UZH), Aziza Merzouki, Orestis Malaspinas, Bastien Chopard, Aurélien Roux, Michel Milinkovitch, Marcos Gonzalez-Gaitan (UNIGE)
- Chopard's Group members (UNIGE).
- Wagner's Group members (UZH).
- You, for the attention and patience.