

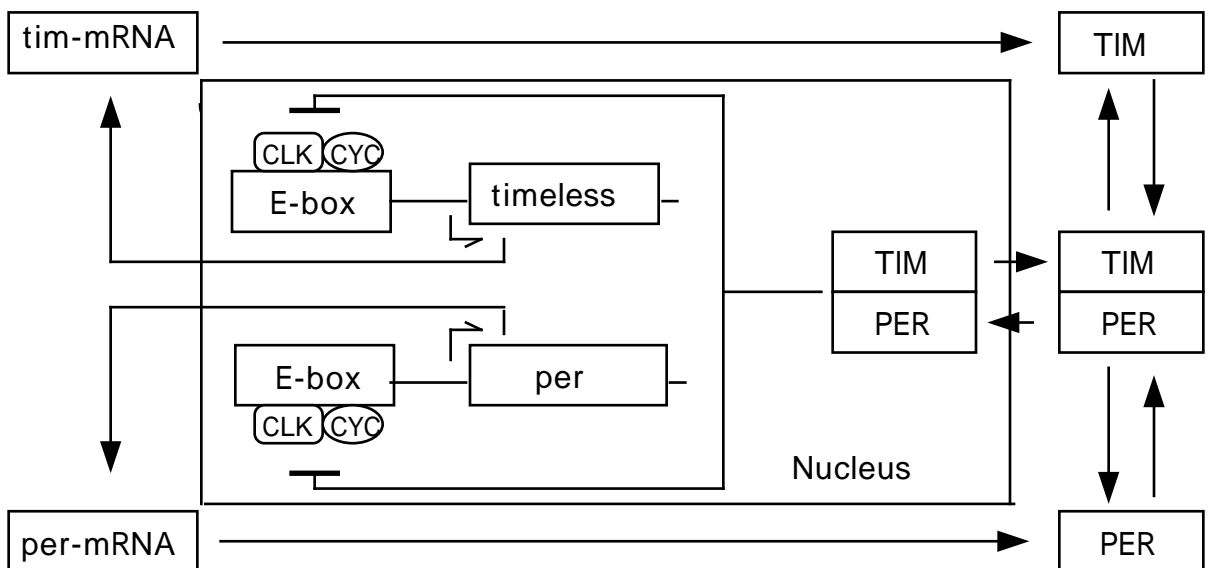
Mathematical Study for Circadian Rhythm in Drosophila :

Condition for Generating Cycle

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PER and TIMELESS proteins are believed to play a crucial role in the gene network to generate the circadian rhythm of Drosophila. They make heterodimers and inhibit the transcriptions of their own in Nucleus. Goldbeter(1998) proposed several mathematical models for this phenomena, and analyzed by numerical simulations. He claimed that the model in which PER-TIMELESS complex regulate the transcription of both genes is easier to generate a stable oscillation than the model in which only PER do feedback control, as the parameter regions for oscillation is larger for the former model than for the latter. We present 3 simpler models that differ in the cooperativity at the negative feedback working on the transcription process, and analyze them in detail. We found that a larger cooperativity generally tend to lose the local stability of equilibrium point and cause a limit cycle . Compared with 3 variables model (per-mRNA, PER in cytosol, and PER in nucleus), 4 variables model (PER is first modified and then enter the nucleus) can generate a stable oscillation with a smaller cooperativity. Compared with these, our PER-TIMELESS complex model can also generate oscillation with a small cooperativity. They show that the modification and heterodimerizaion of proteins are important to cause a limit cycle.



Genetic Network of Circadian Rhythm of Drosophila