

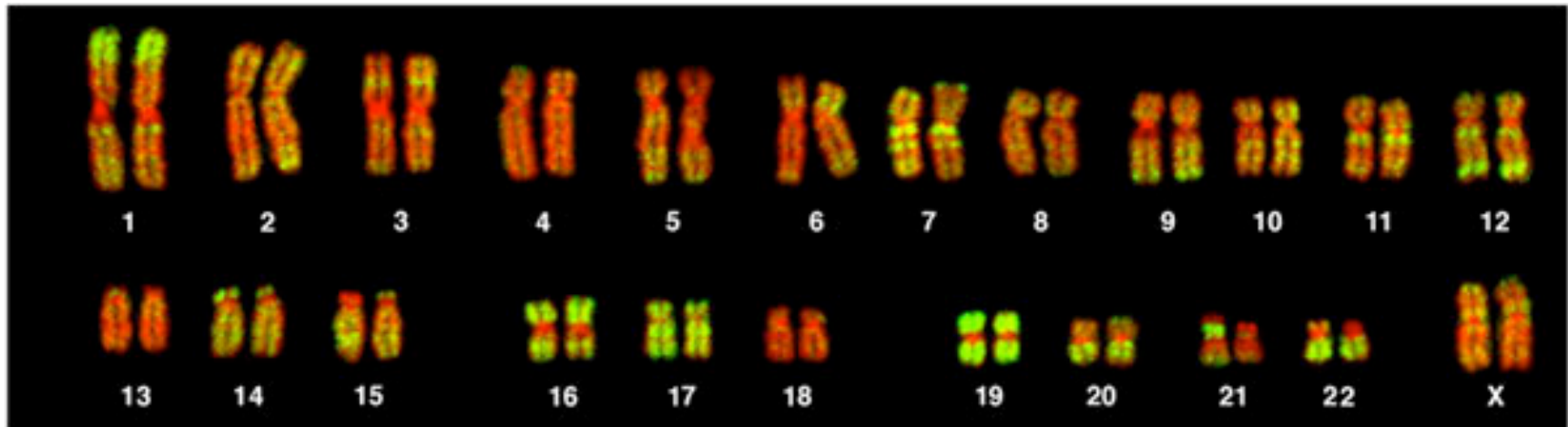
and a 1, and a 2...

Examples of counting and clock-
keeping in biology

N Kuldell for 20.020(S09)

02.19.09

And a 1: telomeres



Source: Bolzer, A., G. Kreth, I. Solovei, D. Koehler, K. Saracoglu, et al. "Three-Dimensional Maps of All Chromosomes in Human Male Fibroblast Nuclei and Prometaphase Rosettes." *PLoS Biol* 3, no. 5 (2005): e157.

DOI:10.1371/journal.pbio.0030157. Courtesy of the authors.

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See Fig. 4.19 in Cooper, G. M.

The Cell: A Molecular Approach. 2nd ed.

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(TTAGGG)_n

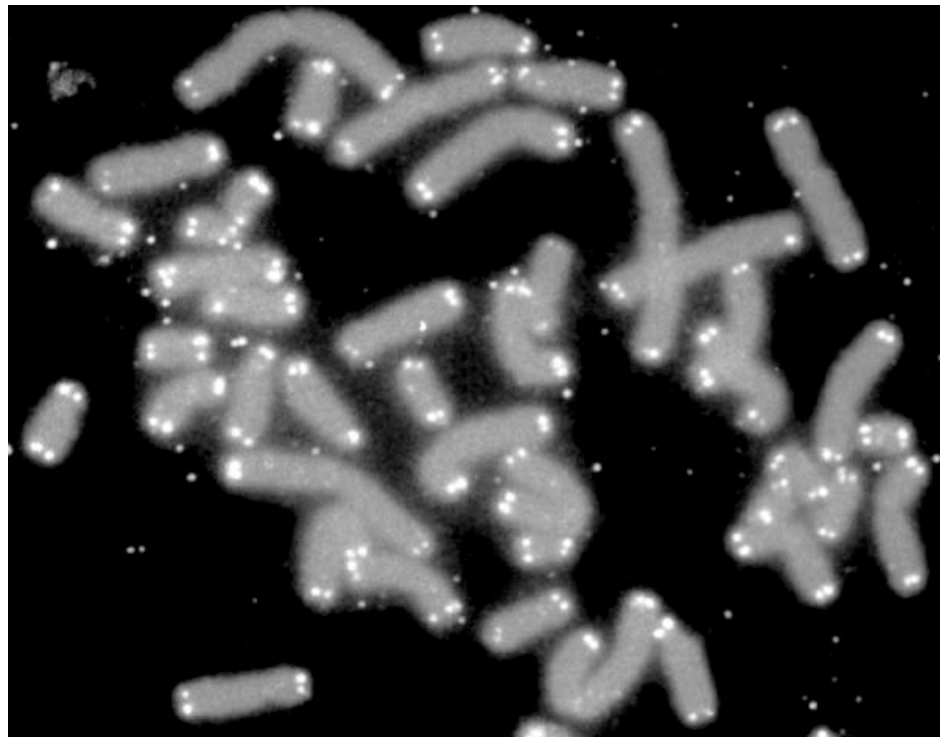
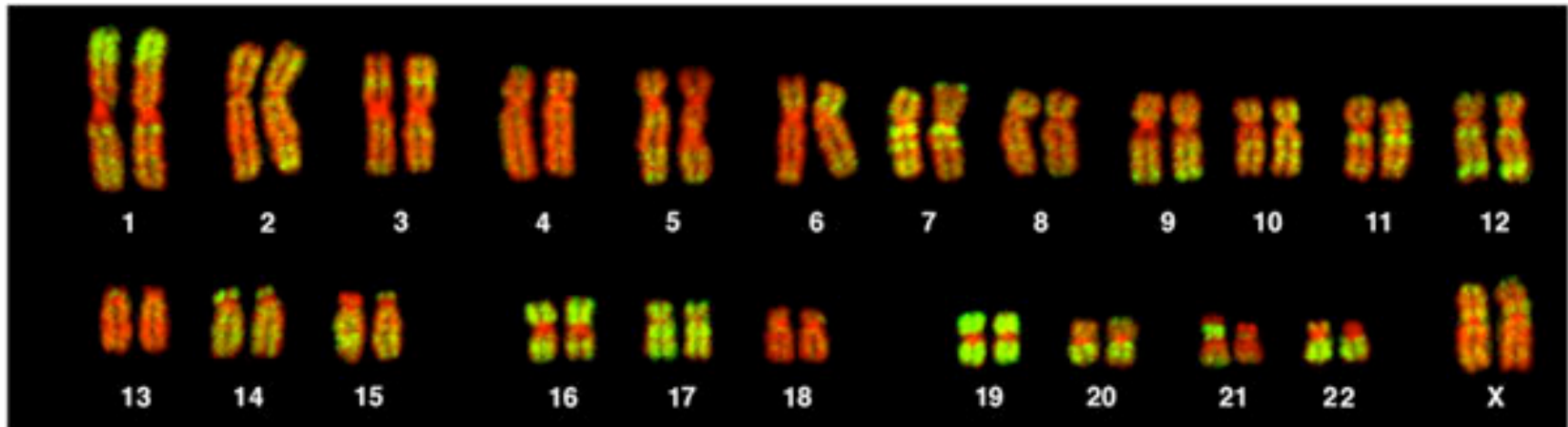


Image: US DOE Human Genome Project.

And a 1: telomeres



Source: Bolzer, A., G. Kreth, I. Solovei, D. Koehler, K. Saracoglu, et al. "Three-Dimensional Maps of All Chromosomes in Human Male Fibroblast Nuclei and Prometaphase Rosettes." *PLoS Biol* 3, no. 5 (2005): e157.
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book=cooper&part=A635&rendertype=figure&id=A635](http://www.ncbi.nlm.nih.gov/bookshelf/br.fcgi?book=cooper&part=A635&rendertype=figure&id=A635)

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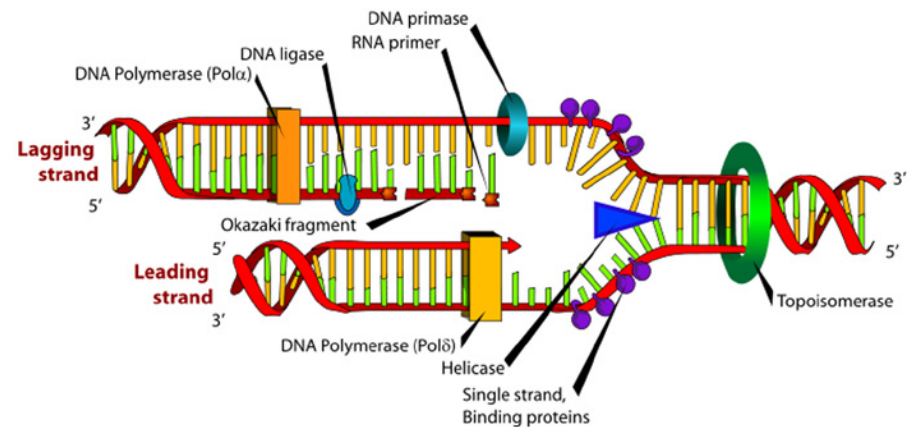


Image: Wikipedia: DNA_replication_en.svg (public domain).

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Counting Cell Divisions with Telomere Repeats

<u>Cell type</u>	<u>Telomerase</u>	<u>Telomere length</u>
Normal Somatic	OFF	shortens

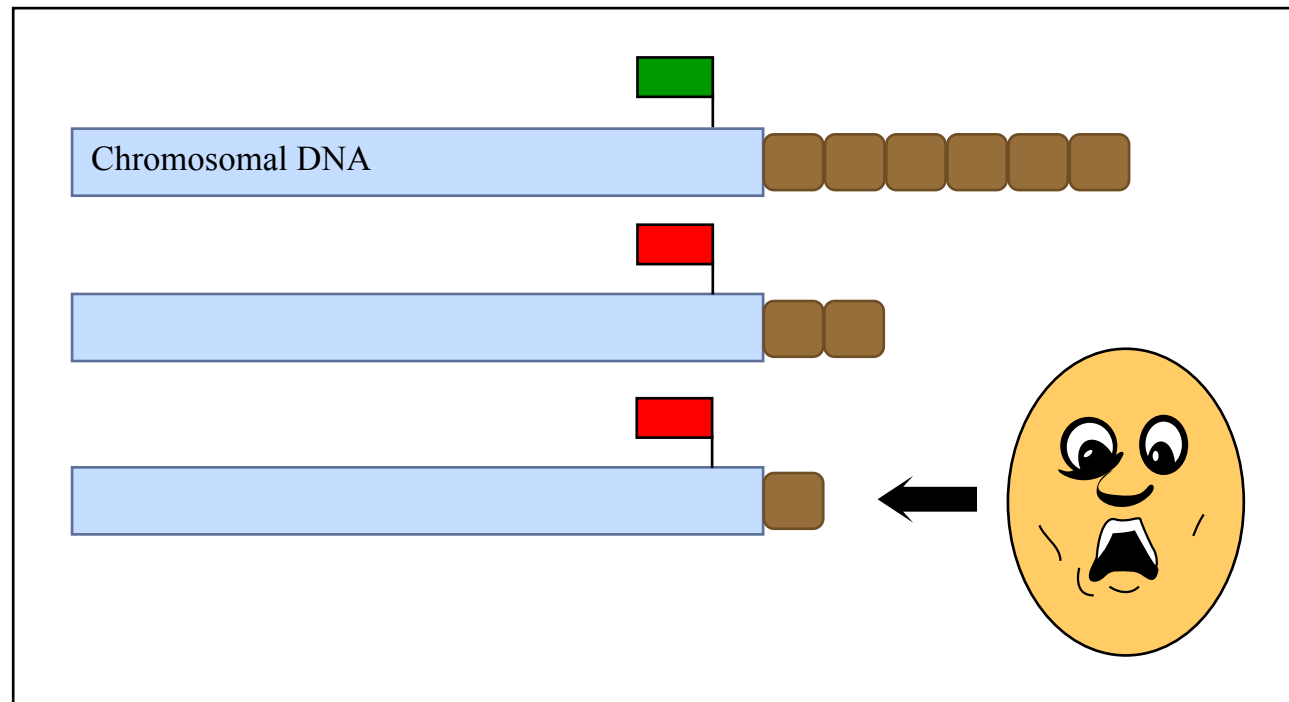


Figure by MIT OpenCourseWare.

See Science Daily, Feb. 16, 2009.

"Shortening Telomeres Linked to Aging in Population Studies, But Original Telomere Length Varies Between Individuals."

Counting Cell Divisions with Telomere Repeats

<u>Cell type</u>	<u>Telomerase</u>	<u>Telomere length</u>
Normal Somatic	OFF	shortens
Cancerous	ON forever	stable

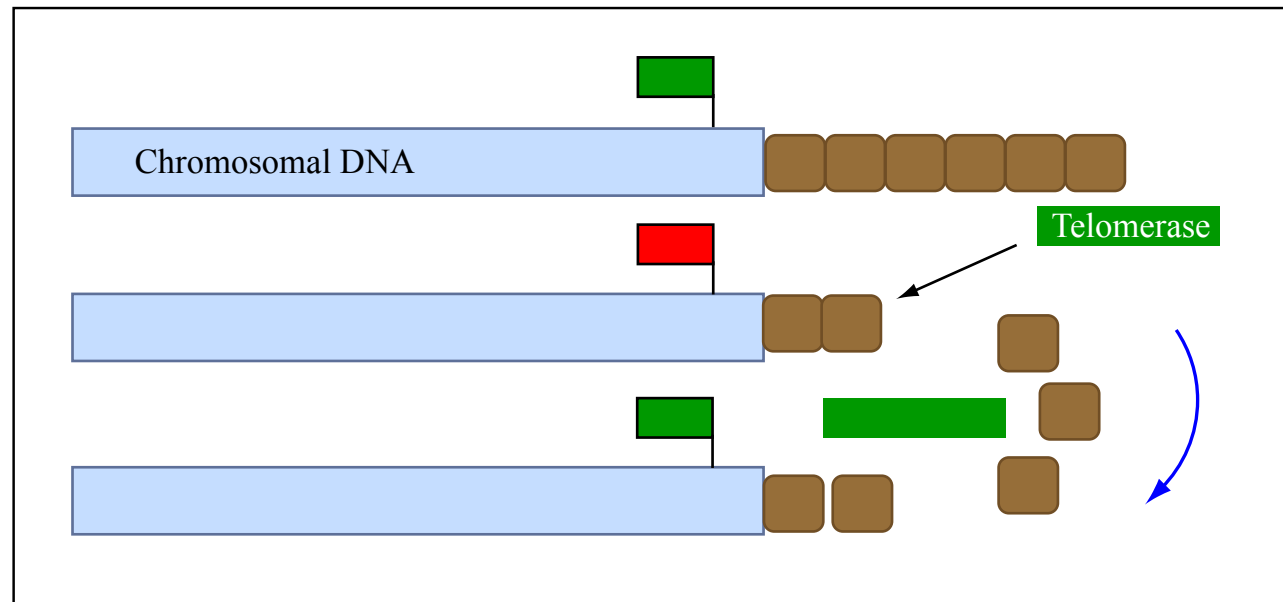


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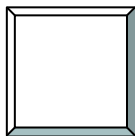
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“Astragaloside IV, found in minute traces in *Astragalus Membranaceus* extract, is known to turn this gene on and 'activate' telomerase.

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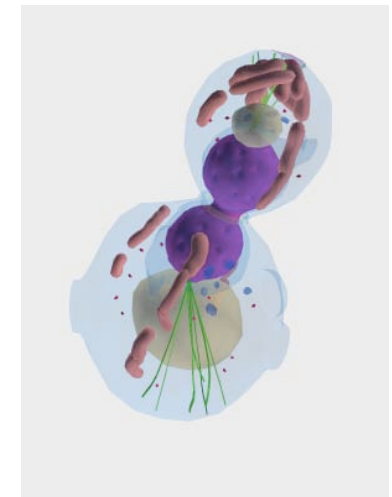
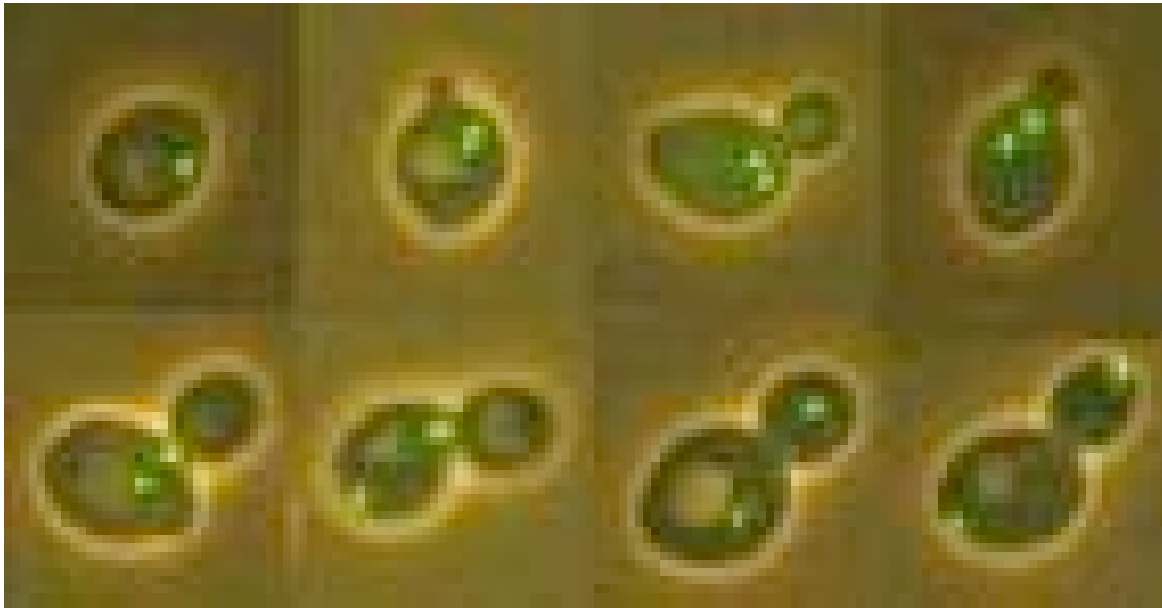
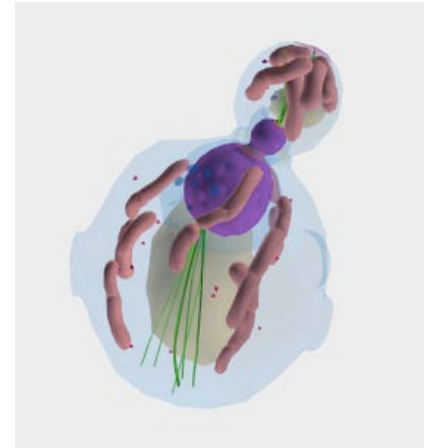
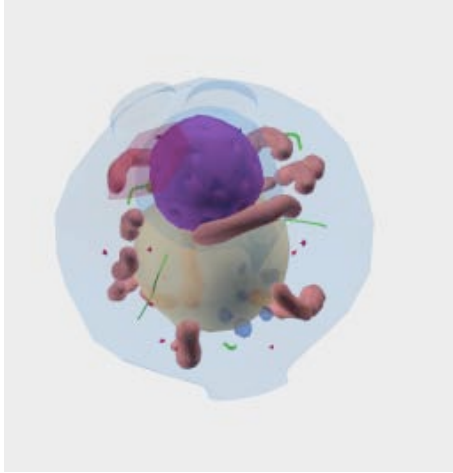


Description

Astragaloside IV is our flagship product. In fact, the prospect of providing it to the public was the inspiration for our company.

And a 2: bud scar counting

<http://organelleview.lsi.umich.edu/orgview2/>



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And a 2: bud scar counting

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See Fig. 3 in Powell, C. D., et al. "Chitin Scar Breaks in Aged *Saccharomyces Cerevisiae*." *Microbiology* 149 (2003): 3129-3137

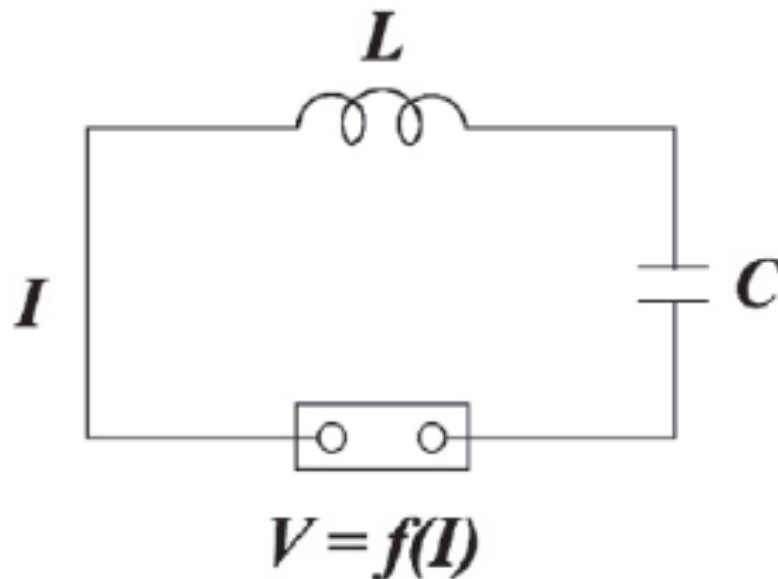
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See Fig. 1 in Cabib, E. et al. "Role of Small g Proteins in Yeast Cell Polarization and Wall Biosynthesis." *Ann Rev Biochem* 67 (July 1998): 307-333.

And a 3: circadian rhythms

Oscillation of alertness, sleep, hormone production, body temperature and organ function

Electronics: van der Pol oscillator



L = inductor

C = capacitor

V = vacuum tube
containing a tetrode

I = voltage supply

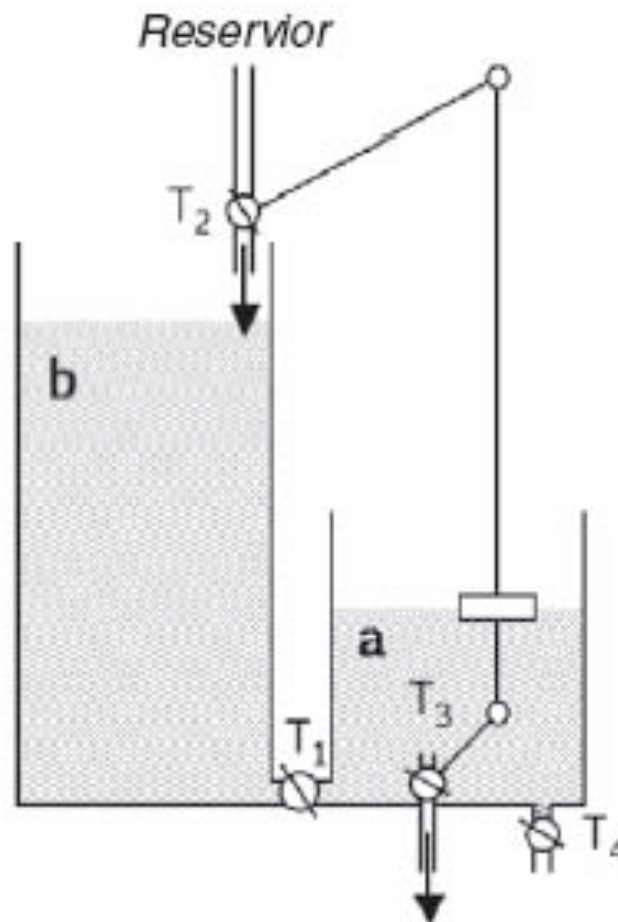
Current Biology 18, R826–R835, September 9, 2008 ©2008 Elsevier Ltd All rights reserved

Modelling Biological Rhythms

And a 3: circadian rhythms

Oscillation of alertness, sleep, hormone production, body temperature and organ function

Hydraulic Model



Negative feedback loop

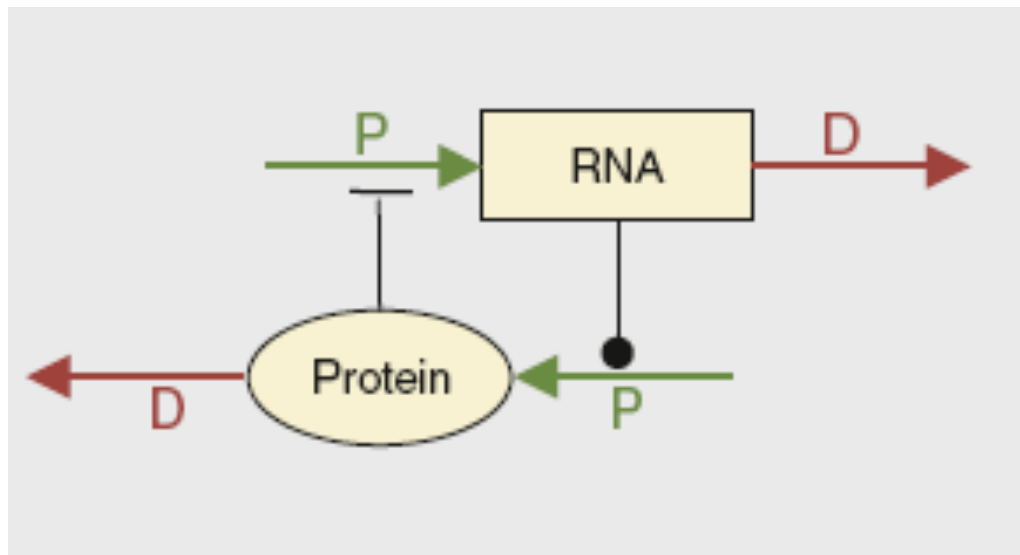
>>water flows into B then through T₁ into A and out through T₄

>>level of A connected to T₃ and T₂ which drain A as level rises

And a 3: circadian rhythms

Oscillation of alertness, sleep, hormone production, body temperature and organ function

Molecular clocks: transcriptional-translational feedback



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>>RNA is made

>>turns protein production on

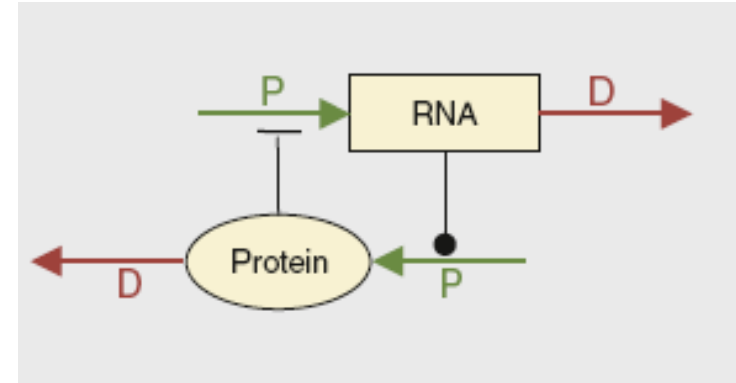
>>protein turns off RNA production

>>absence of RNA turns off protein production

and a 1, and a 2, and a 3



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the end

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20.020 Introduction to Biological Engineering Design
Spring 2009

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