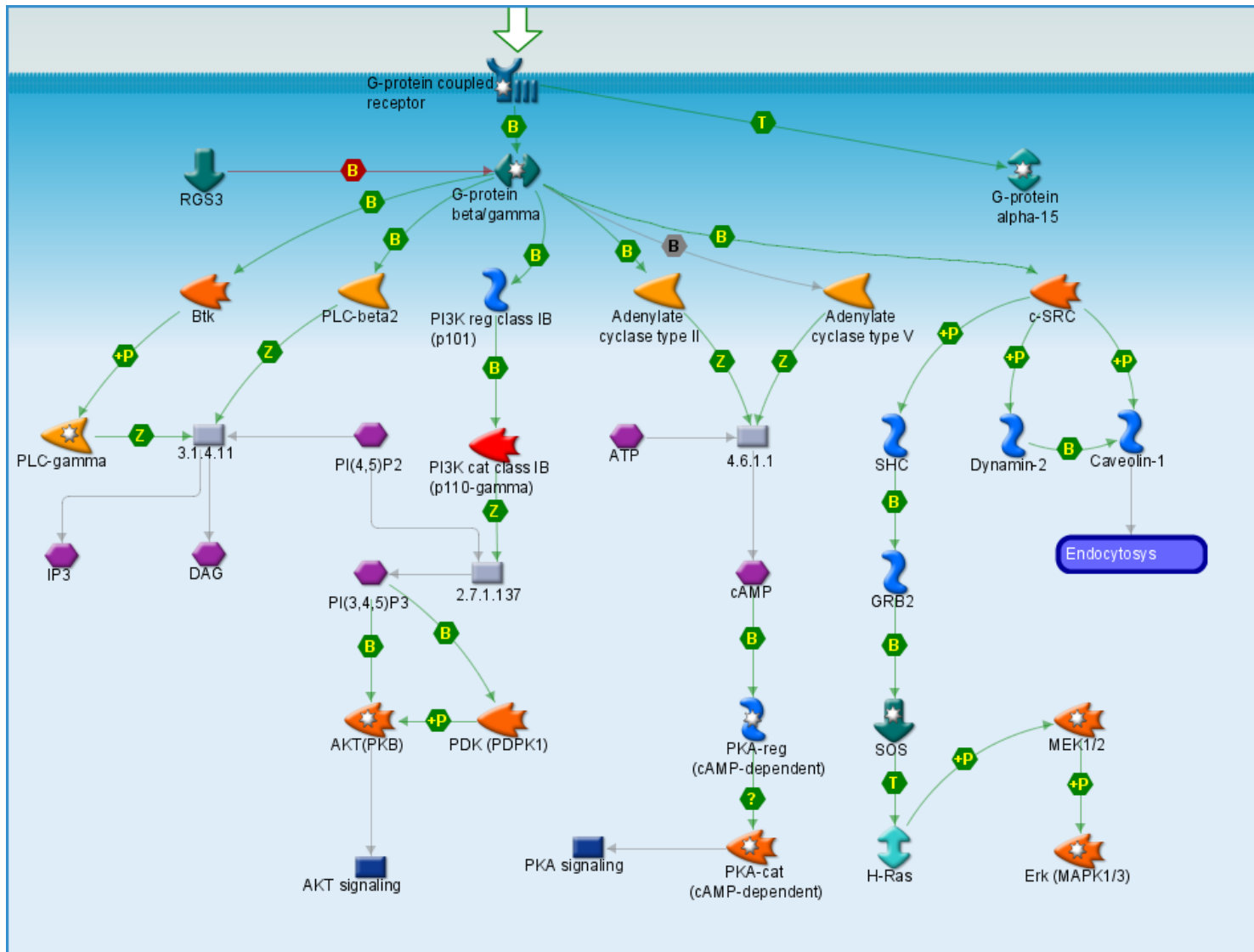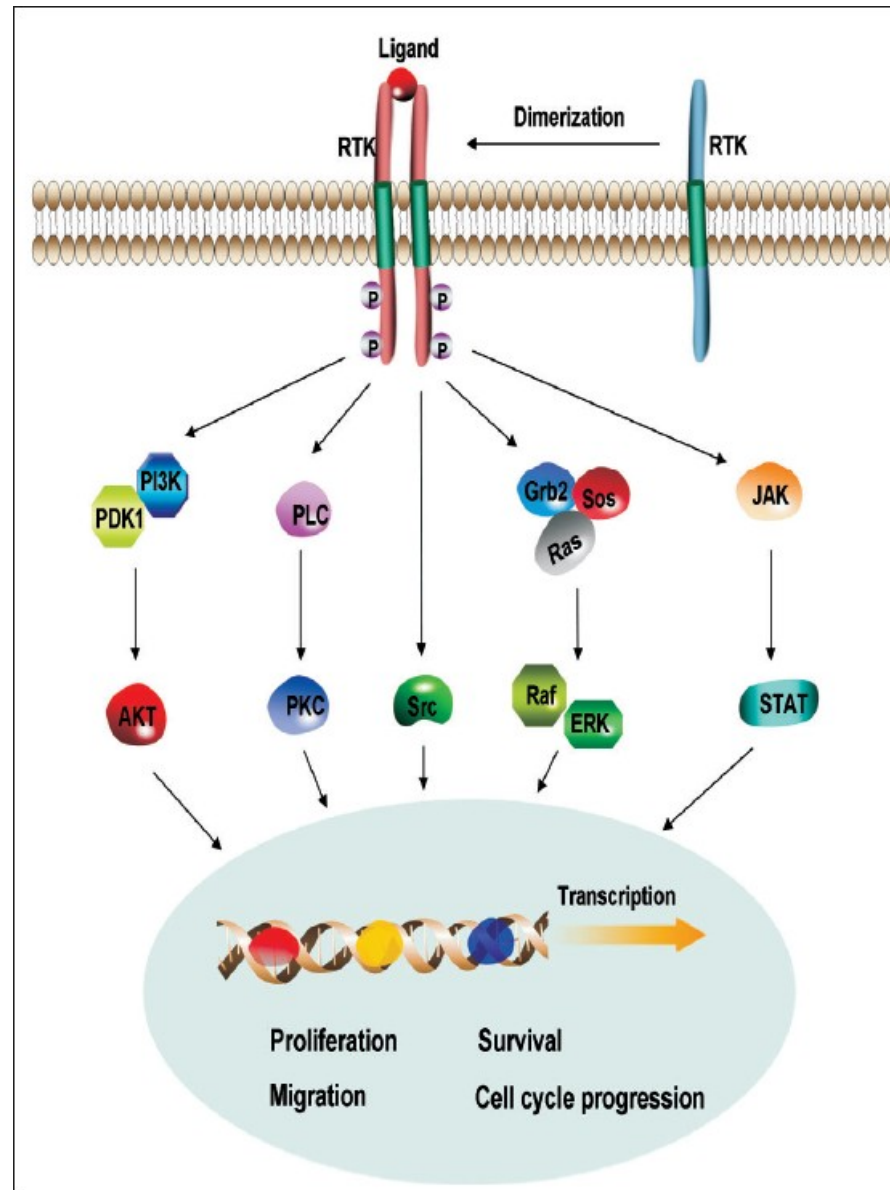# Protein-Protein Interactions and Ion Channels

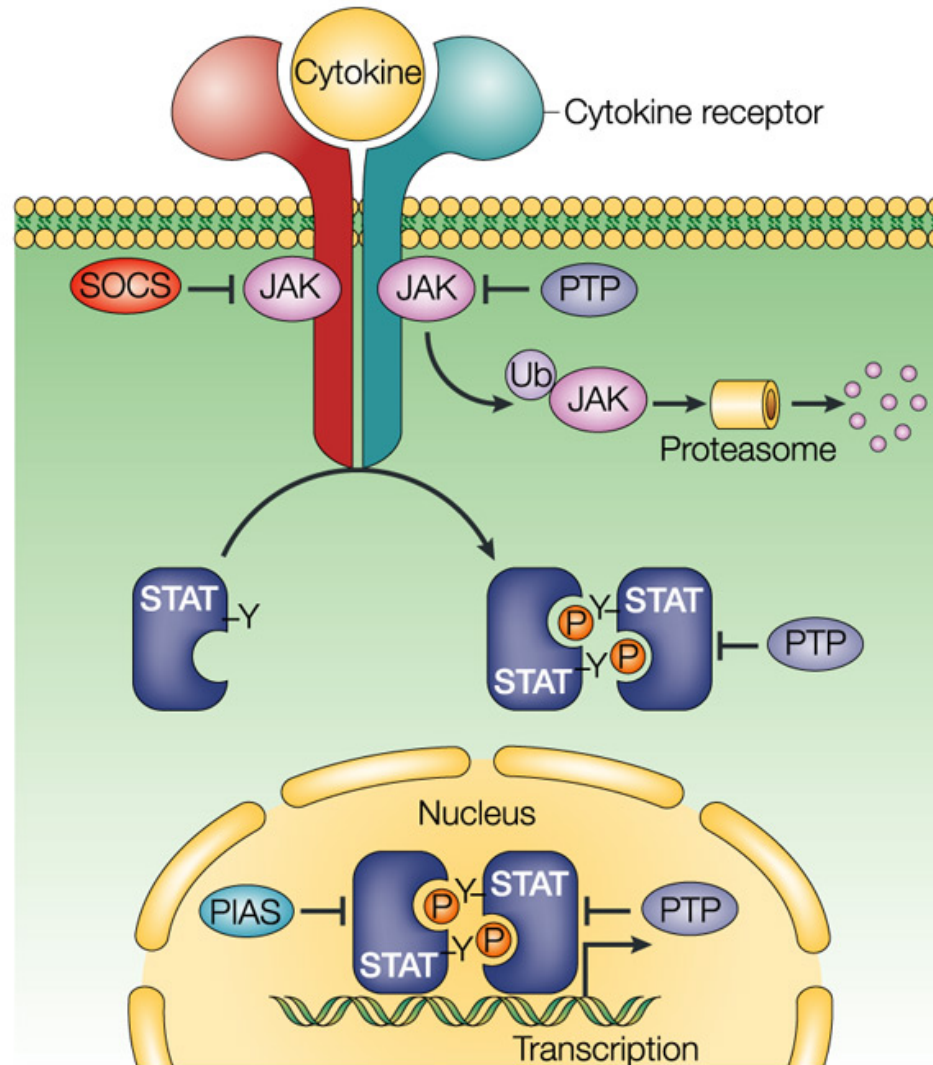# G-Protein Signaling Pathways

Tyrosine Kinase Signaling Pathways

Pullamsetti and Shermully, 2010

JAK-STAT Signaling Pathway

Shuai and Liu, 2003

Feed-Forward Network in Visual Cortex
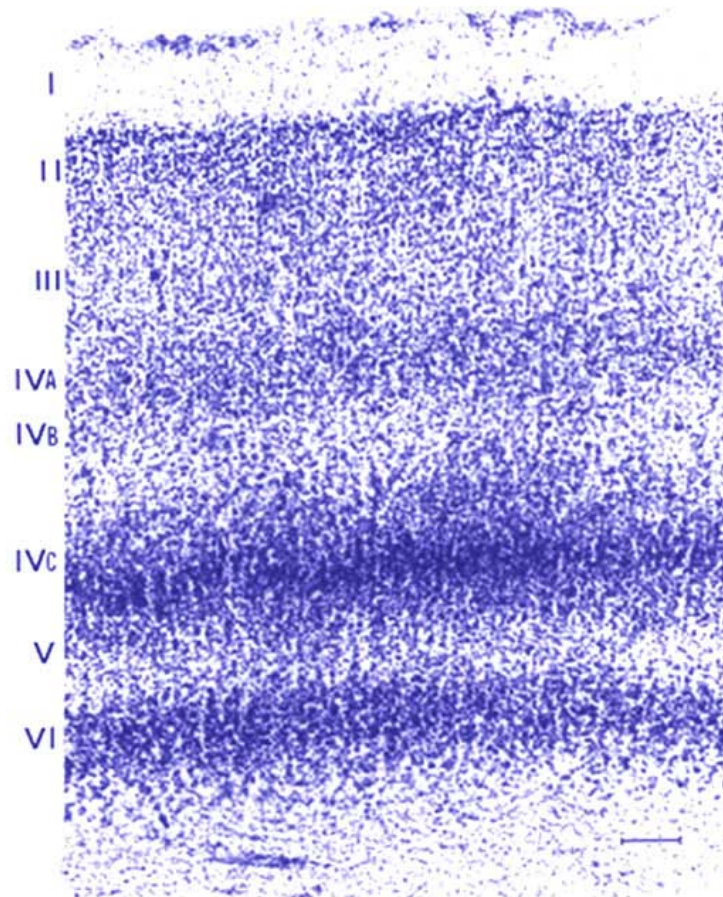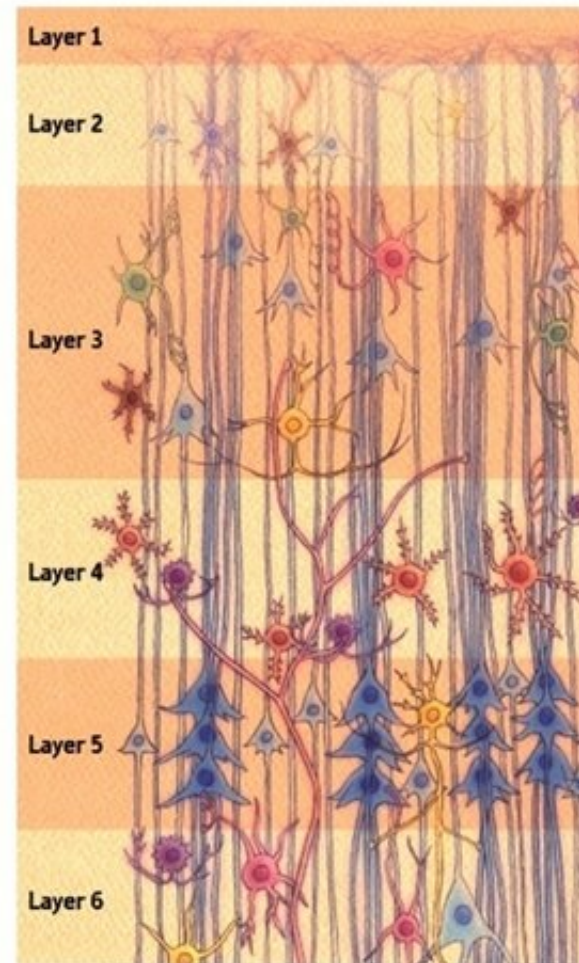
output

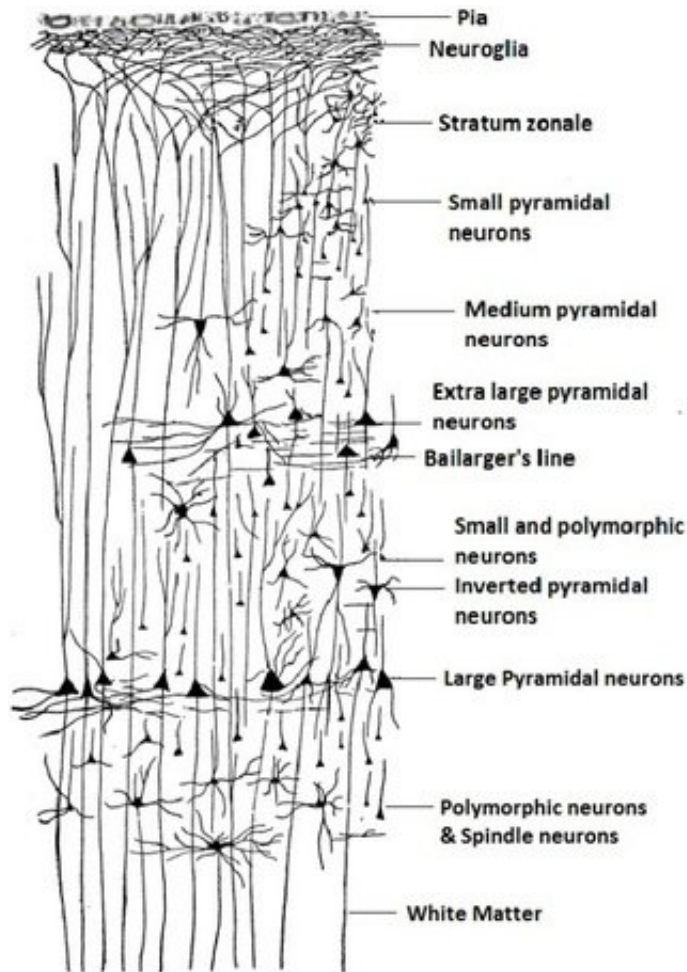
I

II

III

IVA

IVB

IVC

V

VI

Figure 13. Nissl stain of the visual cortex reveals the different layers I through VI quite clearly.
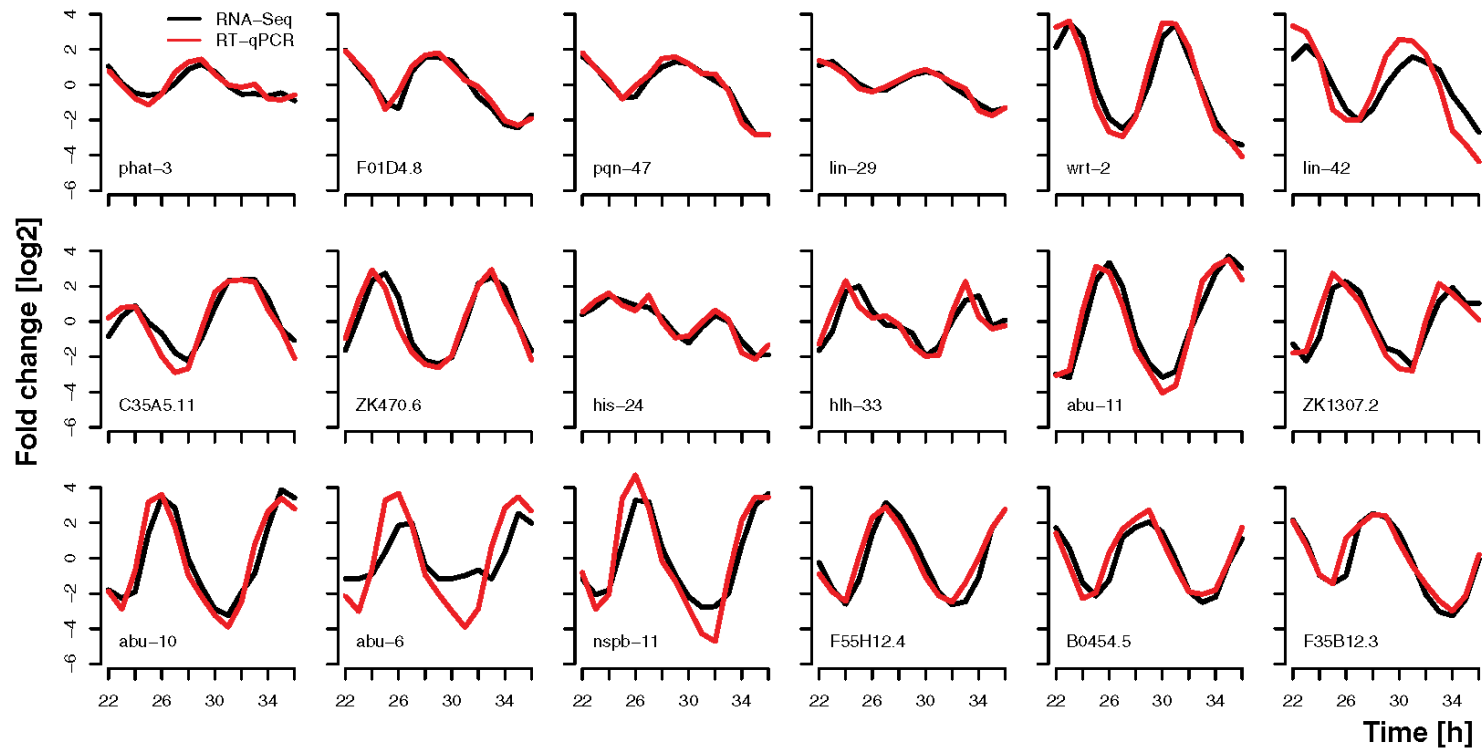
Webvision.org

input

Feed-Forward Network in Visual Cortex

output

input

Oscillatory Gene Expression

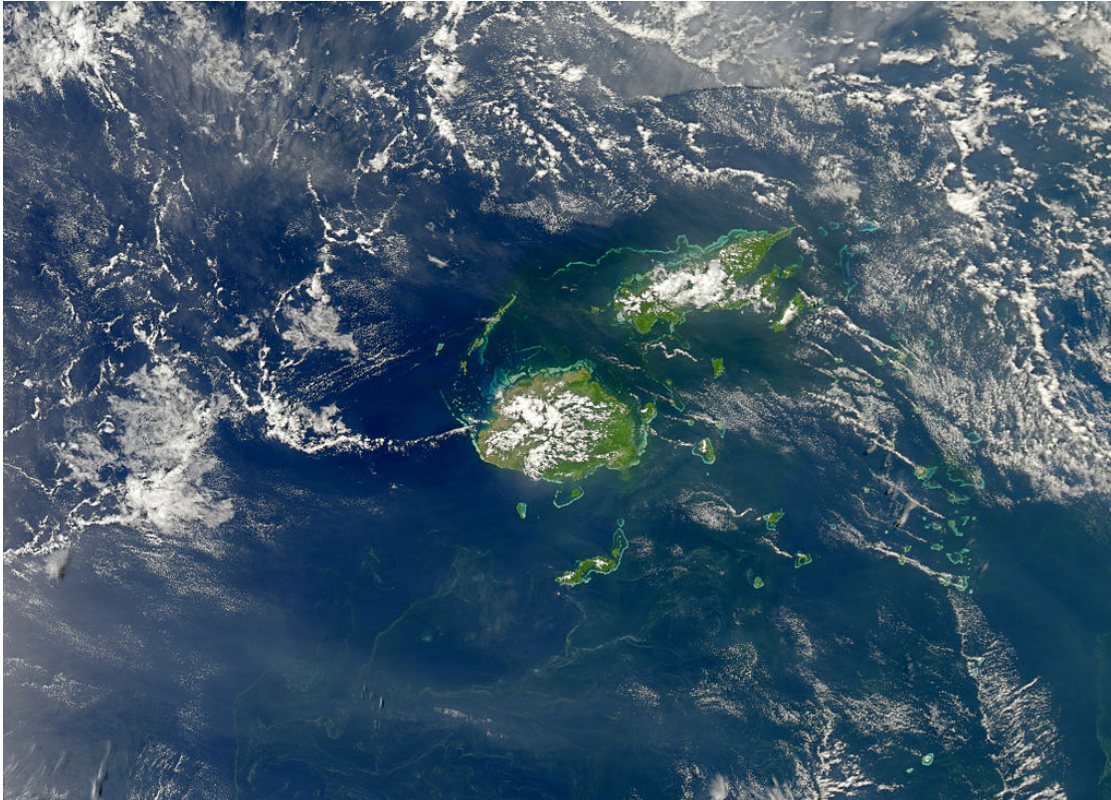Oscillatory expression of many genes in *C. elegans* larval development. Hendrix et al., Molecular Cell, 53:380, 2014.

What are Cyanobacteria?

A very old phylum of bacteria named for their blue-green color. Also called "blue-green algae", but unlike algae they are prokaryotes.
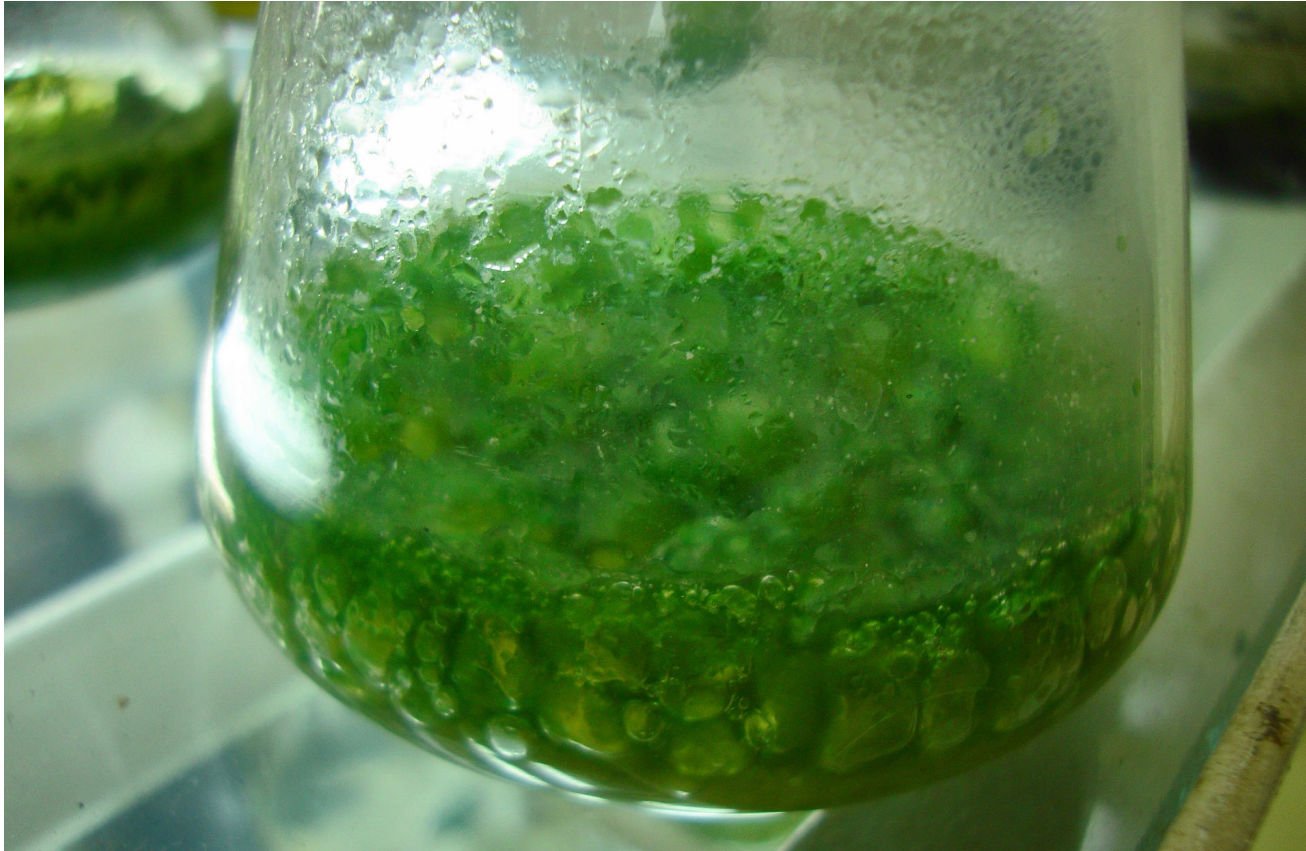
By producing oxygen from photosynthesis they are thought to have caused the Great Oxygenation Event which led the way to animal life on earth.
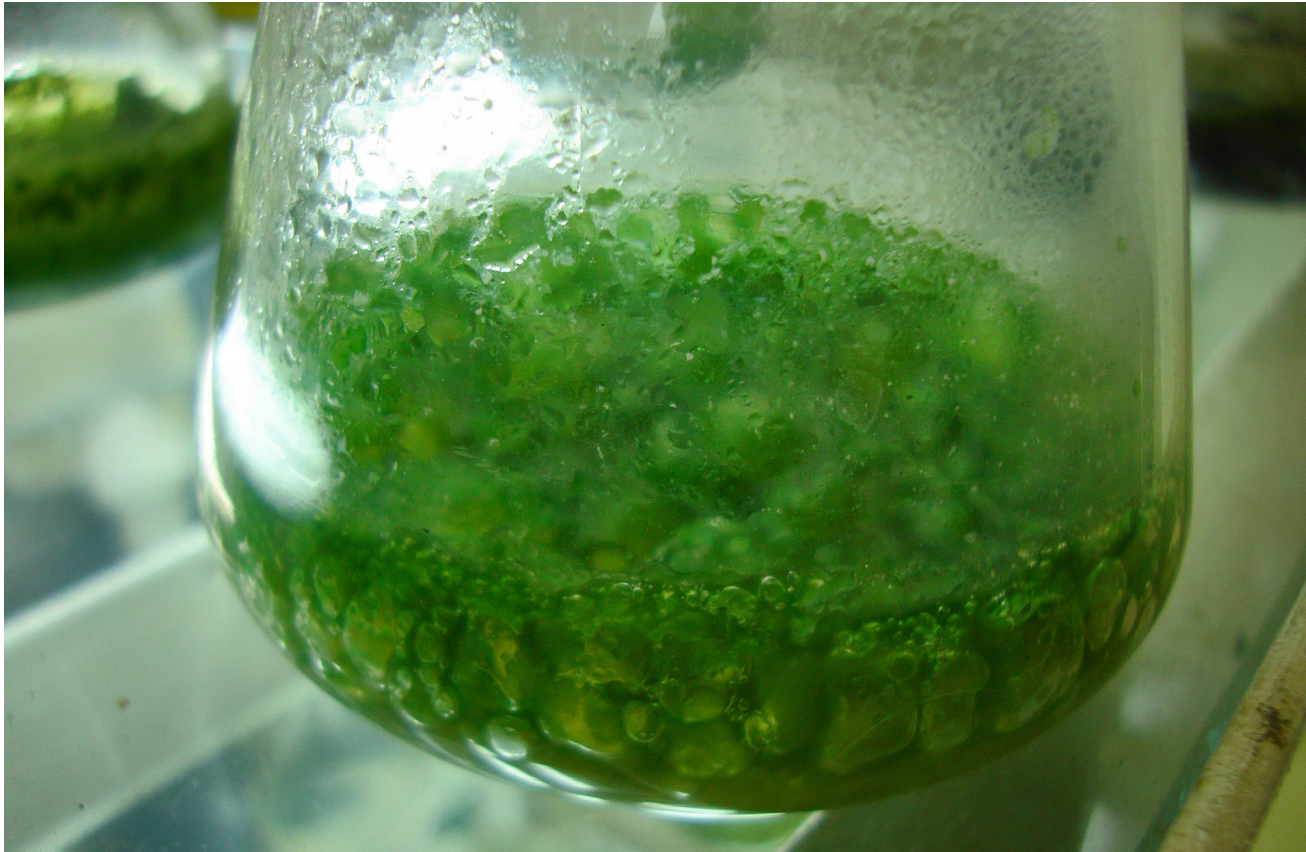
Cyanobacterial Blooms

They reproduce very quickly and can form biofilms. The aquatic forms sometimes form blooms, as in this image taken near Fiji.
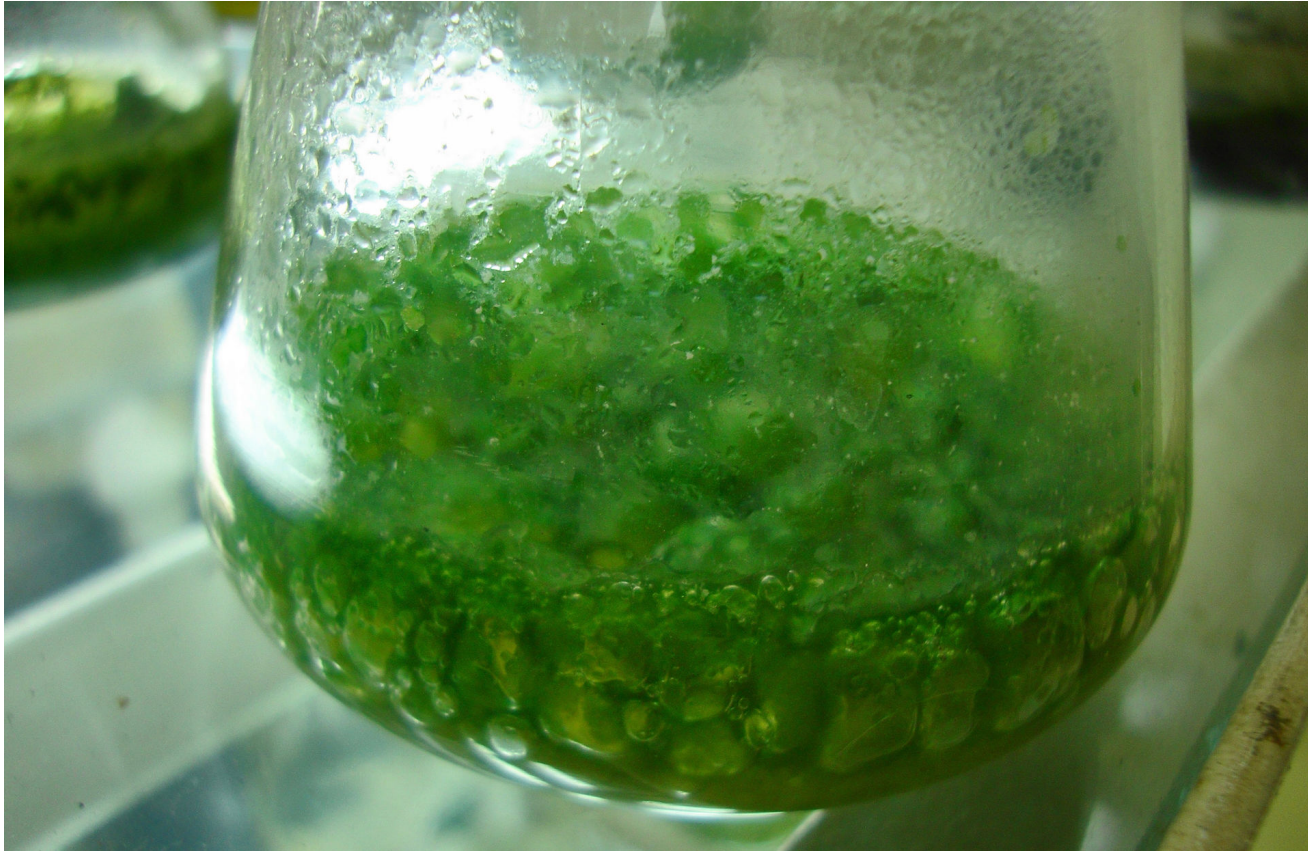
The Good, the Bad, and the Ugly

The Good: Used in agriculture to fix nitrogen, and experiments are underway to use them for biofuel production.
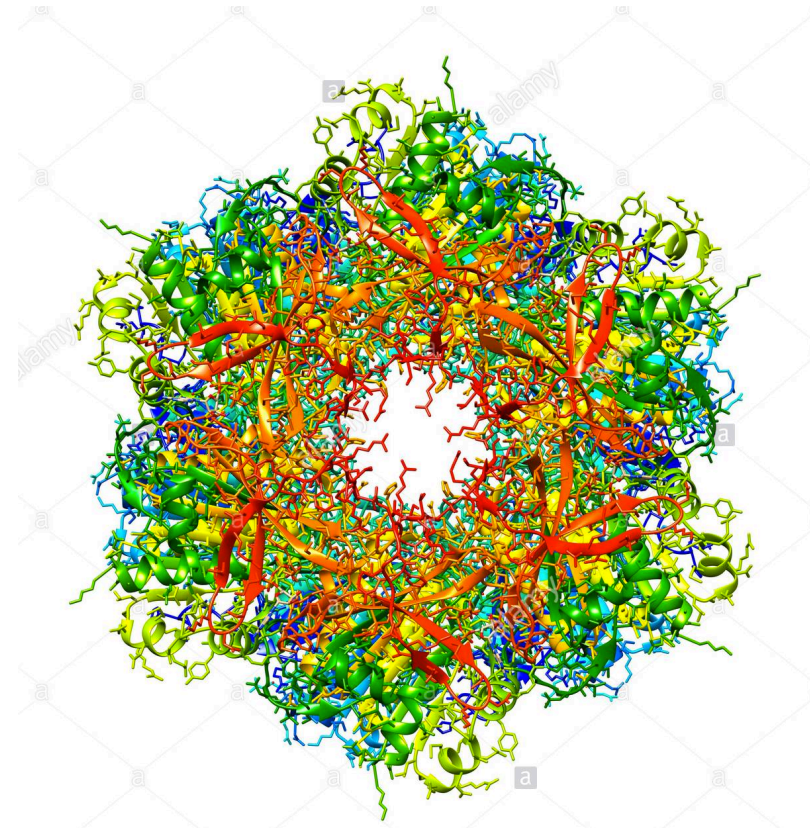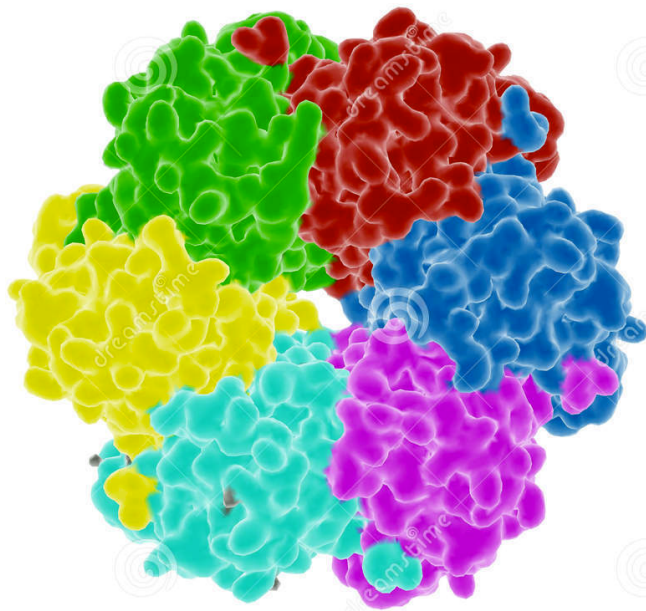
The Good, the Bad, and the Ugly

The Bad: Some cyanobacteria release toxins, called cyanotoxins. Some of these are harmful to humans.
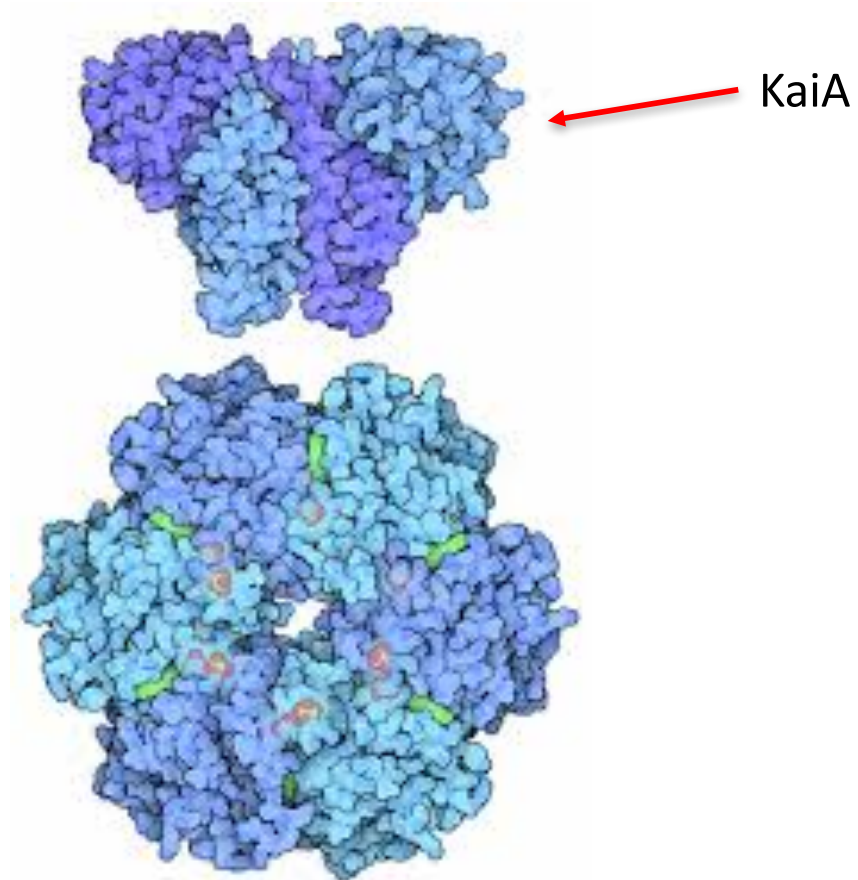
The Good, the Bad, and the Ugly

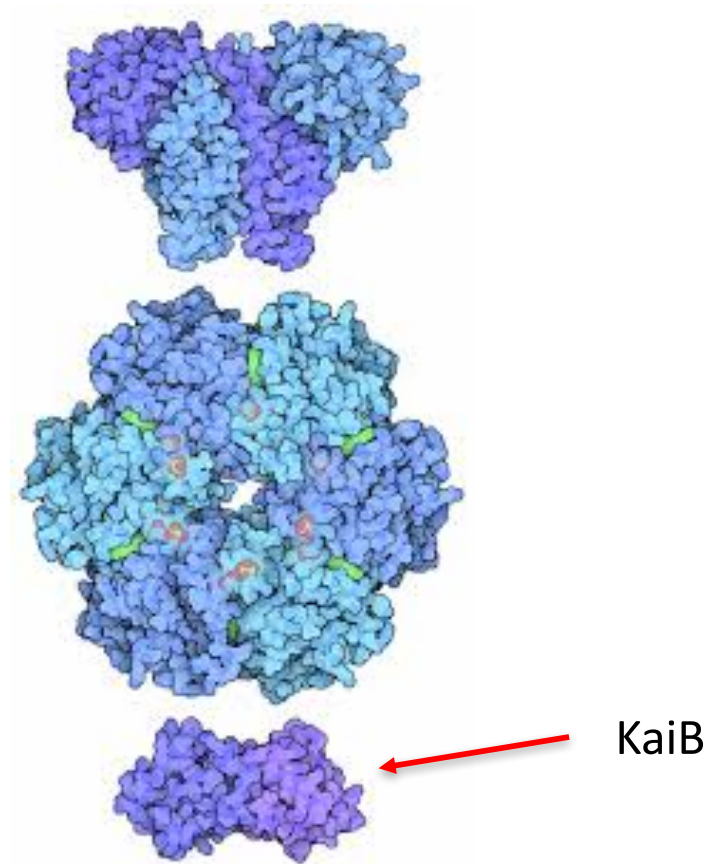The Ugly: No explanation required.

The KaiC Protein

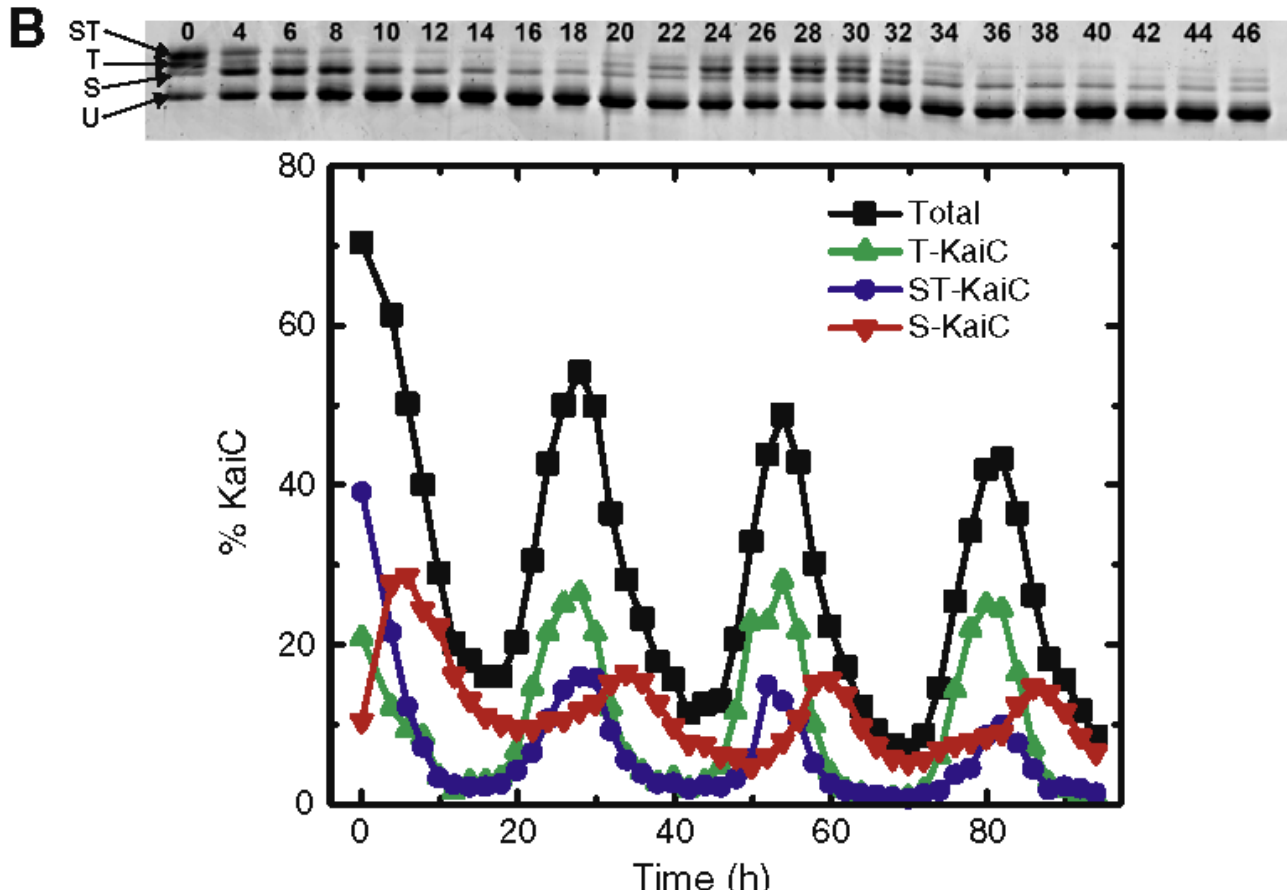Complex protein with six identical subunits

The KaiA Protein

KaiA

KaiA increases KaiC autophosphorylation
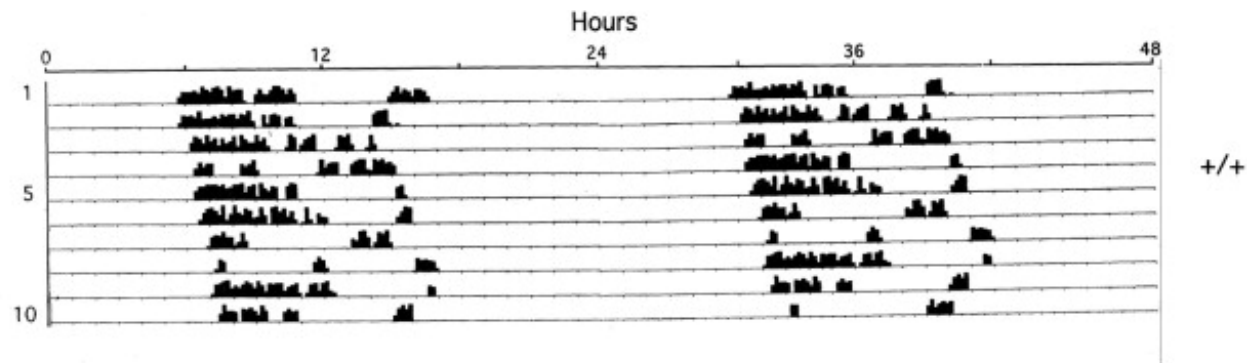
The KaiB Protein

KaiB

KaiB inhibits the action of KaiA

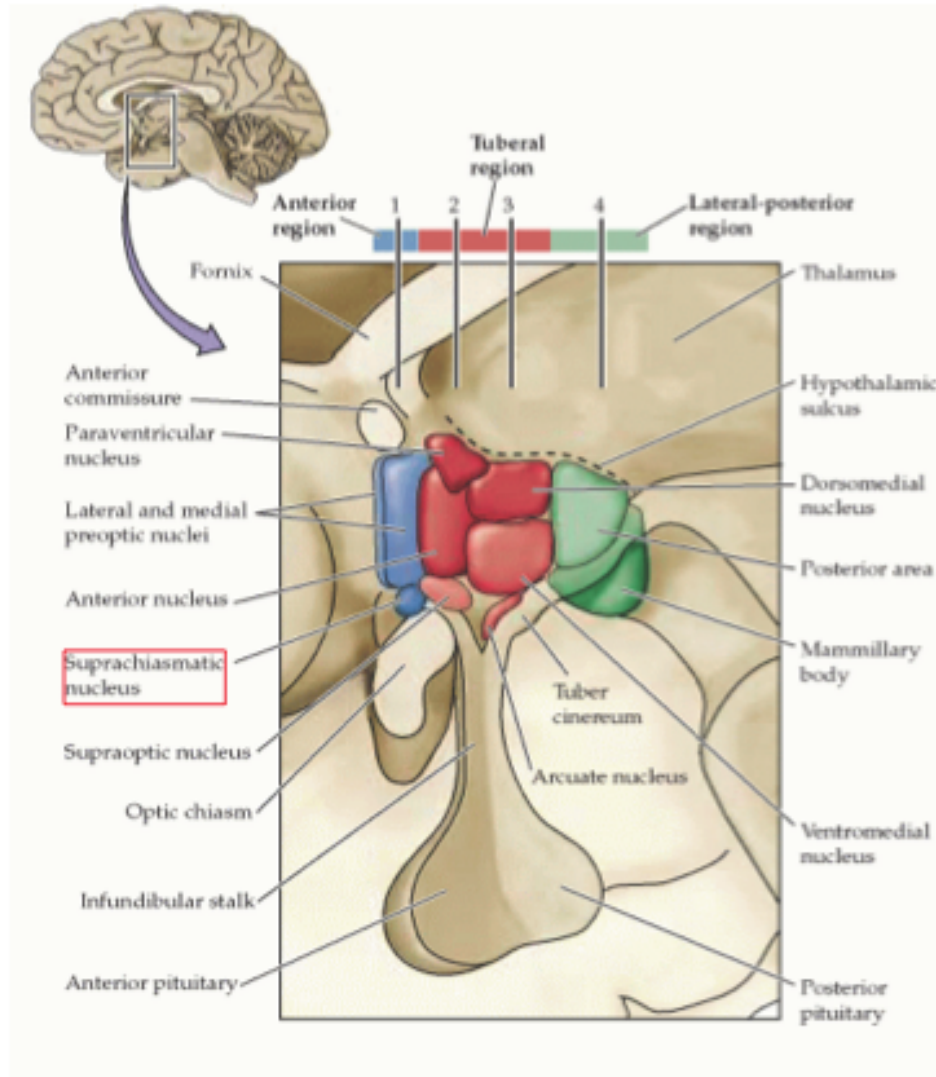# Circadian Rhythm in KaiC Phosphorylation State

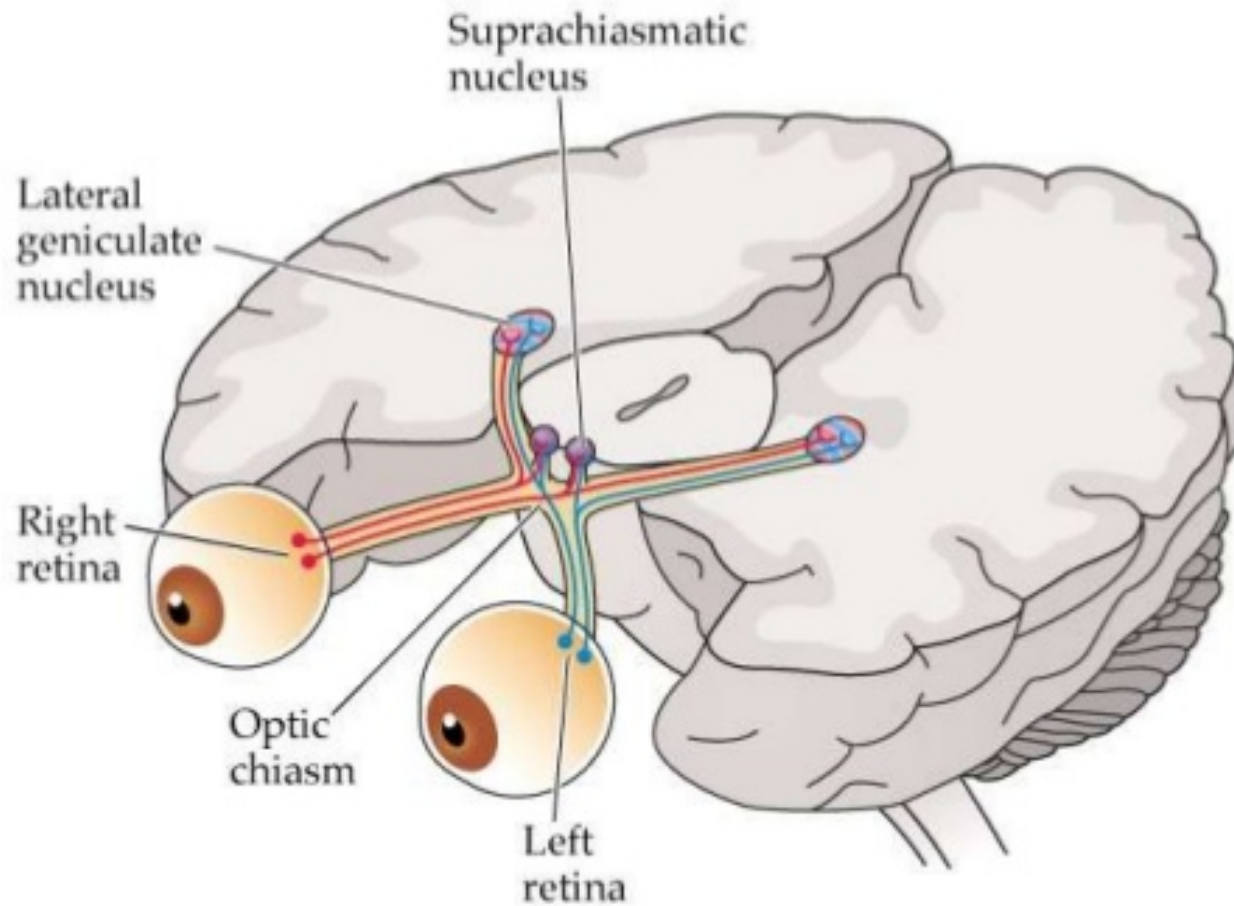# Actogram Showing Circadian Wheel Running

Wheel running activity of a hamster over a period of 10 days.
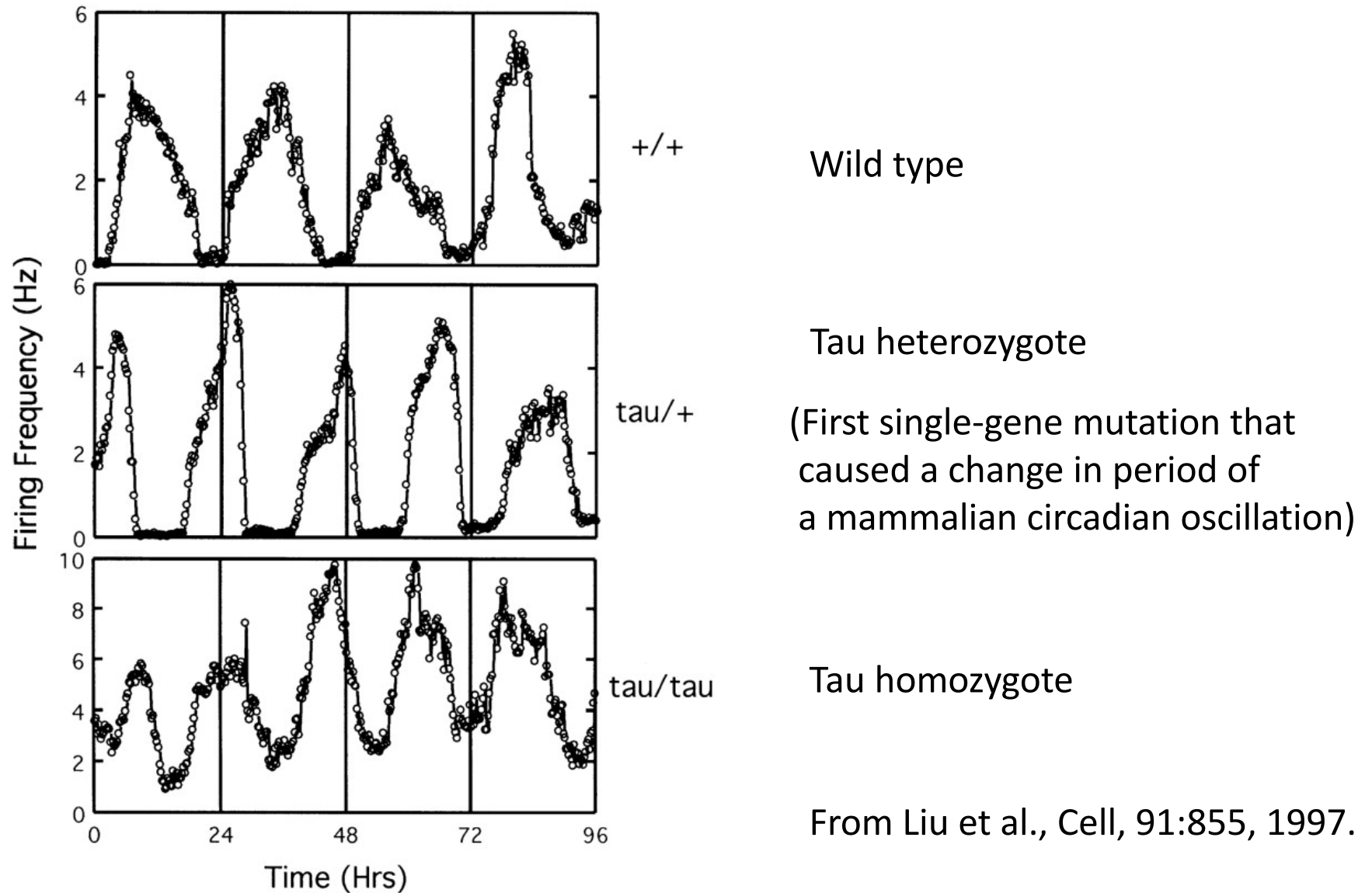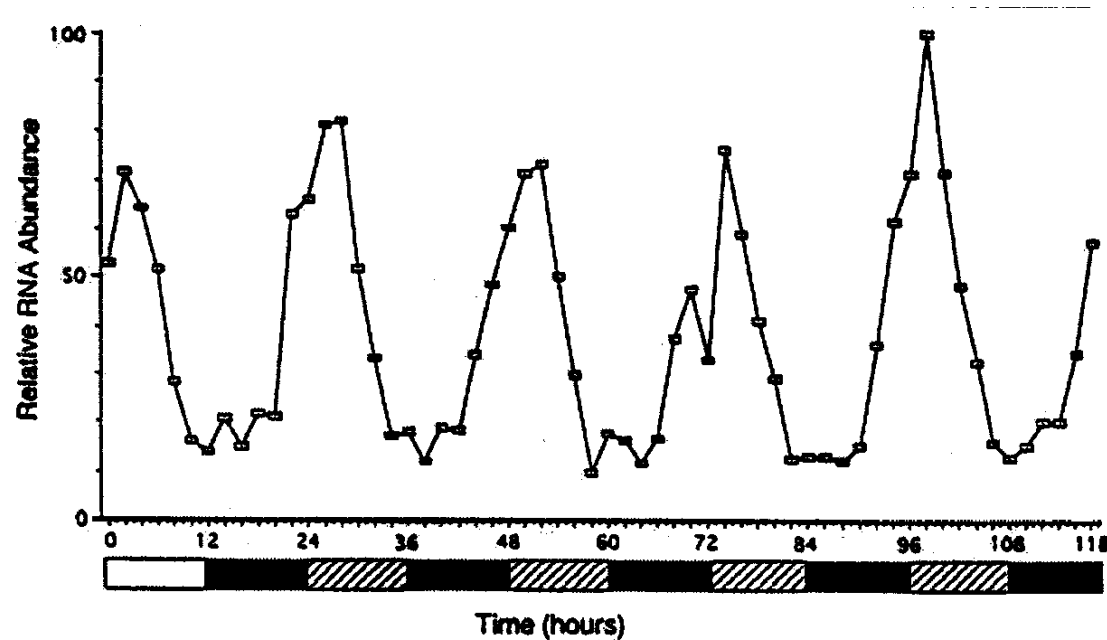From Liu et al., Cell, 91:855, 1997.

Nuclei of the Hypothalamus

Retinohypothalamic pathway

Suprachiasmatic nucleus

Lateral geniculate nucleus

Right retina

Optic chiasm

Left retina

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Circadian Firing Frequency from Dissociated SCN Neurons of a Hamster

Wild type

Tau heterozygote

(First single-gene mutation that caused a change in period of a mammalian circadian oscillation)
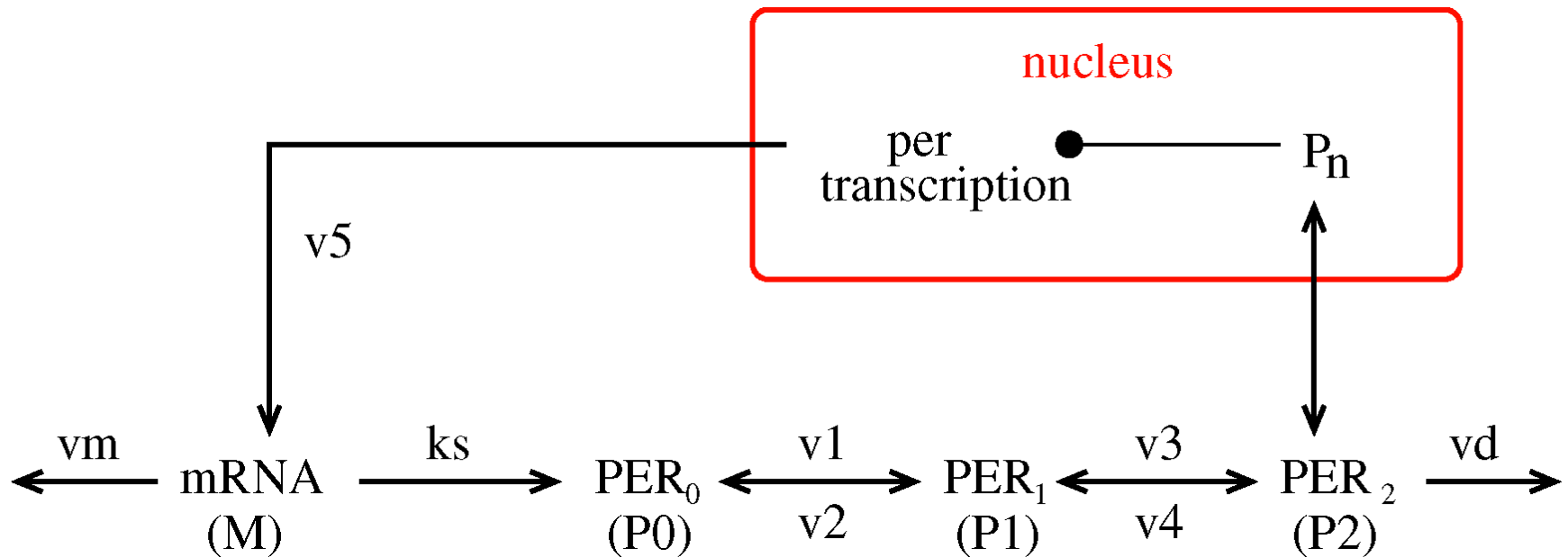
Tau homozygote

From Liu et al., Cell, 91:855, 1997.

Circadian Fluctuations in Period Gene Expression
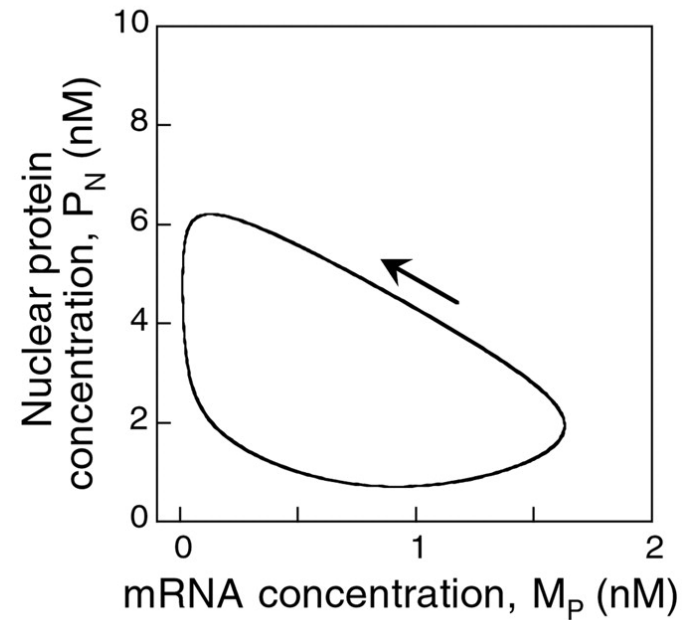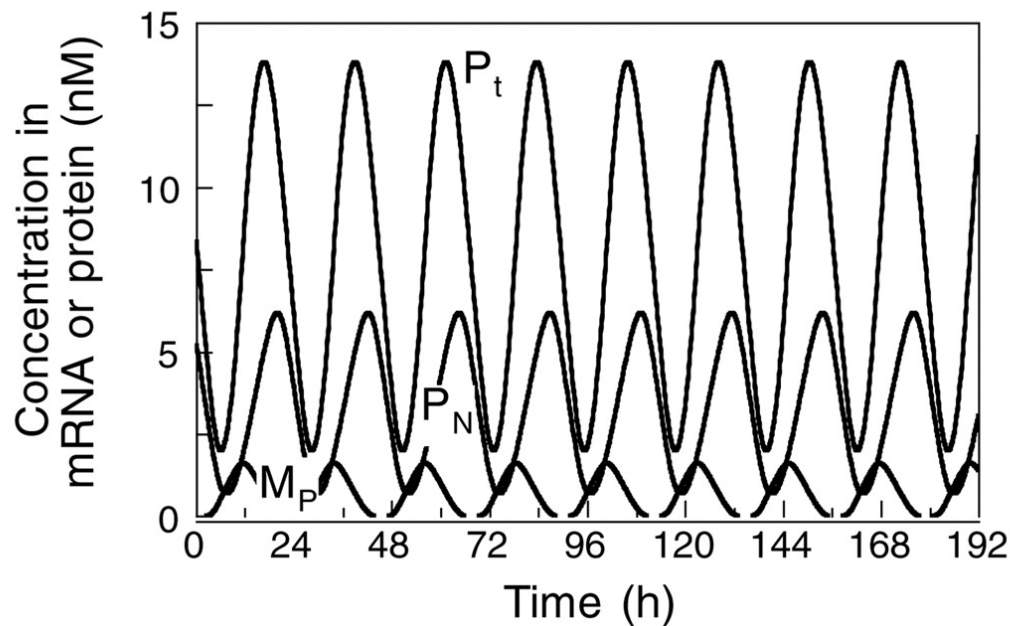

Period gene levels in SCN tissue. Most samples taken during constant darkness. Measurement made using in situ hybridization.
From Shigeyoshi et al., Cell, 91:1043, 1997.

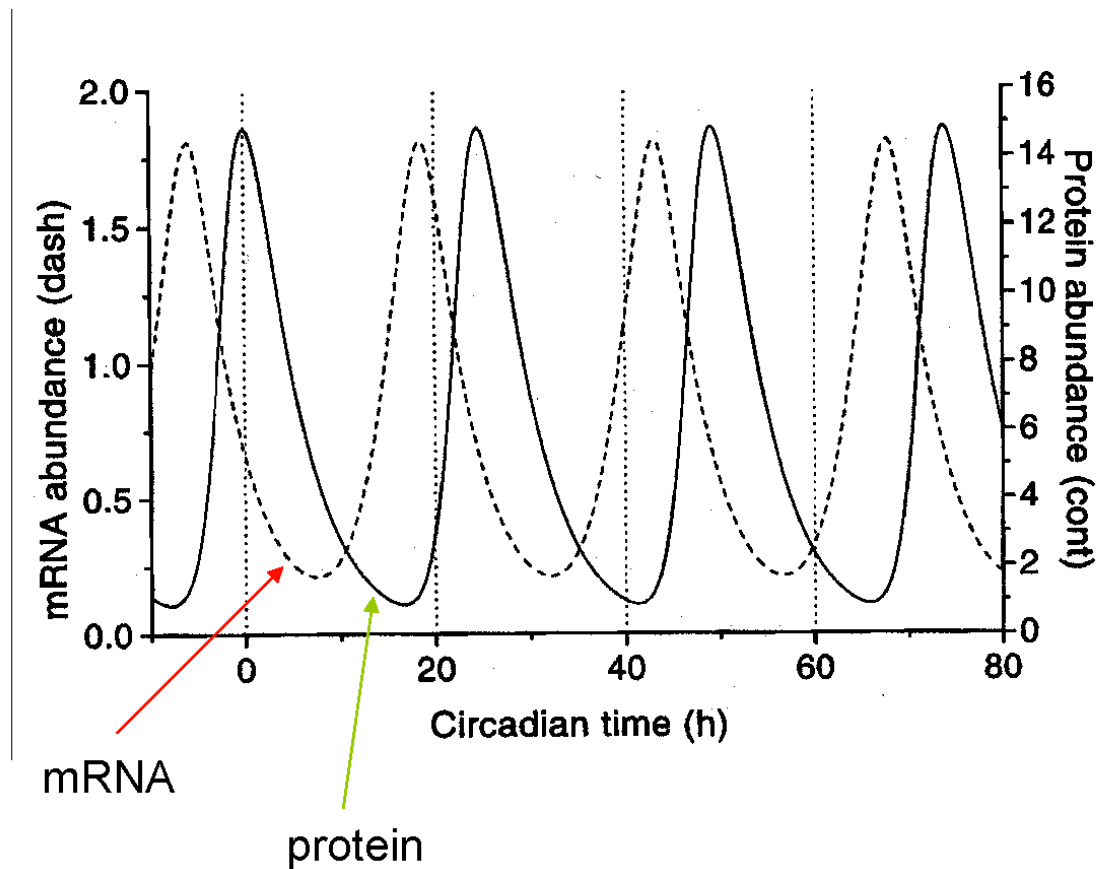# System Diagram of the Goldbeter Model

See Goldbeter, Proc. Royal. Soc. London, 261:319, 1995

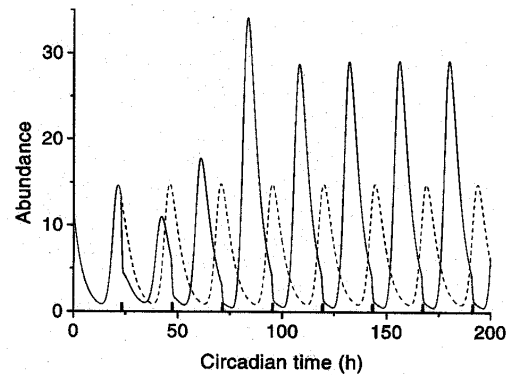# Circadian Rhythm with the Goldbeter model

See Goldbeter, Proc. Royal. Soc. London, 261:319, 1995

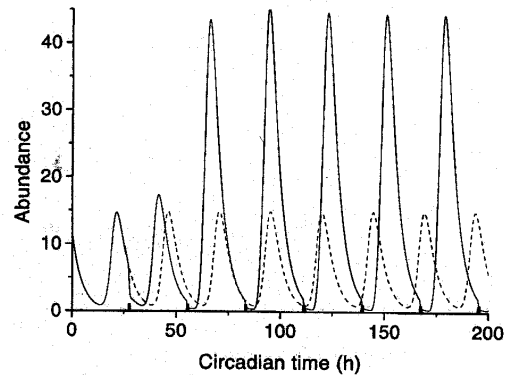# Circadian Oscillations with the Scheper Model

Free-running period is 24.6 hr. From Scheper et al., J. Neurosci., 19:40, 1999

Entrainment of Scheper Model to Short Pulses of "Light"

Stimulus period = 24 hr

(dashed = free-running)

Stimulus period = 28 hr

Light is simulated by short periodic pulses in which q_p is doubled.