Foundations of Medical Physics

1. Could be considered as the first part of **Medical Biophysics** course in the second semester. The two courses form one unit.
2. **Summary** and **overlook** of the physical bases with new "medical" aspects.
3. **It is not a premedical course of elementary physics.** If you do not know the basic physical quantities and laws, you have to learn it from textbooks or internet (e.g. HyperPhysics in Google)!

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Why do we learn it?

Reasons:

1. The structure and function of human body,
2. the methods, techniques, equipments of medical diagnosis and therapy have bases of natural science.

φυσιζ = nature
physics = natural science

It is interesting that the meaning of
„physic" = „art of healing, medical science"

3. Medical mentality
   logical, analyzing, systematic,
   an important peculiarity is the continual skepticism.

Purposes:

I. To get knowledge
II. Solving problems, methods
III. Approach, attitude of mind

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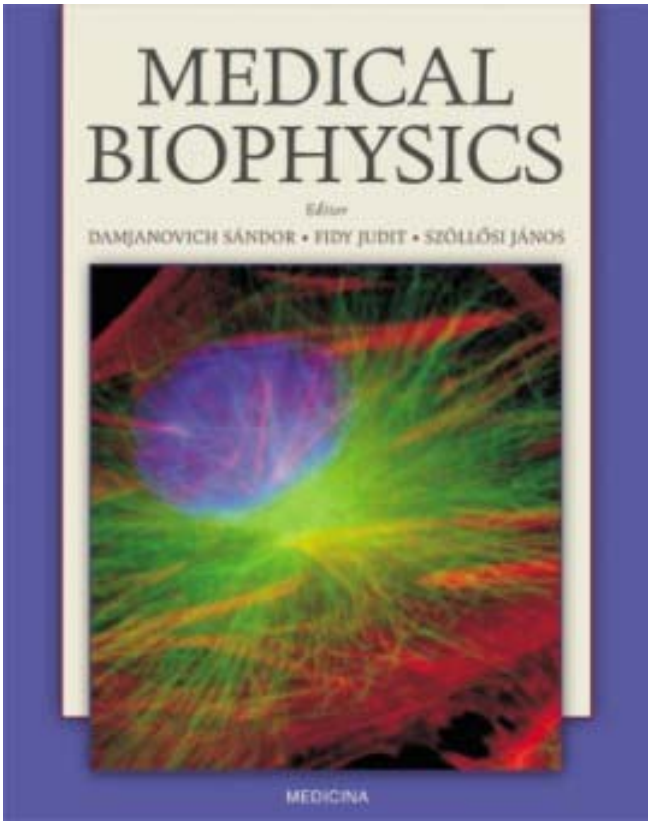
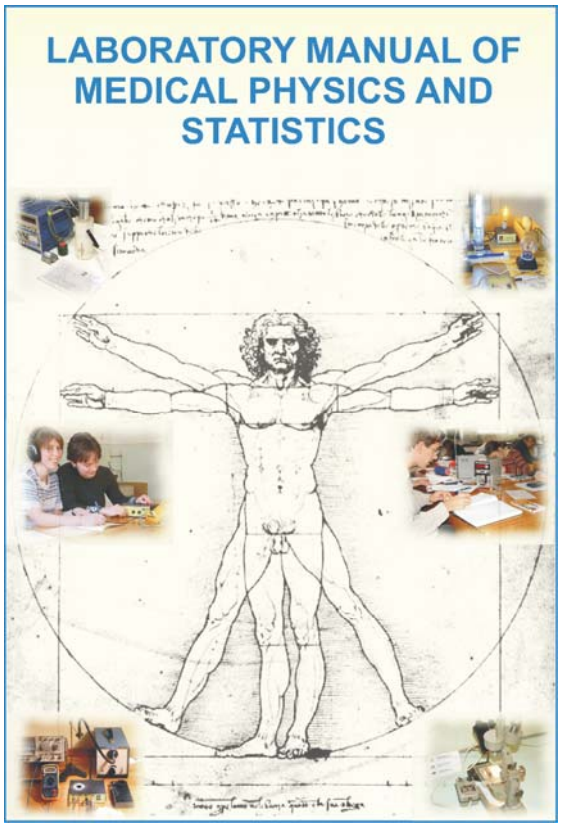
Suggested textbook and manual:
(they are usable for second semester as well)

Medical Biophysics
Editors: Damjanovich Sándor, Fidy Judit, Szöllősi János
Medicina

LABORATORY MANUAL OF MEDICAL PHYSICS AND STATISTICS
Authors: staff of the Institute of Biophysics and Radiation Biology





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Mathematical basis

Need not too much, but…

e.g. log (ab) = ?, log a^b = ?

Simple functions and their graphical representations

e.g. f(x) = ax + b or f(x) = a sin (x – b)

Usage of calculators, calculation with exponents

EE or EXP or $\times 10^x$ and not y^x

How much is the circumference and area of a circle,
or the surface area and volume of a sphere?

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Physical quantities, units, prefixes, orders of magnitude

We need accurate definitions.

e.g.. „radiation" is not a physical quantity, thus we can not speak about its decrease and increase.

Sometimes definition is a simple formula, but it could be a measuring instruction with several conditions (see in 2nd semester e.g. dosimetry).

Notations:

p could be momentum, but pressure or permeability as well.

A numerical data without unit tells nothing.

If the units are known they could help.

e.g. What is the simple connection among
the speed of light (c [m/s]),
its wavelength (λ [m]) and
its frequency (f [1/s])?

~~$c = \lambda/f$~~ , or ~~$c = f/\lambda$~~ , either $\boldsymbol{c = \lambda f}$?

Prefixes: (**you should know**)

10^{-18}	atto	a
10^{-15}	femto	f
10^{-12}	pico	p
10^{-9}	nano	n
10^{-6}	micro	μ
10^{-3}	milli	m
10^{-2}	centi	c
10^{-1}	deci	d
10^{0}		
10^{1}	deka	da
10^{2}	hecto	h
10^{3}	kilo	k
10^{6}	mega	M
10^{9}	giga	G
10^{12}	tera	T
10^{15}	peta	P
10^{18}	exa	E

Order of magnitudes:

e.g. aJ ~ atomic energy
fm ~ size of a nucleus
pm ~ wavelength of x-ray
GW ~ power of the nuclear power plant in Paks

Remark: have to know the Greek letters and their conventional meanings

e.g. $\Delta x = x_2 - x_1$

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Geometrical and wave optics

What is light?

Visible electromagnetic radiation

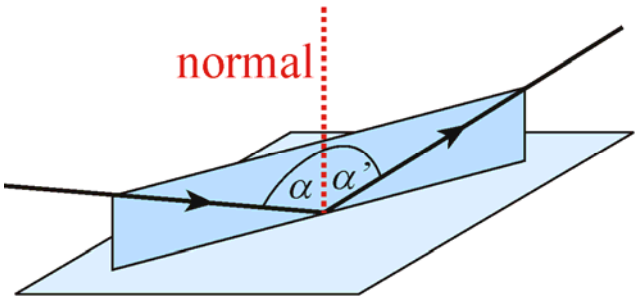
Geometrical optics (model)

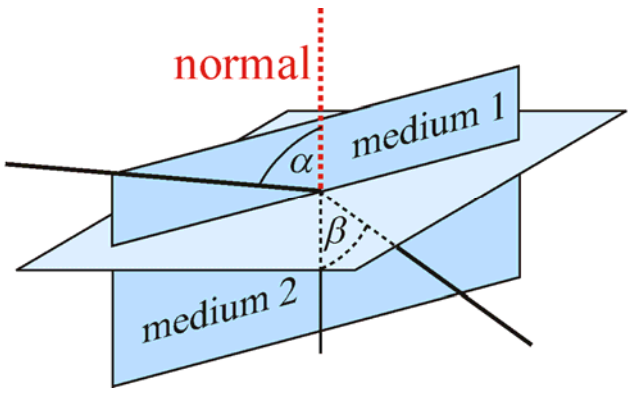
Light-ray: extremely thin parallel light beam

Using this model, the explanation of several optical phenomena can be given as the solution of simple **geometric problems**.

1. law of rectilinear propagation
2. law of reflection
3. law of refraction

2a, 3a) The incident ray, the normal and the reflected ray, or refracted ray lie in the same plane.





2b) $\alpha = \alpha'$

3b) $$\frac{\sin\alpha}{\sin\beta} = \frac{c_1}{c_2} = n_{21} = \frac{n_2}{n_1}$$

$(c_1 > c_2$ thus $n_1 < n_2)$

All the angles are measured from the normal!

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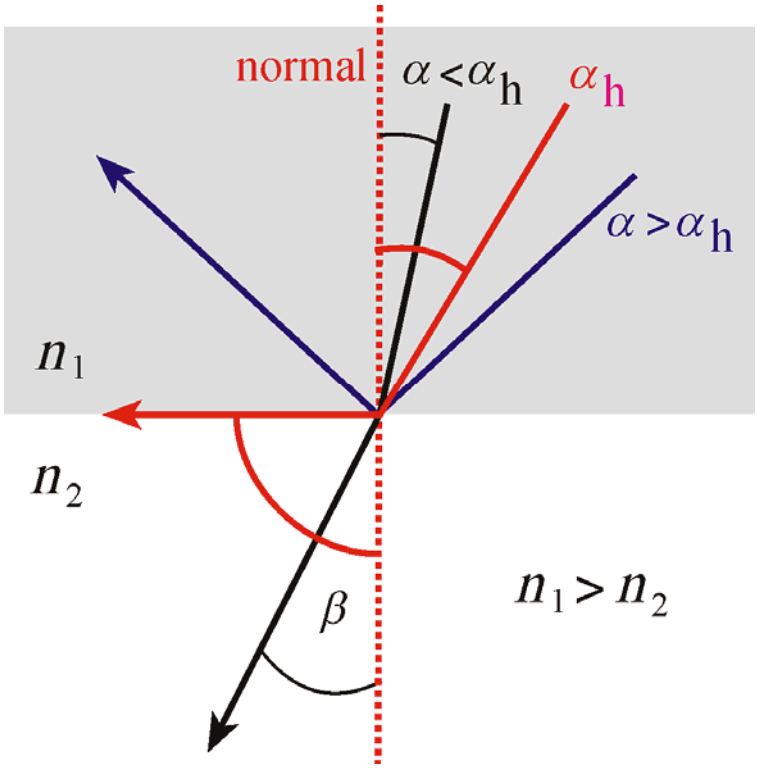
All these laws can be deduced from a single common principle!

Fermat-priciple

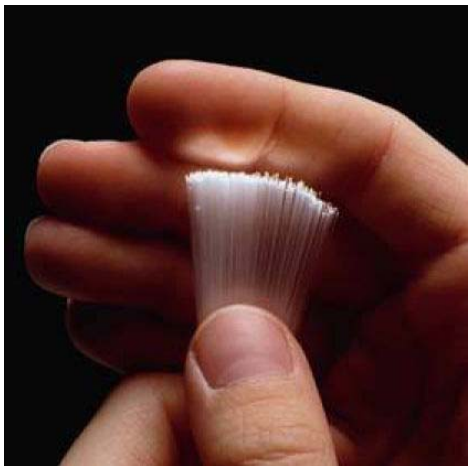
The **'principle of shortest time'**: out of the geometrically possible paths, light will travel along the one that requires the shortest time to pass.

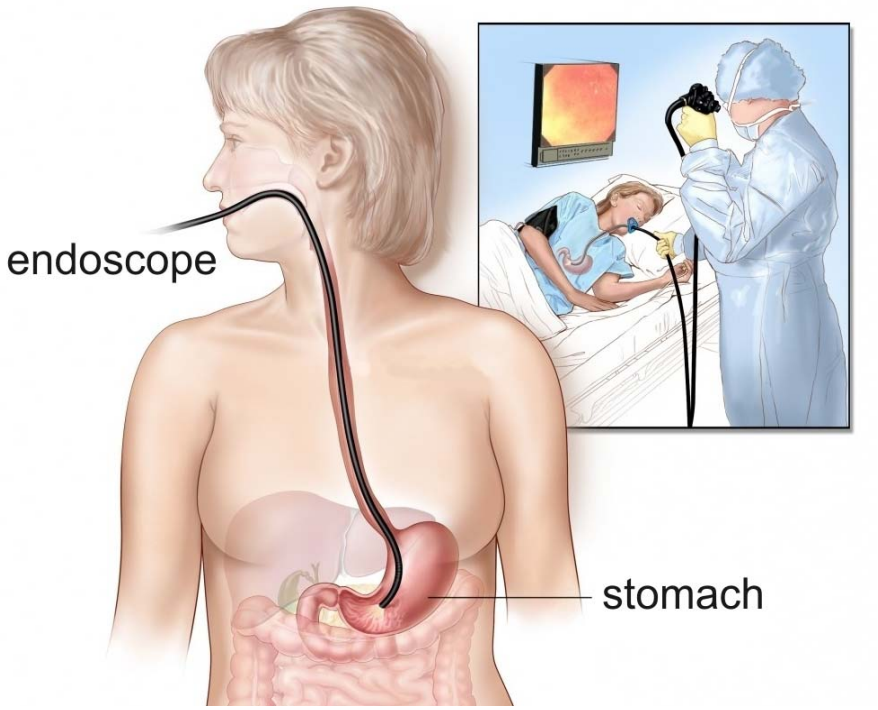
Total reflection
(If $n_1 > n_2$)

$$\frac{\sin \alpha_h}{\sin \frac{\pi}{2}} = \sin \alpha_h = \frac{n_2}{n_1}$$



Application e.g.: Optical fiber (endoscopy)





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