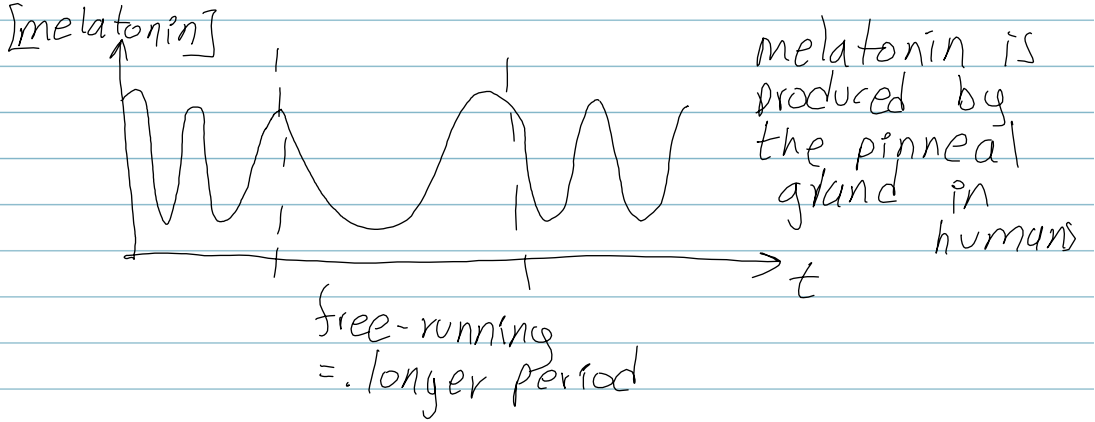
Circadian Oscillations

Oscillations with period ≈ 24 hours

Oscillations continue even in constant dark or constant light.

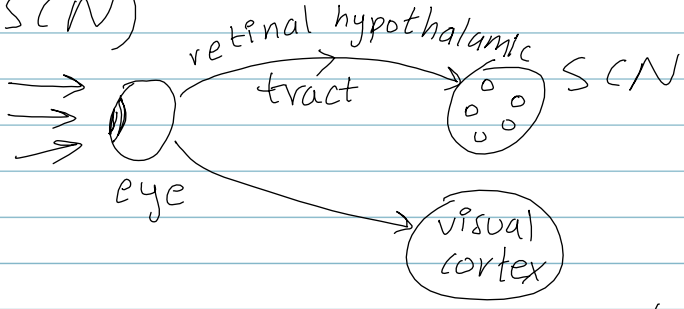
Light + Darkness entrain the endogenous circadian oscillator to give appropriate period.



Melatonin causes drowsiness and decreases the body temperature.

In invertebrates, the circadian oscillator sensors are in the eyes.

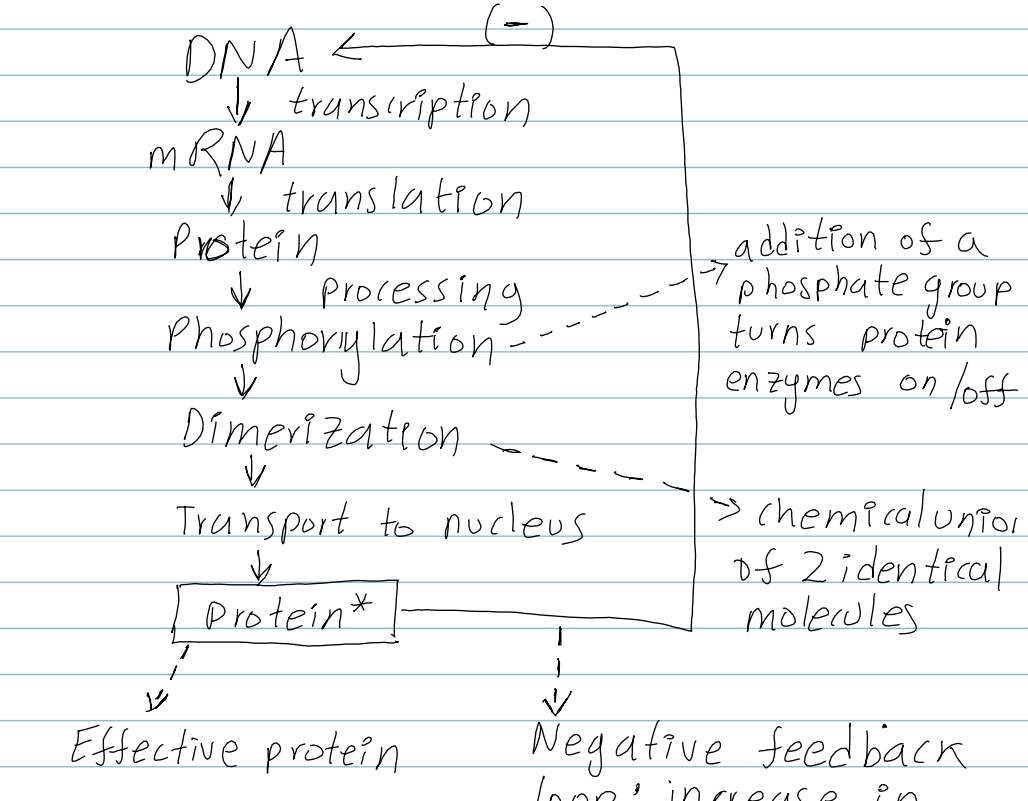
In mammals, cells that produce C.D.s are in the hypothalamus (region of the brain above brain stem). These cells are in the region called the suprachiasmatic nucleus (SCN)



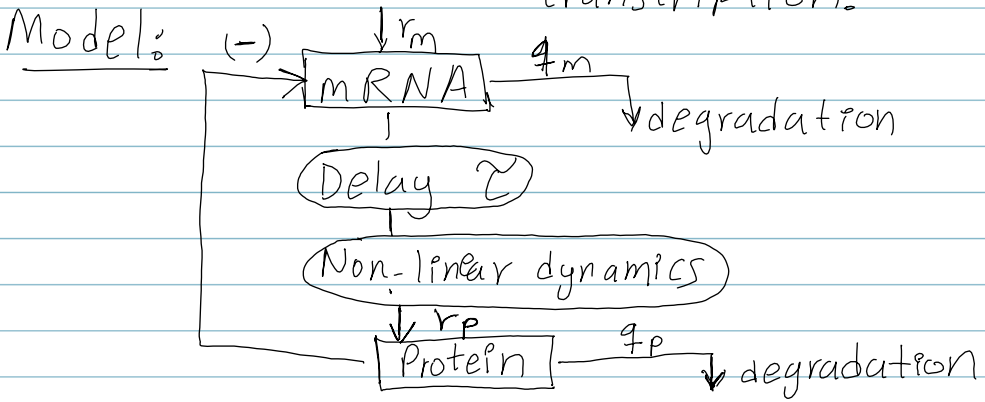
These cells are independent of vision cells.

An example of circadian rythms:
"Minimal model of circadean oscillators"
By Scheper et al.
J. Neuroscience, vol 19 p.p. 40-47, 1999

Biology: Circadian gene/protein



Model:



Variables:

m = [mRNA]

P = [protein]

Parameters (rates):

r_m = mRNA production

r_p = protein production

q_m = mRNA degradation

q_p = protein degradation

Key features:

(1) Time delay (τ) → 4 hours in original paper

(2) Negative feedback from protein* → mRNA

(3) Non-linearity: Nonlinear functions

⇒ mRNA: $\dot{m}$ = in − out

$$\dot{m} = \frac{r_m}{1+p^2} - q_m m$$

Protein: $\dot{p}$ = in − out

$$\dot{p} = r_p m(t-\tau)^3 - q_p p$$

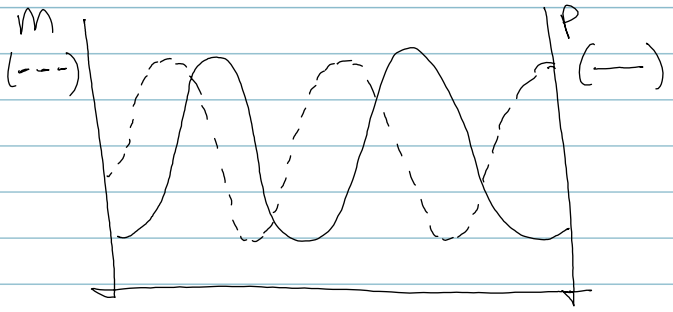
In the paper: $r_m = 1\ h^{-1}$, $r_p = 1\ h^{-1}$

$q_m = 0.21\ h^{-1}$, $q_p = 0.21\ h^{-1}$

The expression for $\dot{p}$ is a delay differential equation

phase plane does not work.

Trajectories can cross.



mRNA reaches maximum before protein.