
Biomaterials - Tissue Interactions

Homework #7

1. A set of force vs time data has been obtained using the cell force monitor (Fig. 1). The system consists of fibroblasts supported on an analog of the extracellular matrix in culture medium. The data have been fitted well at each level of the cell density using the following equation:

$$f(t) = f_{\infty}[1 - \exp(-kt)]$$

where f_{∞} and k are constants.

Derive $df(t)/dt$ and calculate its limiting values at $t = 0$ and $t = \infty$. Describe an analytical procedure for measuring k .

2. Assume for the moment that the cells in this system act noncooperatively, i.e., independently of each other. Derive a mathematical relation between the limiting value of $df(t)/dt$ at $t = 0$, i.e., $(df/dt)_0$, and the cell density D .

3. Tests for cell-cooperativity.

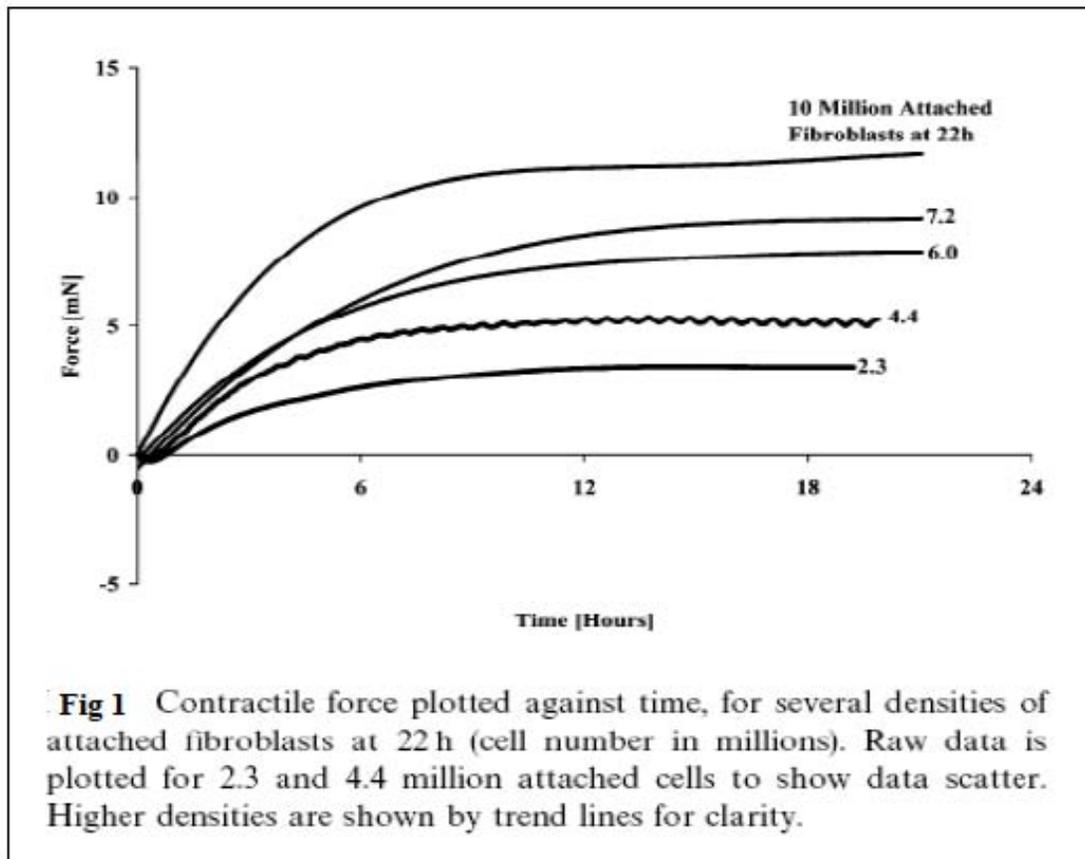
(A) Assume that a problem has developed in your laboratory with the cell culture medium. As a result, the cells have started to behave irreproducibly after staying 4 h in the medium. You are limited to data obtained before $t = 4$ h. Can data obtained at $t < 4$ h be used to detect the presence or absence of cell-cell cooperativity in the data? Explain briefly.

(B) The same equation (see above) has been used to fit separately each of the curves in Fig. 1. Can this fact be used, by itself (without any further data), to detect the presence or absence of cell-cell cooperativity in the data? Explain.

4. In the articles by Freyman et al. the asymptotic force per cell was calculated as the total force f_{∞} generated by the cells divided by the number of attached cells. Describe an experimental method, using an instrument(s) and an experimental configuration of your choice, that can be used to measure the force per cell directly (i.e., not calculated from the data in Fig. 1).

5. You are managing the quality control department of a plant that manufactures matrix similar to the one used in the studies of Freyman et al. The matrix is sold to researchers of cell-matrix interactions who use it as a research tool to identify the integrins that are utilized during such interactions, the identity of ligands on the matrix, etc. Your manufacturing specifications are based entirely on quality control data of the type represented by Eq. 1. Your job is twofold: (A). Develop a simple, easy to measure and report, specification to ensure, day in and day out, that the batches of matrix come out within this specification. (B). If a batch falls out of specifications, your job is to troubleshoot the manufacturing problem and then fix it.

Which of the two quantities, $df(t)/dt$ or k , are you inclined to select for task A? Which for Task B? Explain briefly.



Source: Freyman, T. M., I. V. Yannas, R. Yokoo, and L. J. Gibson. "Fibroblast Contraction of a Collagen-GAG matrix." *Biomaterials* 22 (2001): 2883-2891. Courtesy Elsevier, Inc., <http://www.sciencedirect.com>. Used with permission.

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