

Announcements

I'm here.

Klaus Schulten to speak March 26th.

New Assignment

Pick: 1) an article, 2) a review article,
and 3) some general textbook(s)

Which you will give a 10 min. talk on (plus 2-3 min for questions.

Next Wednesday, hand in your articles (1 and 2),
plus a ½ - 1 page write up.

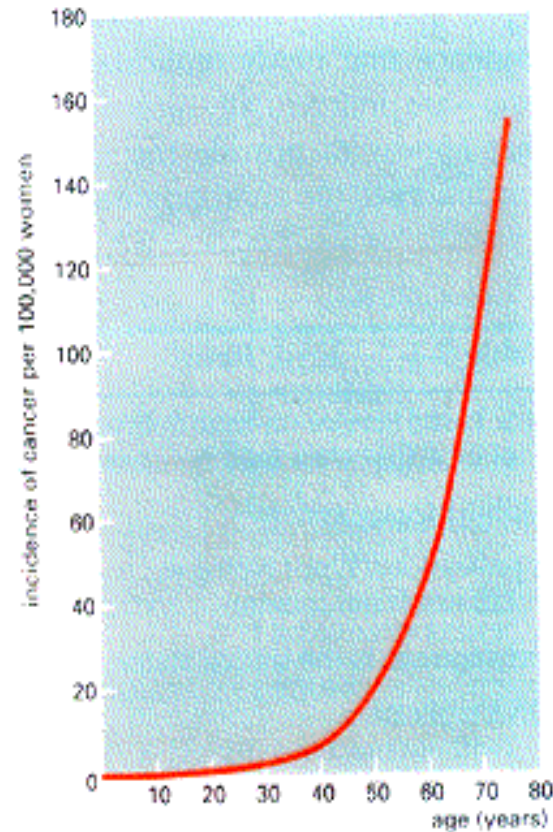
- 1) Why you are interested in it,
- 2) what you think major technical innovation is,
- 3) what is main biological point.

This afternoon, I MAY assign 1 or 2 problems, also due next Wed.

Quiz #6 (2/27/08) Chpt 4, ECB

1. Molecules that assist in the folding of proteins in vivo are called [molecular] chaperones.
2. The two structured secondary folds are called alpha helix and beta sheet.
3. Proteins that couple the chemical energy from ATP hydrolysis into mechanical work are called molecular motors.
4. The transfer of a phosphate group onto a protein is performed by a family of proteins called protein kinases. The reverse reaction is performed by a family called protein phosphatases.
5. The functional part of an enzyme, i.e where the enzymatic activity actually takes place, is called the active site.

DNA Replication: made with very high fidelity



Cancer Incidence vs age:

$$P(\text{cancer}) \propto \text{Age}^6$$

Question: What no. of mutations on average causes cancer?

Assume mutations accrue
at constant rate
i.e. probability of mutation \propto time.

If each mutation is independent, then probability of:

2 mutations = t^2

3 mutations = t^3

.

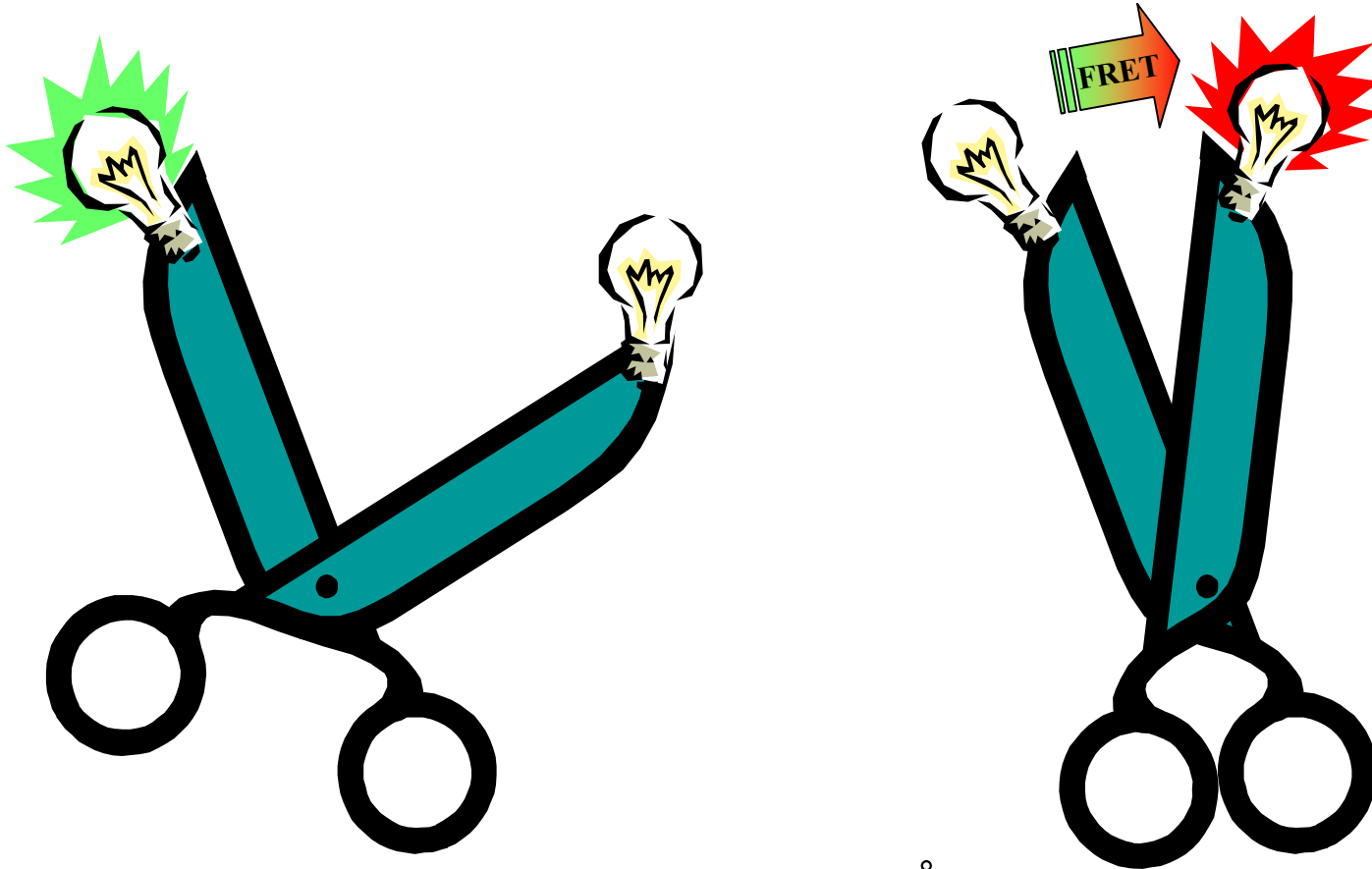
.

.

6 mutations = t^6

**Since Probability (cancer) $\sim t^6$,
likely that cancer caused by average of six mutations**

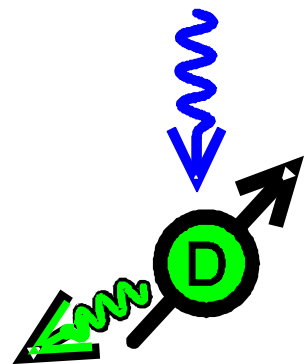
FRET: measuring conformational changes of single biomolecules



FRET useful for 20-80Å

Distance dependent interactions between green and red light bulbs can be used to deduce the shape of the scissors during the function.

Why is fluorescence at longer wavelength than excitation wavelength?



Absorption

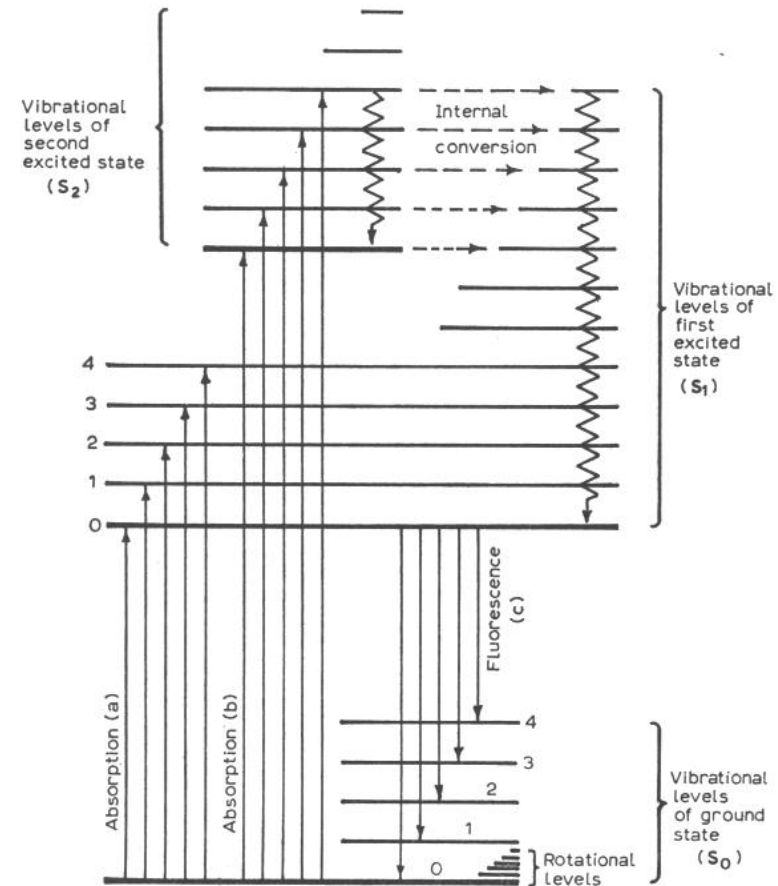
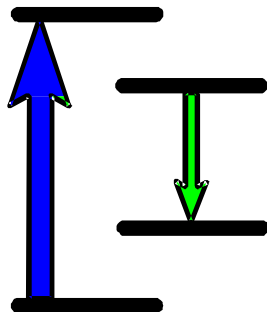
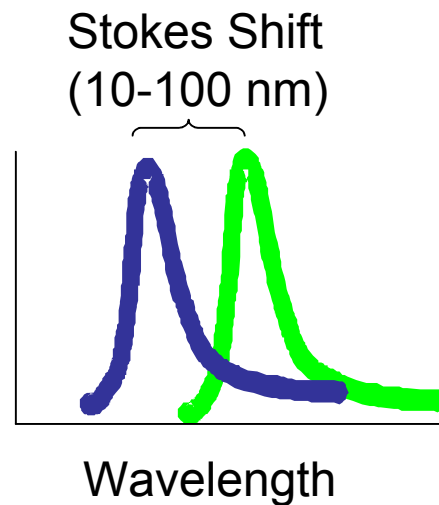


Fig. 1. Transitions giving rise to absorption and fluorescence emission spectra.

Excitation from lowest ground state to excited states (fsec).
 Relaxation to lowest excitation singlet state (psec).
 Transition to multiple ground states (nsec).

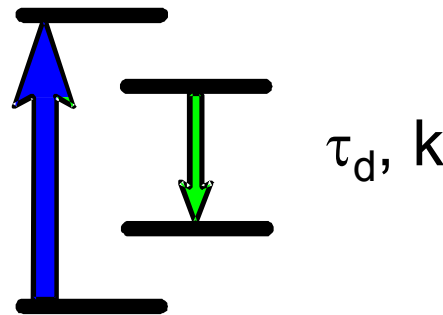
Lifetimes and Quantum Yields

Lifetime (τ_d): $\exp(-\tau/\tau_d)$: 1-100nsec

$$\tau_d = 1/k$$

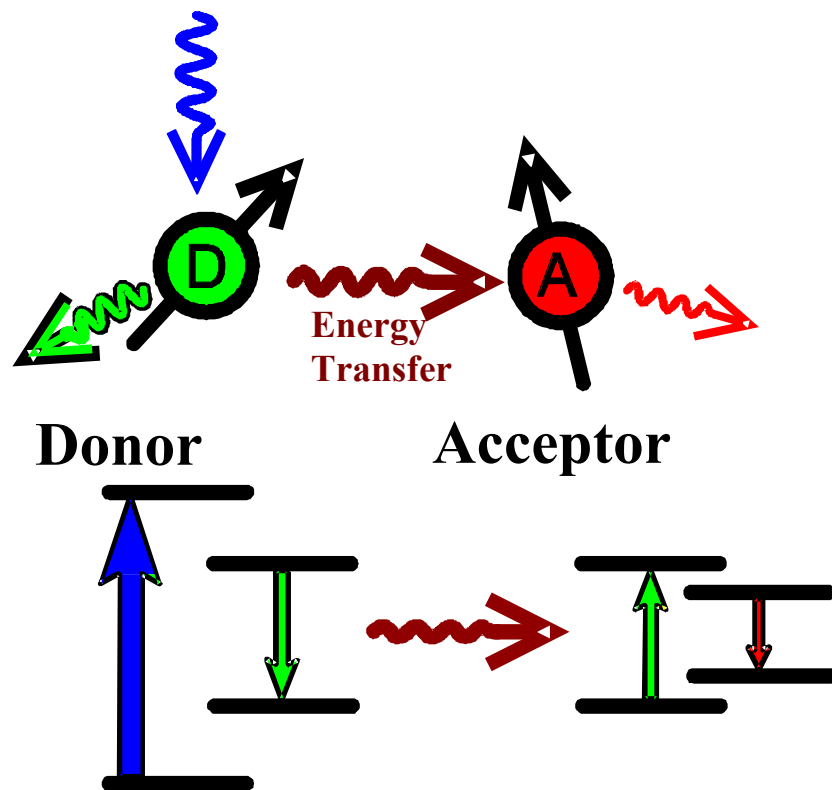
Quantum yield(ϕ, q) : $k_{\text{rad}} / (k_{\text{rad}} + k_{\text{non-rad}})$

[how much of excited-state energy goes into light vs. heat]



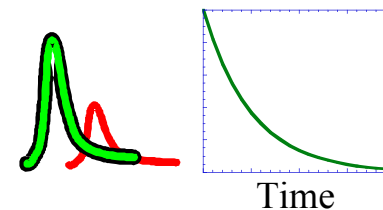
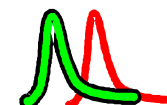
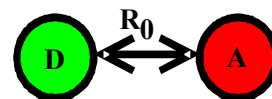
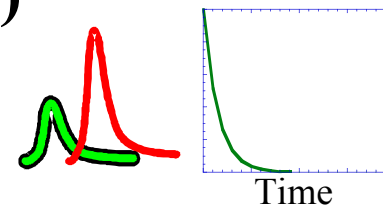
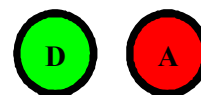
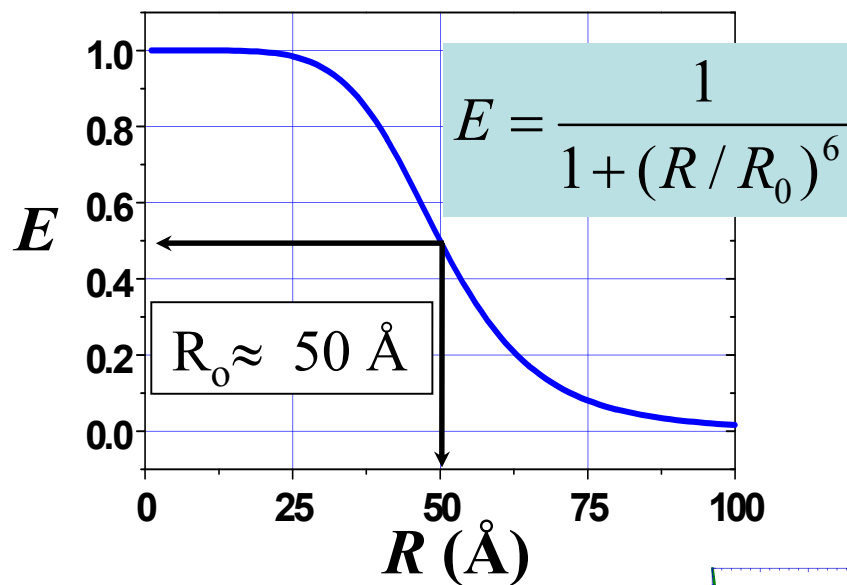
Fluorescence Resonance Energy Transfer (FRET)

Spectroscopic Ruler for measuring nm-scale distances, binding



Dipole-dipole Distant-dependent
Energy transfer

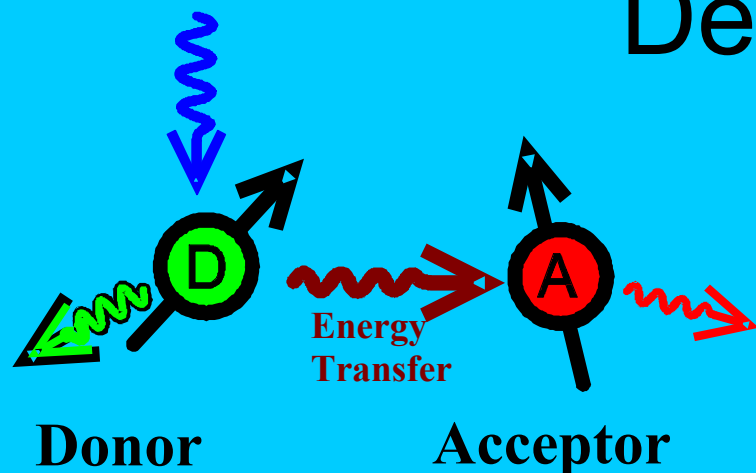
Look at relative amounts
of **green** & **red**



Question

Derive $1/R^6$

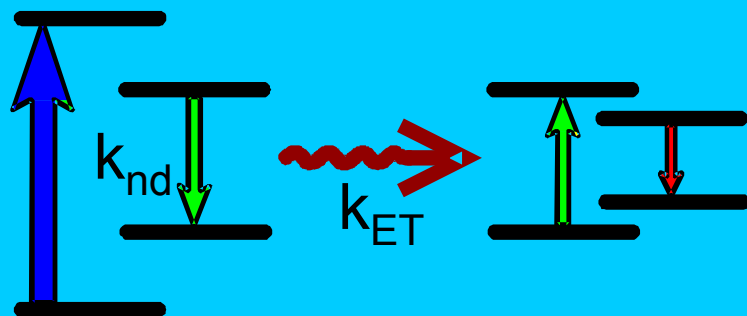
$$E = \frac{1}{1 + (R/R_0)^6}$$



$$E.T. = k_{ET}/(k_{ET} + k_{nd})$$

$$E.T. = 1/(1 + k_{nd}/k_{ET})$$

$$E.T. = 1/(1 + 1/k_{ET}\tau_D)$$



How is k_{ET} dependent on R ?

$$k_{\text{non-distance}} = k_{nd} = k_f + k_{\text{heat}}$$

Quantum Mechanically

Determine Hamiltonian (Energy) of Interaction.

By Fermi's Golden Rule, rate goes like H^2 .

Dipoles interacting:

$$H = \frac{\mu_D \cdot \mu_A}{R^3} - \frac{3(\mu_D \cdot \mathbf{R})(\mu_A \cdot \mathbf{R})}{R^5}.$$

E.T. depends on R^3 : $H^2 = R^6$

Classically: How is k_{ET} dependent on R ?

How does electric field go like?

Far-field: $1/R^2$

Near-field: $1/R^3$ ($d \ll \lambda$)

Dipole emitting: Energy = $U = p_e E = p_e/R^3$. (E = electric field)

Dipole absorption:

Probability that absorbing molecule (dipole) absorbs the light $p_a E$

So light absorbed goes like pE^2 , $p_e p_a/R^6$

$$E.T. = 1/(1 + 1/k_{ET}\tau_D)$$

$$E.T. = 1/(1 + (R^6/R_0^6))$$

Classically: E.T. goes like R^{-6}

Class evaluation

1. What was the most interesting thing you learned in class today?
2. What are you confused about?
3. Related to today's subject, what would you like to know more about?
4. Any helpful comments.

Answer, and turn in at the end of class.