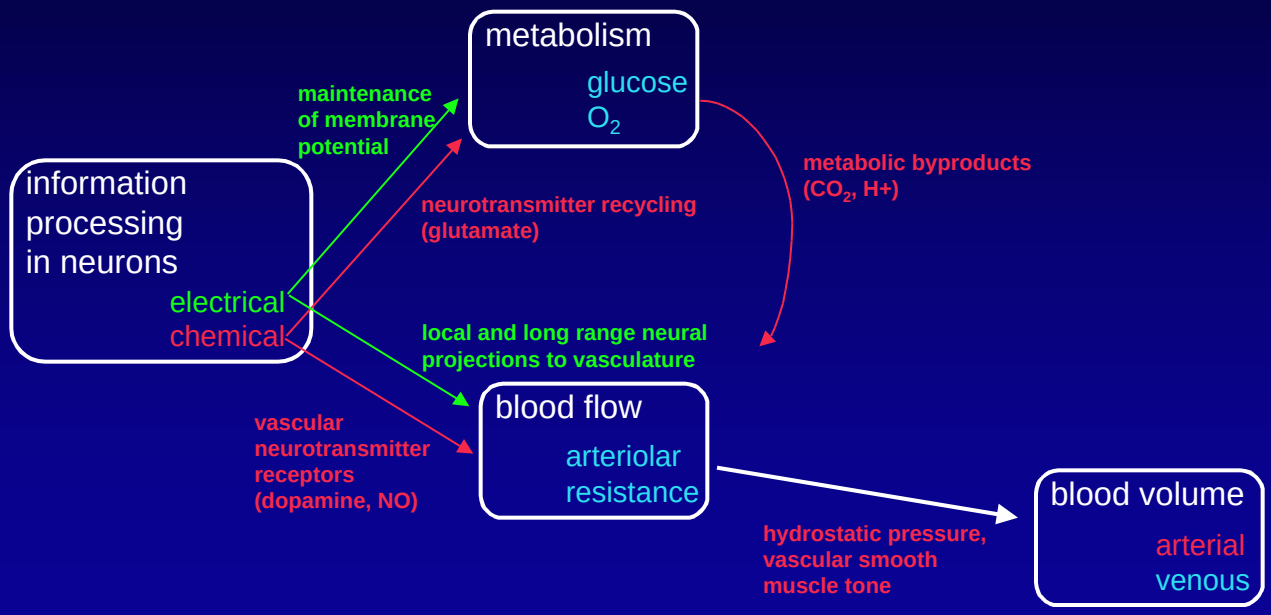
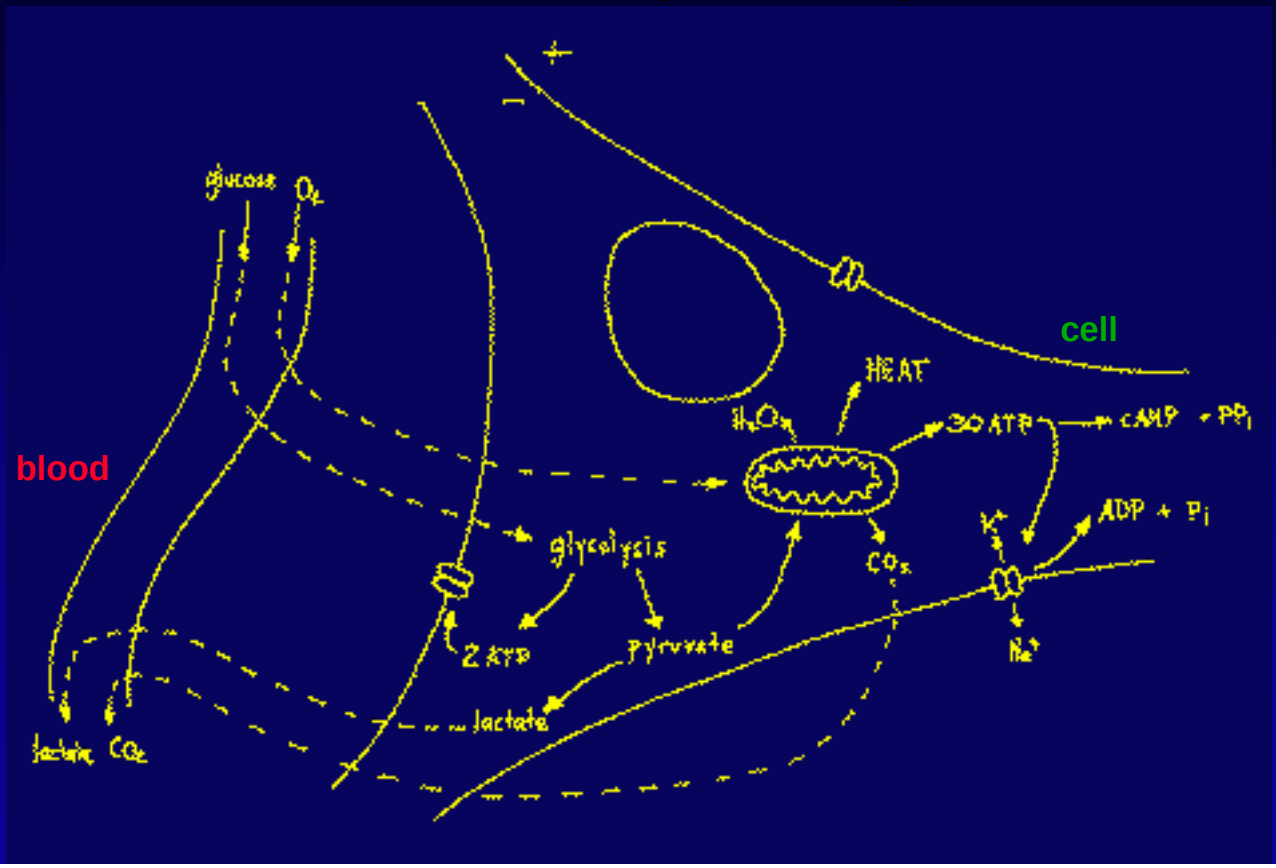
Physiological basis of functional brain mapping

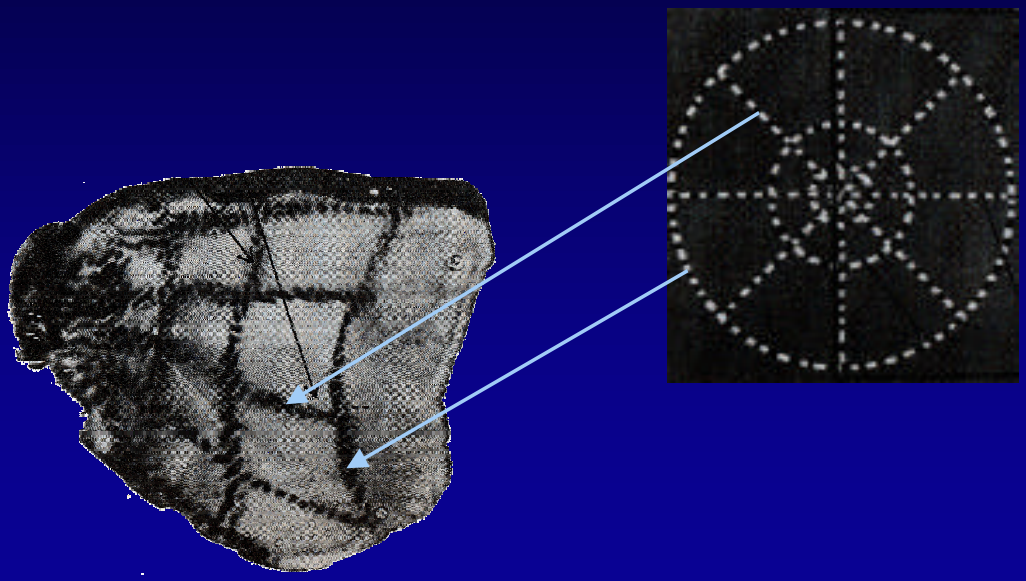
Physiological Events Accompanying Neuronal Activation



Metabolic pathways

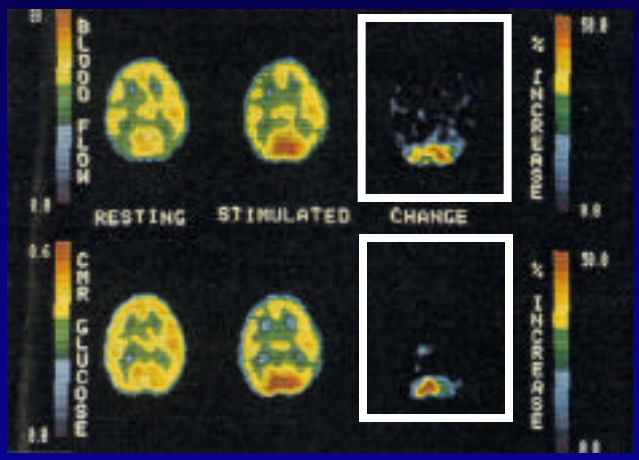


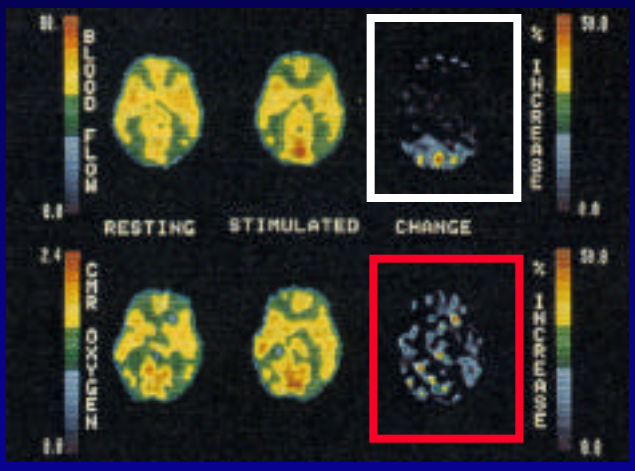
2DG autoradiography



tootell *et al*.

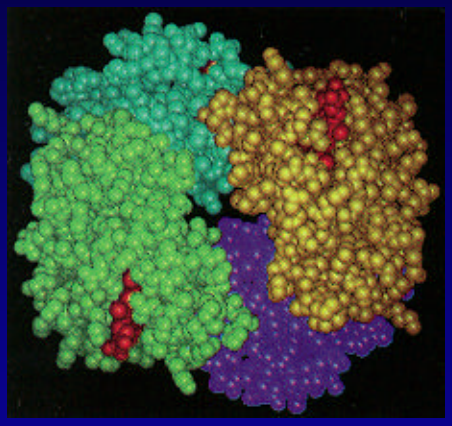
Positron emission tomography





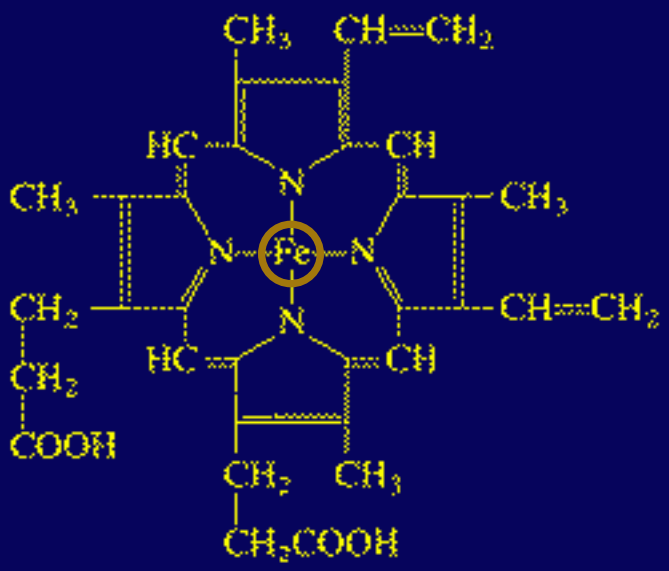
Fox *et al*.

Hemoglobin: a marker for blood volume and oxygenation



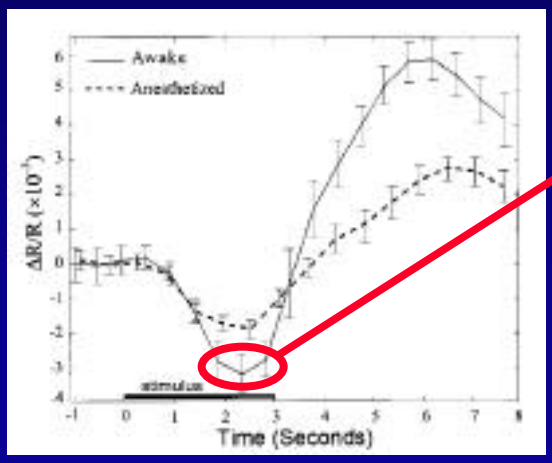
- transports oxygen in blood
- tissue concentration: ~ 84 μmolar

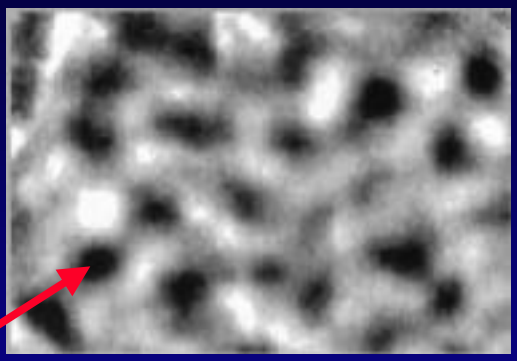
Heme



- unpaired electrons in reduced Fe lead to paramagnetism, absorbance of red light

Hemoglobin-based optical imaging

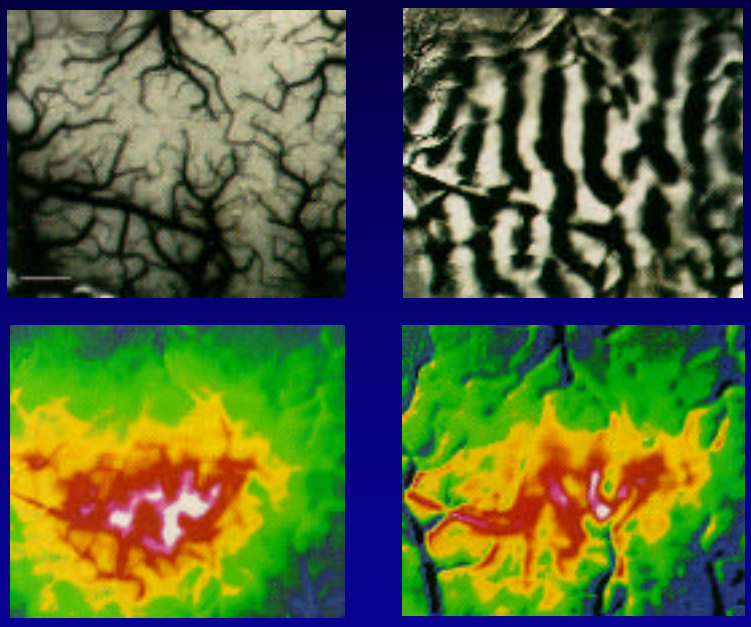




monkey orientation columns

Shtoyerman, Grinvald *et al*.

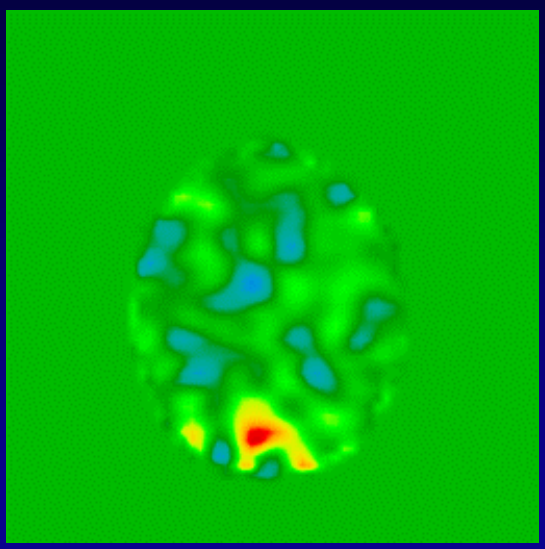
Functional NIRS imaging in animals



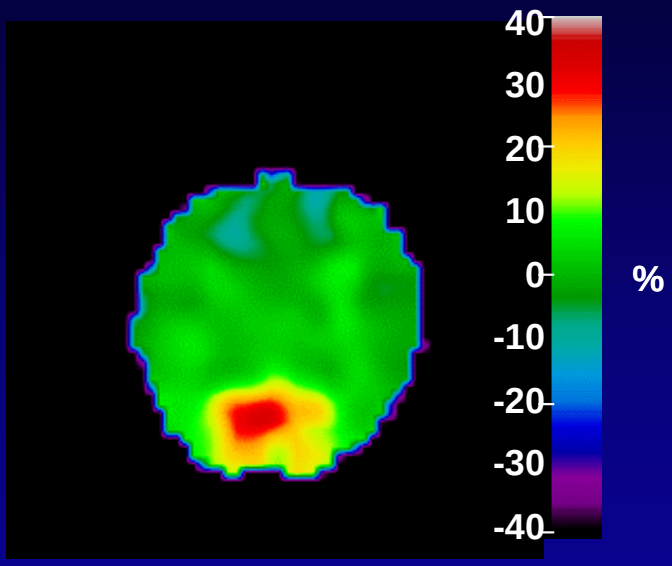
monkey ocular dominance columns

- Frostig *et al*. 1990

PET and MRI-based $\Delta CMRO_2$ values

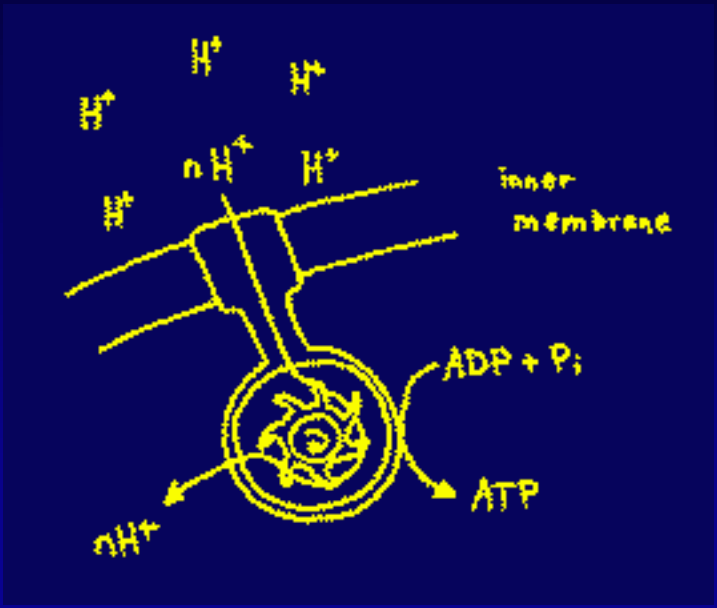


PET (Marrett *et al*.)



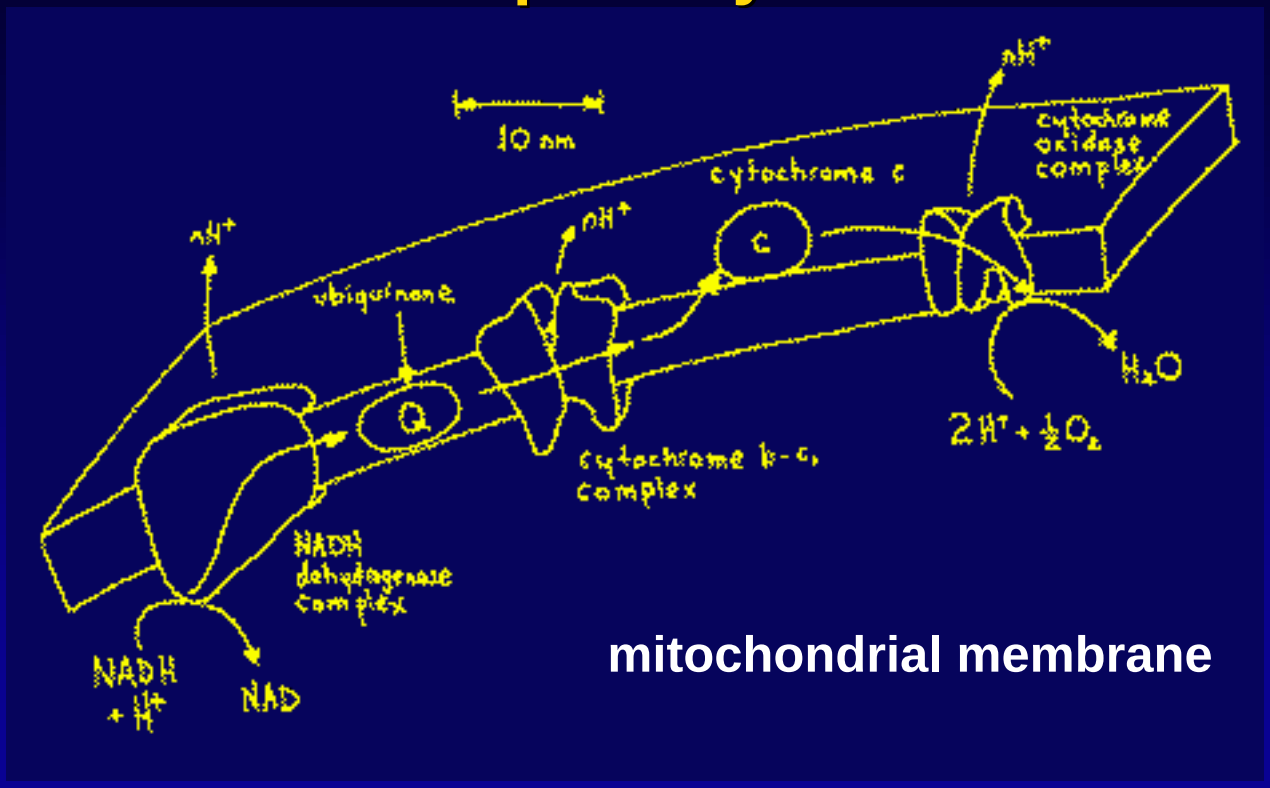
MRI
(same stimulus, different subjects)

ATP synthase

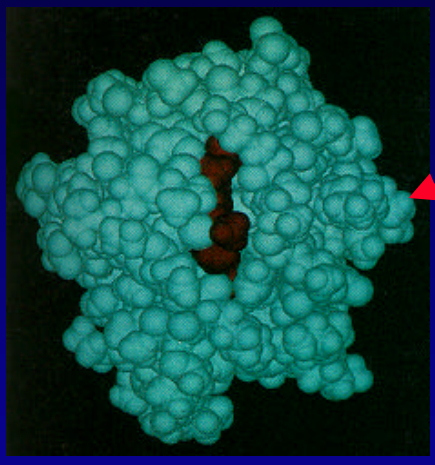


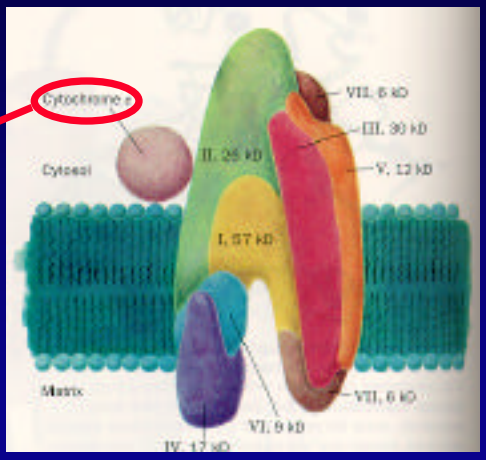
ATP synthase acts like a H^+ powered pump

The respiratory chain



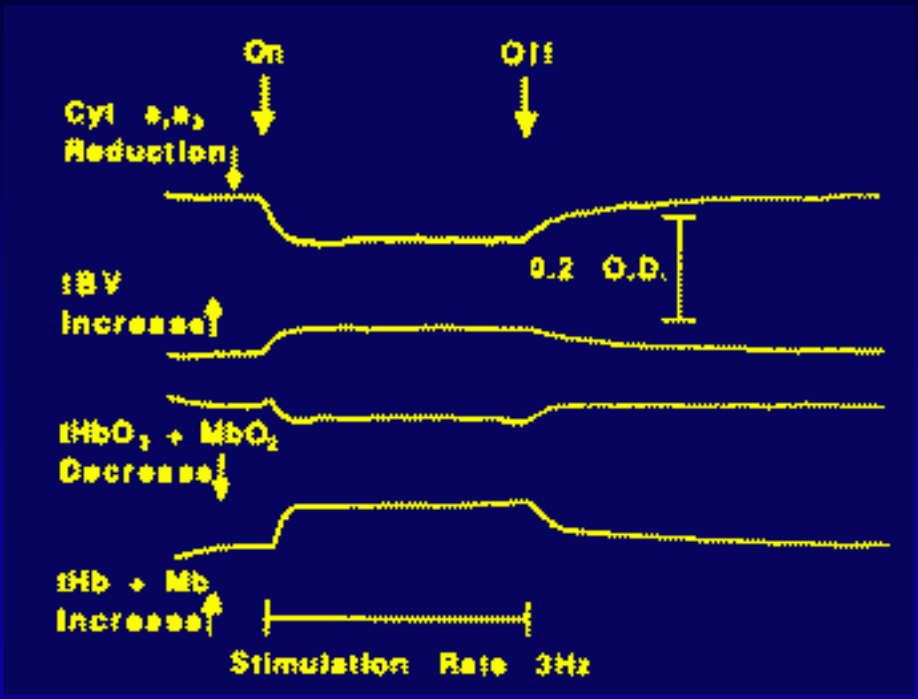
Cytochromes and cytochrome oxidase





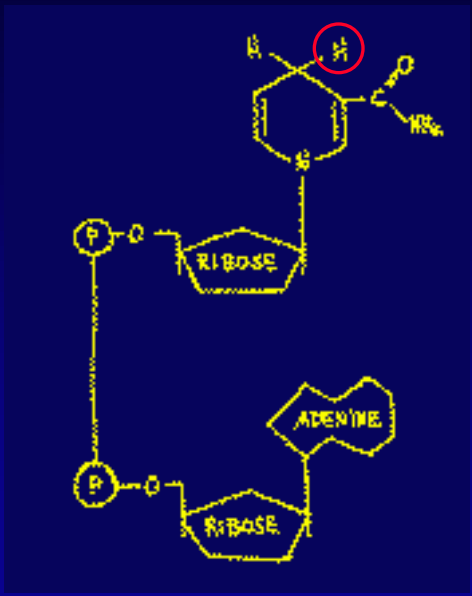
- transport electrons/protons in mitochondrial membrane
- contain heme groups with characteristic spectra

Muscle contraction studies (canine)



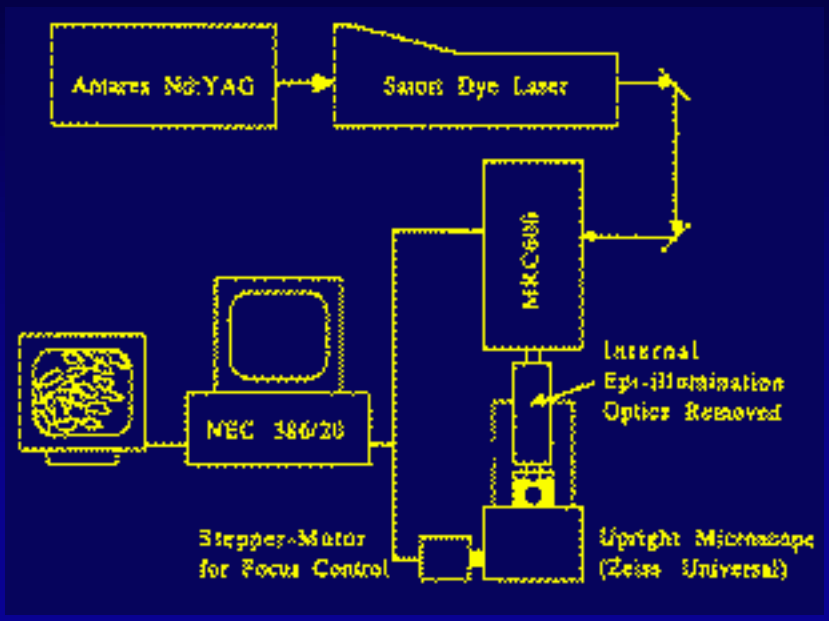
- Duhaylongsod *et al*. 1993

Oxidized/reduced nicotinamide adenine dinucleotide (NAD^+, NADH)



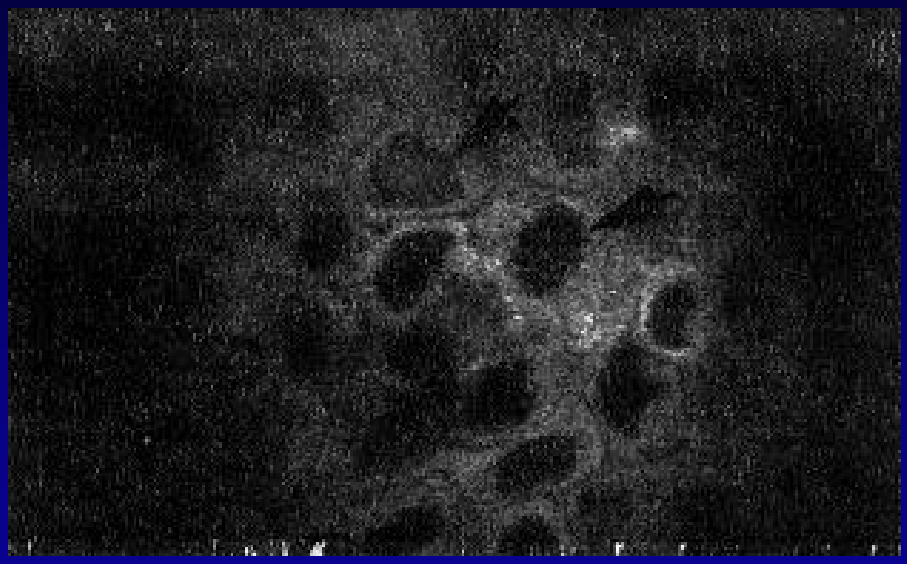
- transports electrons/protons in mitochondrial membrane
- NAD^+ concentration increases in active tissue
- NADH fluoresces at 340 nm (UV)

NADH fluorescence imaging with 2-photon excitation



- Piston *et al*. 1995

NADH fluorescence imaging of rabbit cornea



corneal cells after administration of cyanide
(a blocker of respiratory enzymes)

- Piston *et al*. 1995