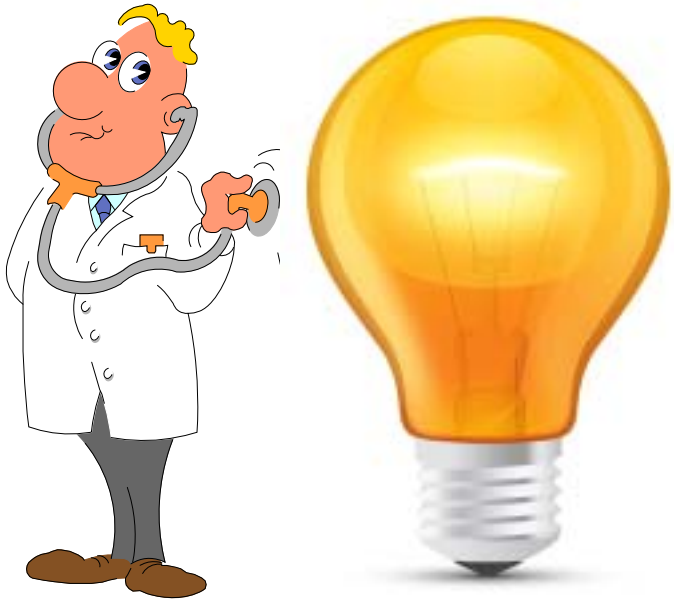
CENTER OF MEDICAL OPTICS AND PHOTONICS

M.Sc.
Medical Photonics



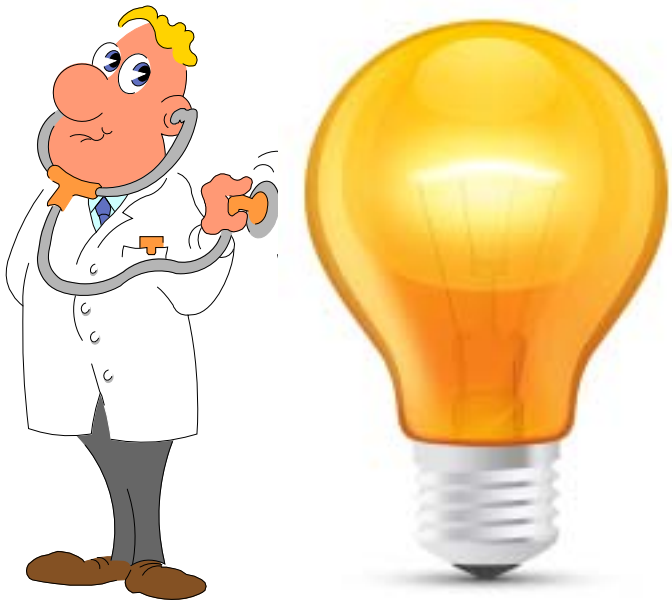
The examination committee

- Chair: Prof. Dr. Christoph Biskup (Medical Faculty)
- Prof. Dr. Rainer Heintzmann (Faculty of Chemistry and Earth Sciences)
- Prof. Dr. Herbert Gross (Faculty of Physics and astronomy)
- apl. Prof. Dr. Michael Schmitt (Faculty of Chemistry and Earth Sciences)
- Students: Moemi Kawashima

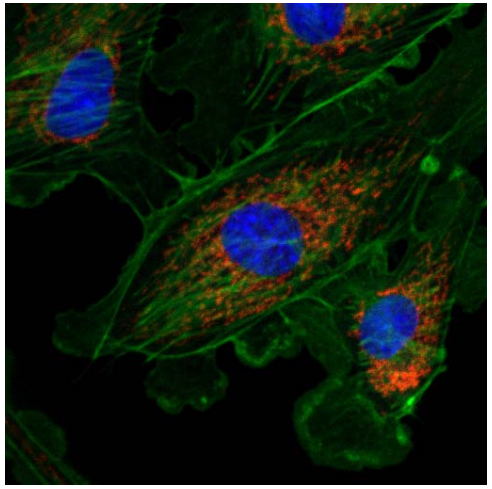
The coordinator

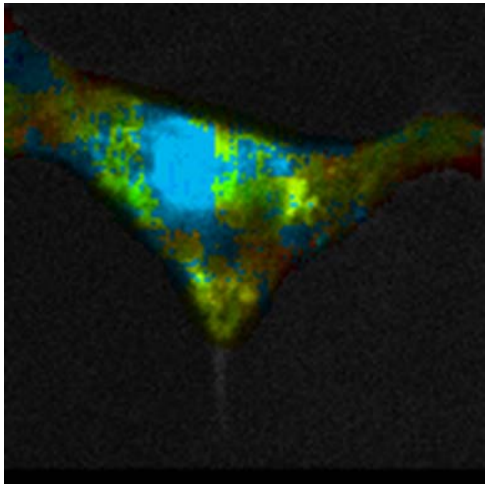
- Dr. Holger Babovsky

Why do we need a M.Sc. Medical Photonics ?



Biomedical Research

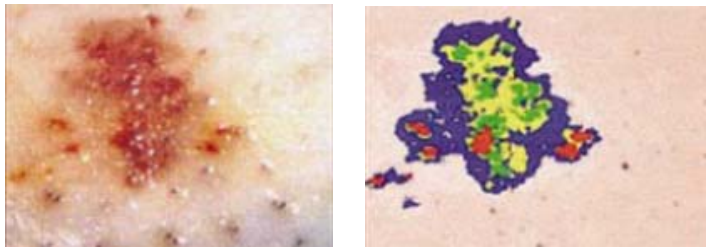




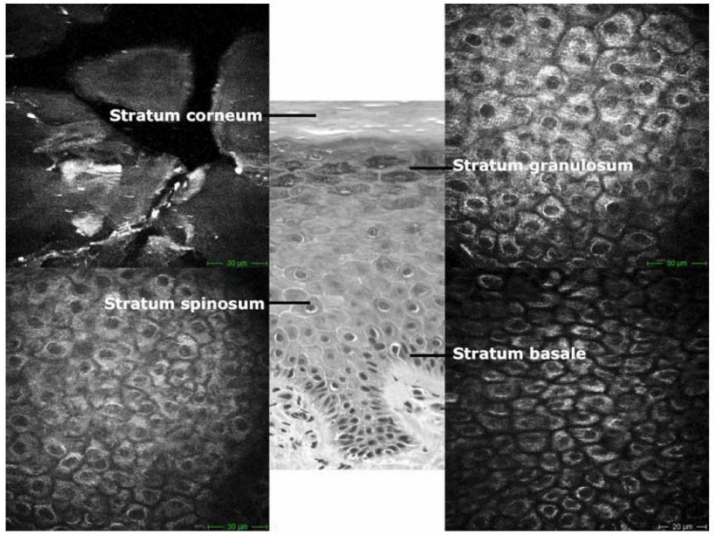
Medical diagnostics

Medical diagnostics

Dermatology



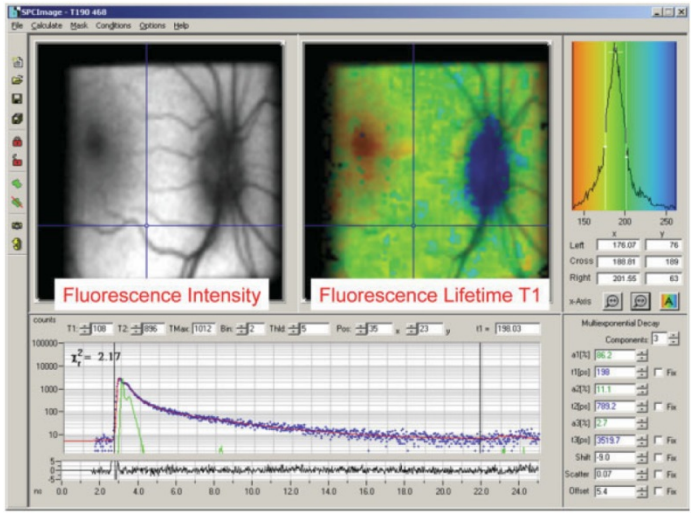
Frakas et al. Pigment Cell Res 14, 2-8 (2002)



Kaatz, Hautarzt 61, 397–409 (2010)

Ophthalmology

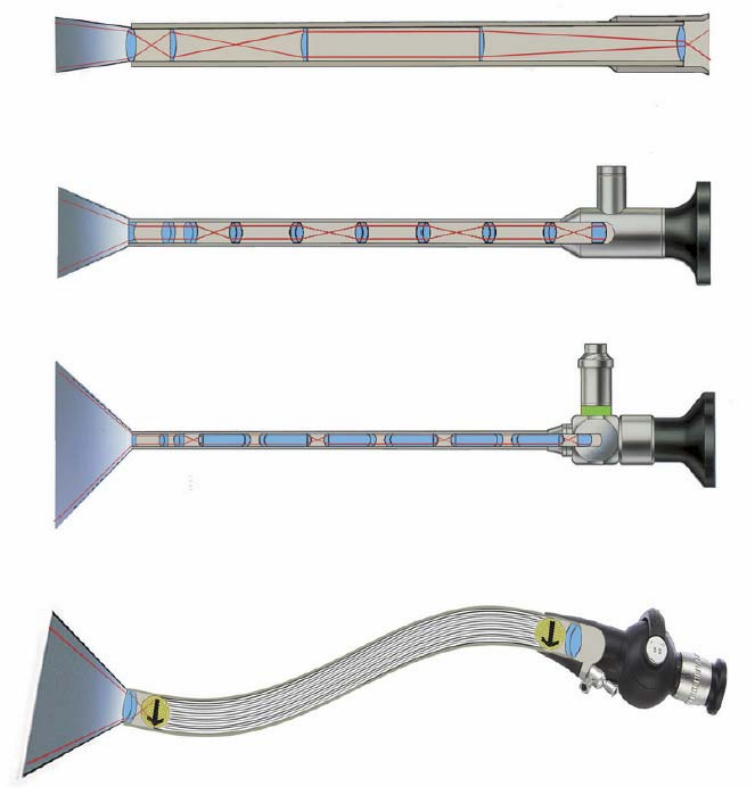
Canadian Neoro-Ophthalmology Group



Schweitzer, Microsc Res Tech 70, 410-419 (2007)

Medical diagnostics

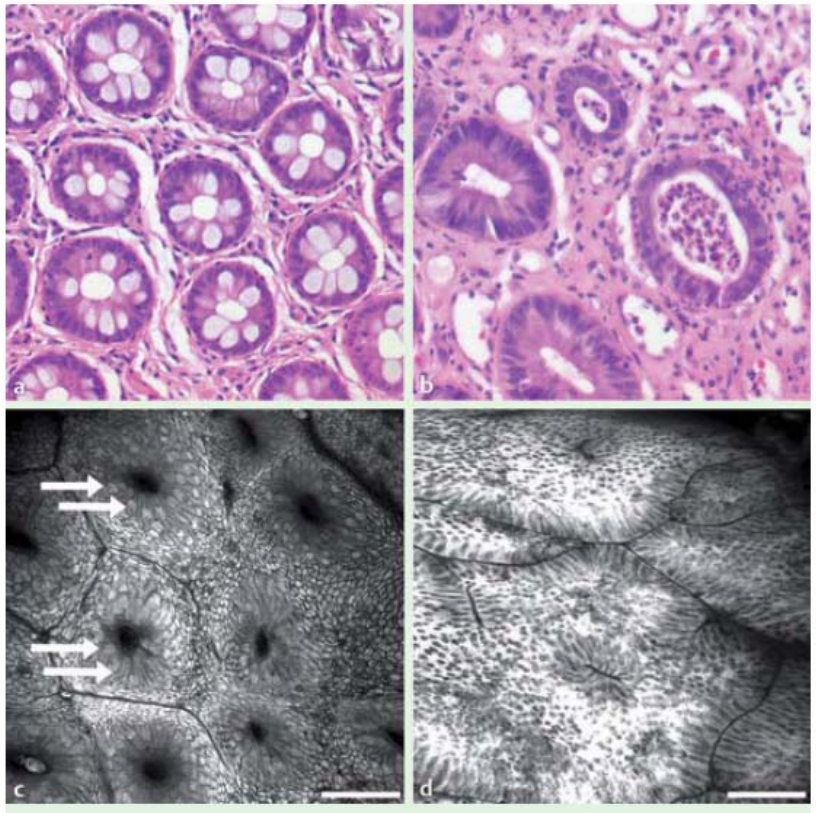
Endoscopy



Gaab, World Neurosurg 79, S14.E11-E21 (2013)

Endomicroscopy

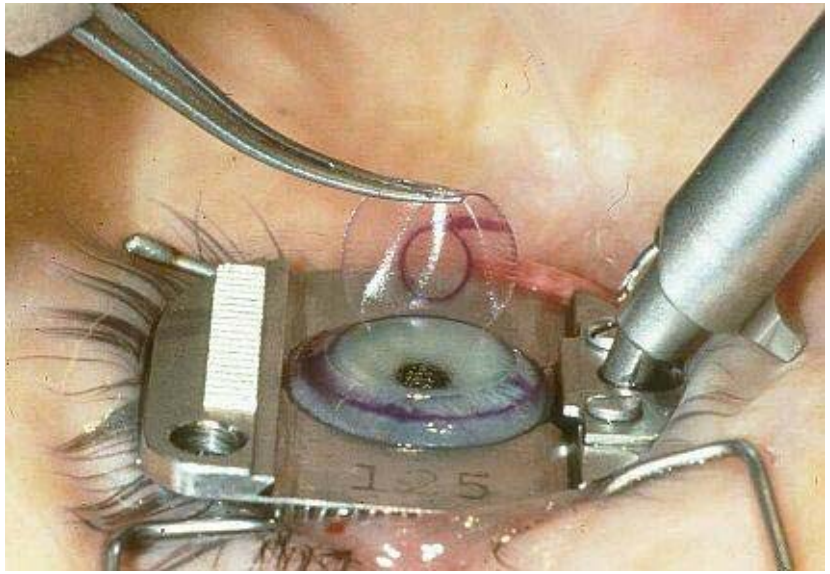
healthy colon | infectious colitis



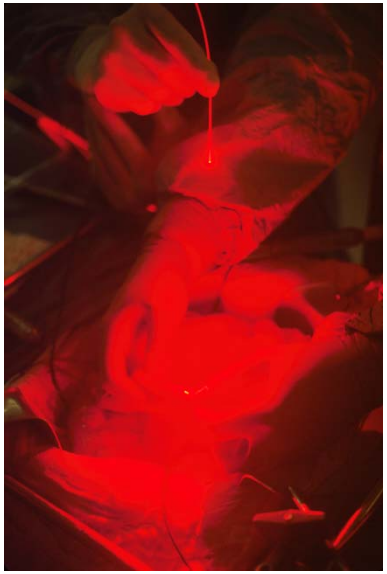
Bojarski et al. Endoscopy 41,433-438 (2009)

Therapy

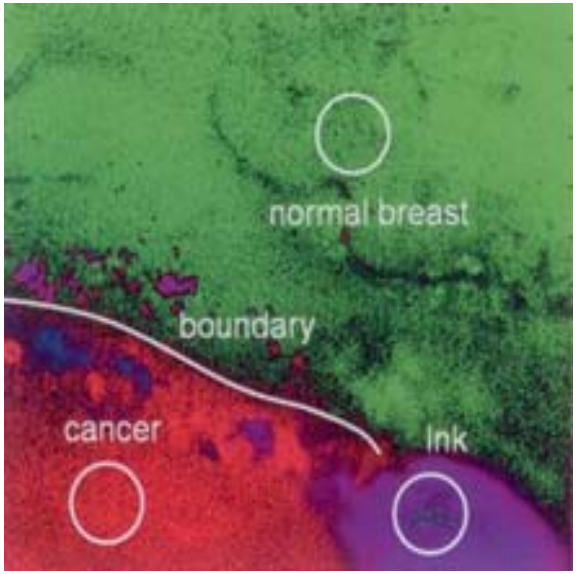
Ophthalmology



Photodynamic Therapy

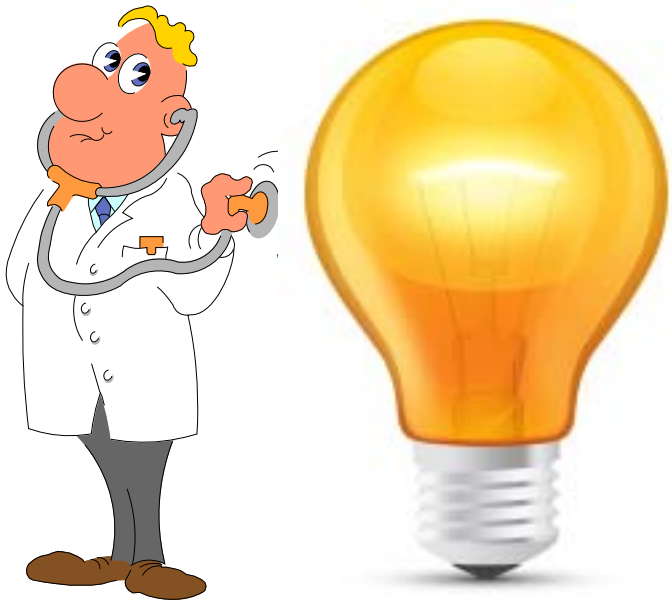


Surgery

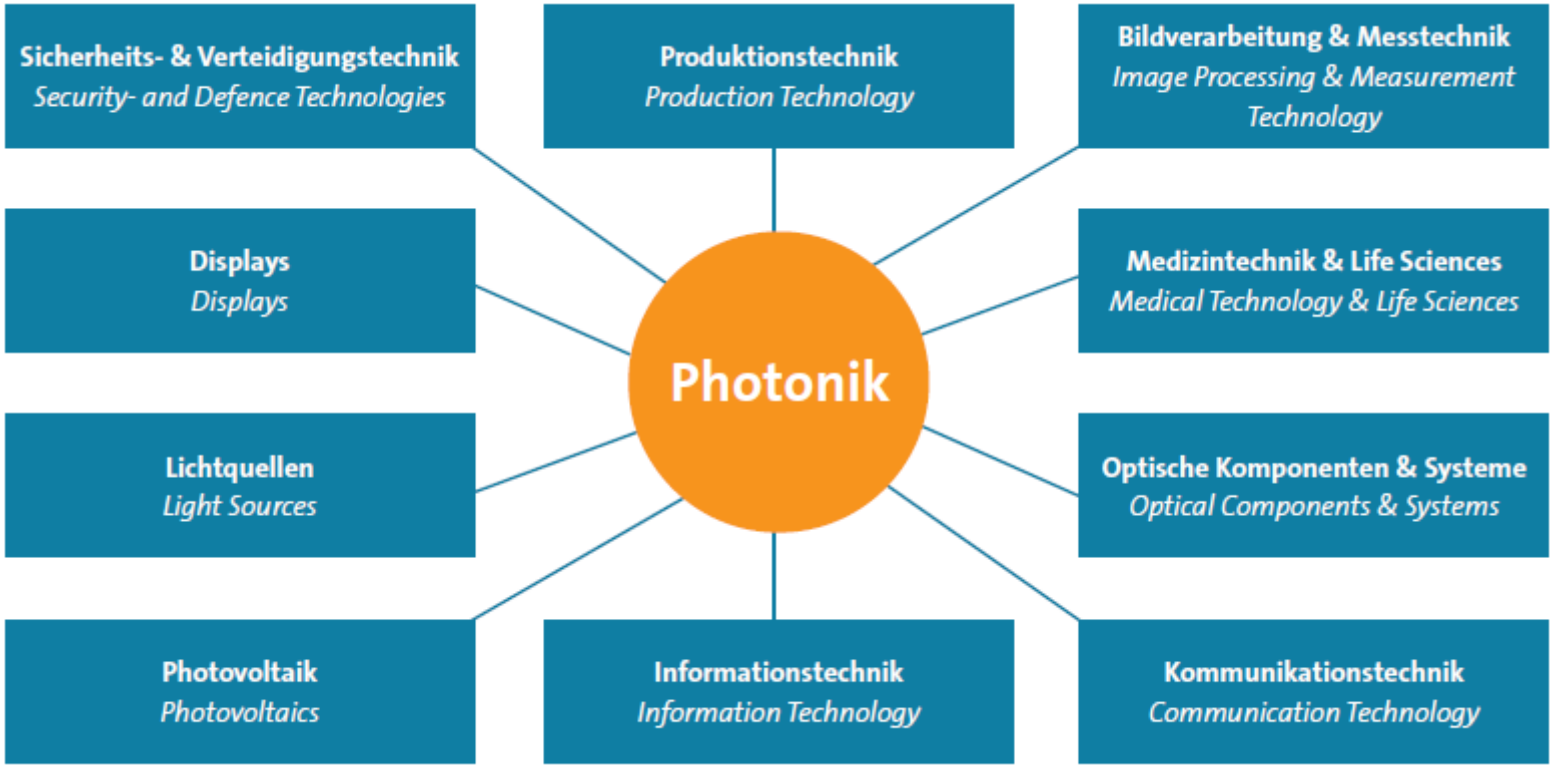


Burton et al.: Spectral optical imaging in biology and medicine.
In: Fujimoto, Farkas: Biomedical Optical Imaging, Oxford University Press, Oxford, New York 2009, S.29-72

Field of work + career opportunities



Career opportunities

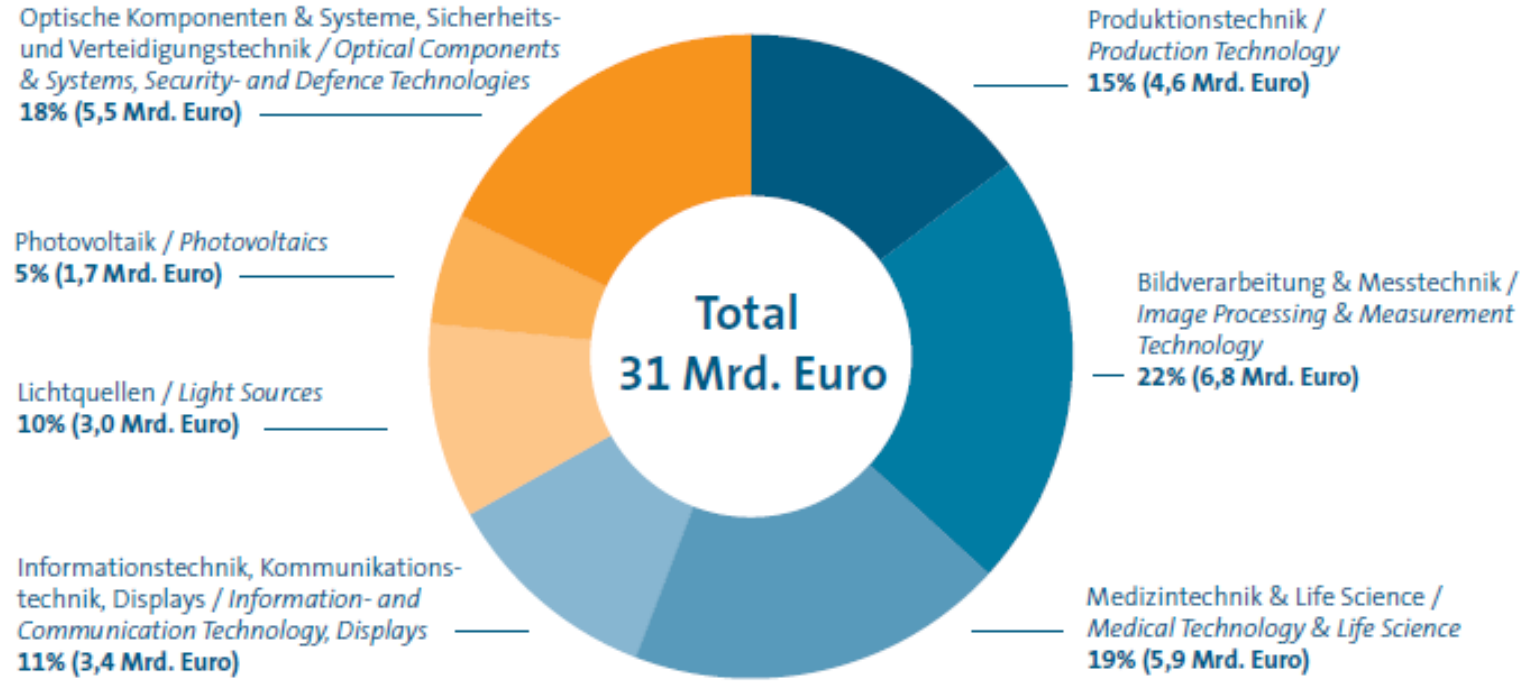


Career opportunities in research

"Optics and photonics" is one of the core research areas of the Friedrich-Schiller-University Jena, of the Jena University Hospital and extramural research institutions.

Career opportunities in the industry

Photonik Inlandsproduktion Deutschland 2016
Domestic Photonics Production Germany 2016

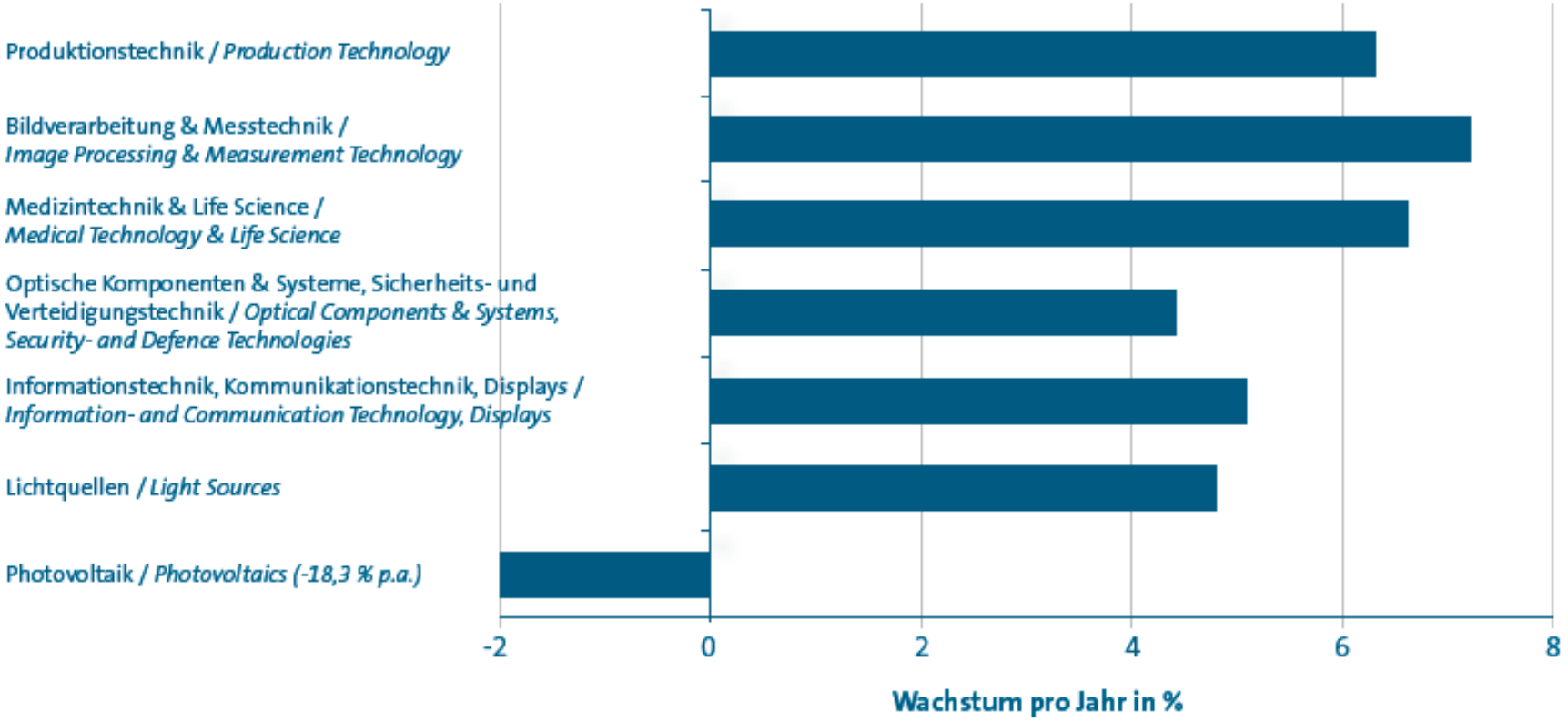


Quelle/*Source*: OPTECH CONSULTING, 2017

Career opportunities in the industry

Inlandsproduktion Photonik Deutschland / *Domestic Production Germany*

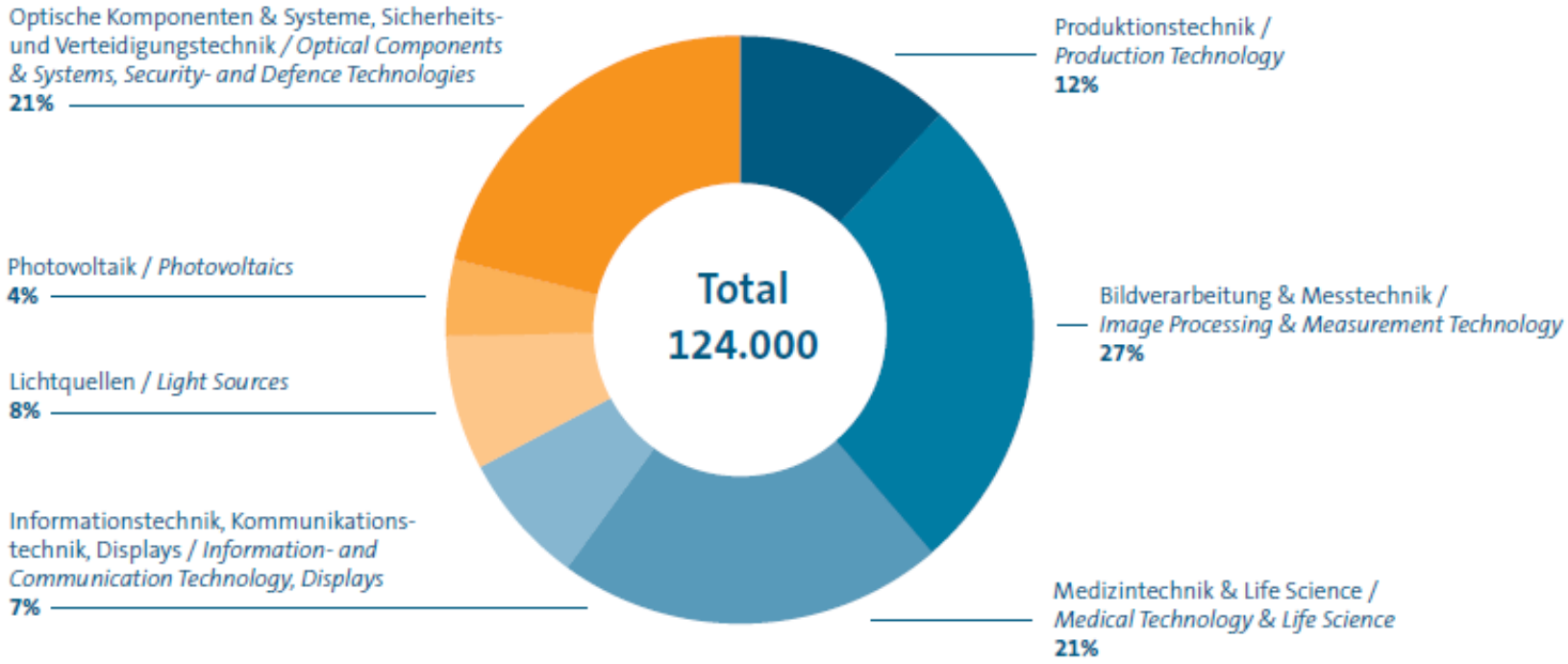
Durchschnittliches jährliches Wachstum 2011 bis 2016 / *Compound annual growth of domestic production 2011 to 2016*



Quelle/*Source*: OPTECH CONSULTING, 2017

Career opportunities in the industry

Beschäftigte in der Photonik-Industrie in Deutschland 2016 (ohne Zulieferer)
Employees in the photonics industry in Germany 2016 (excluding suppliers)



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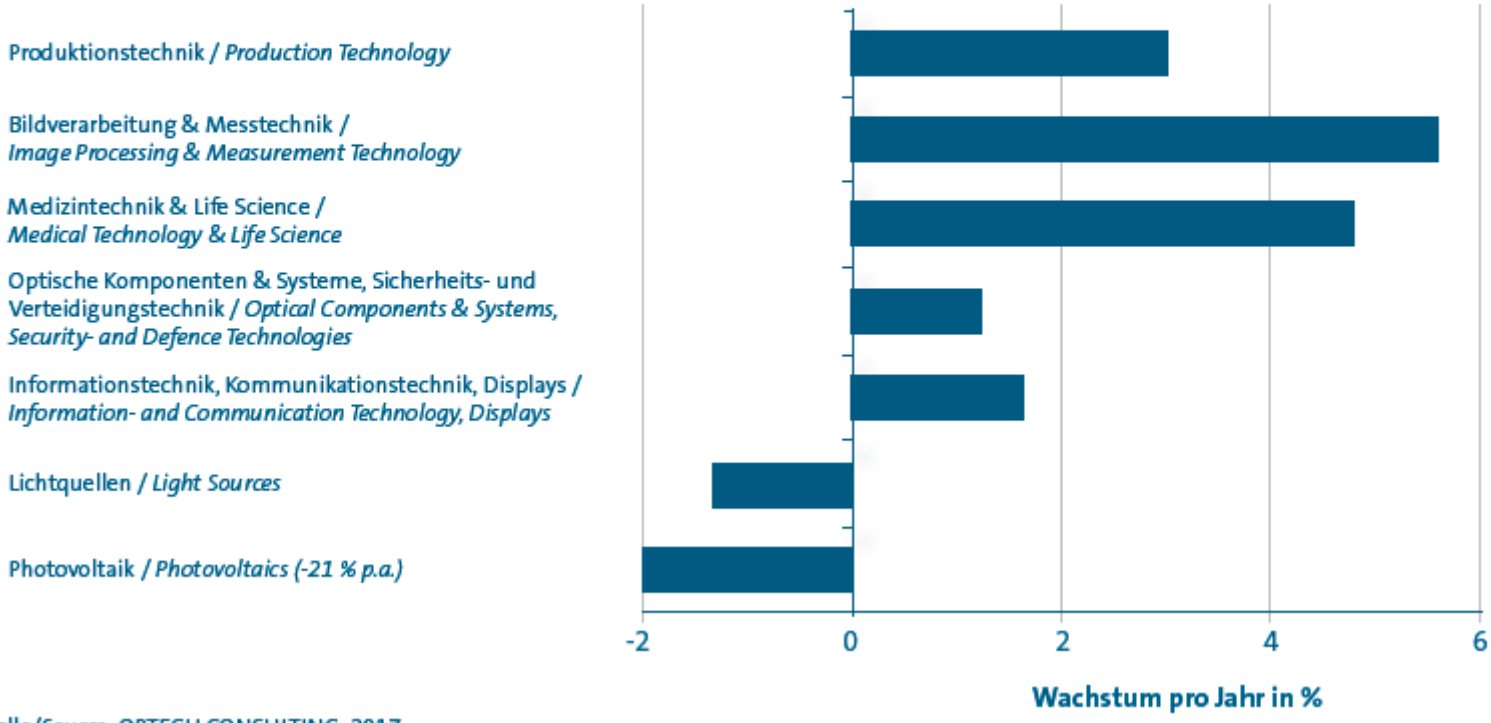
Career opportunities in the industry

Beschäftigung in der Photonik-Industrie in Deutschland (ohne Zulieferer)
Employment in the photonics industry in Germany (excluding suppliers)

Durschnittliches jährliches Wachstum 2011 bis 2016 / *Compound annual growth 2011 to 2016*



Quelle/*Source*: OPTECH CONSULTING, 2017

Admitted students in this Master's Programme

- B.Sc. Physics
- B.Sc. Chemistry
- Medical Doctors
- B.Sc. Biology, B.Sc. Biochemistry , B.Sc. Biomedicine, B.Sc. Biotechnology
- Pharmacy
- B.Sc. Electrical Engineering

1st semester Adjustment & Fundamentals	30 CP	2nd semester Adjustment & Fundamentals	30 CP	3rd semester Specialization & Research	30 CP	4th semester Research	30 CP

Adjustment — 16 CP

Mathematical Methods Precourse (3 weeks)	A0.1	
Introduction to Chemistry Precourse (3 weeks)	A0.2	
Mathematical Methods (M/C) 2L +2E	A1.1 4 CP	
Physical Optics (M/C) 2L + 1E	A1.2 4 CP	Optical Engineering (M/C) 2L + 1E — A2.1, 4 CP
Physical Chemistry (M/P) 4L + 2E	A1.3 8 CP	Light Matter Interaction (M/P) 2L + 1E — A2.2, 4 CP
Human Biology I (C/P) 4L + 2E	A1.4 8 CP	Human Biology II (C/P) 2L + 1E — A2.3, 4 CP

Legend for compulsory modules:
M = course is compulsory for students having a bachelor degree in biological sciences or having completed the basic studies in medicine
C = course is compulsory for students having a bachelor degree in chemical sciences
P = course is compulsory for students having a bachelor degree in physical sciences

Fundamentals — 8 CP / 8 CP

Image Processing I (M/C/P) 2L + 1E	F1.1 4 CP	Image Processing II (M/C/P) 2L + 1E — F2.1, 4 CP
Biomedical Imaging I (M/C/P) 2L + 1E	F1.2 4 CP	Biomedical Statistics (M/C/P) 2L + 2E — F2.2, 4 CP

Specialization — 8 CP / 12 CP

Basic techniques		Specialization towards microscopy	
Advanced mathematics 2L + 2E	S2.1 4 CP	Biological microscopy 2L + 1E	S3.1 4 CP
Biomedical Imaging II 2L + 1E	S2.2 4 CP	Single-molecule microscopy 2L + 1E	S3.2 4 CP
Microscopy 2L + 1E	S2.3 4 CP	Electron microscopy 2L + 1E	S3.3 4 CP
Labies (Dyes, Nanoparticles, etc.) 2L	S2.4 4 CP	Nanooptics 2L + 1E	S3.4 4 CP
Lasers in medicine 2L + 1E	S2.5 4 CP	**Specialization towards clinical applications**	
Fiber optics 2L + 1E	S2.6 4 CP	Ophthalmoscopy 2L + 1E	S3.5 4 CP
Image understanding 2L + 1E	S2.7 4 CP	Medical diagnosis and therapy 2L + 1E	S3.6 4 CP
Visual recognition and analysis 1L + 2E	S2.8 4 CP	Theranostics 2L + 1E	S3.7 4 CP
Management of scientific data 2L + 2E	S2.9 4 CP	Biomaterials 2L + 1E	S3.8 4 CP
		Specialization towards spectroscopy / diagnostics	
		Chemometrics 2L + 1E	S3.9 4 CP
		Microspectroscopy 3L	S3.10 4 CP
		Mass Spectrometry Imaging 2L + 1E	S3.11 4 CP
		Optical Sensors, Microfluidics 2L + 1E	S3.12 4 CP

Practical Training

Practical Course	P1 12 CP	Research Labworks	P2 18 CP	Master Thesis	M 30 CP

1st semester	30 CP
Adjustment & Fundamentals	

2nd semester	30 CP
Adjustment & Fundamentals	

Adjustment	16 CP
Mathematical Methods Precourse (3 weeks)	**A0.1**
Introduction to Chemistry Precourse (3 weeks)	**A0.2**
Mathematical Methods (M/C) 2L +2E	**A1.1** 4 CP
Physical Optics (M/C) 2L + 1E	**A1.2** 4 CP
Physical Chemistry (M/P) 4L + 2E	**A1.3** 8 CP
Human Biology I (C/P) 4L + 2E	**A1.4** 8 CP

	8 CP
Optical Engineering (M/C) 2L + 1E	**A2.1** 4 CP
Light Matter Interaction (M/P) 2L + 1E	**A2.2** 4 CP
Human Biology II (C/P) 2L + 1E	**A2.3** 4 CP

Fundamentals	8 CP
Image Processing I (M/C/P) 2L + 1E	**F1.1** 4 CP
Biomedical Imaging I (M/C/P) 2L + 1E	**F1.2** 4 CP

	8 CP
Image Processing II (M/C/P) 2L + 1E	**F2.1** 4 CP
Biomedical Statistics (M/C/P) 2L + 2E	**F2.2** 4 CP

2nd semester Adjustment & Fundamentals	30 CP

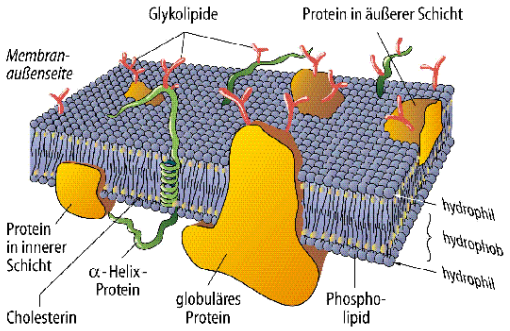
3rd semester Specialization & Research	30 CP

Specialization	8 CP
Basic techniques	
Advanced mathematics 2L + 1E	S2.1 4 CP
Biomedical Imaging II 2L + 1E	S2.2 4 CP
Microscopy 2L + 1E	S2.3 4 CP
Lables (Dyes, Nanoparticles, etc.) 2L + 1E	S2.4 4 CP
Lasers in medicine 2L + 1E	S2.5 4 CP
Fiber optics 2L + 1E	S2.6 4 CP
Image understanding 2L + 1E	S2.7 4 CP
Visual recognition and analysis 1L + 2E	S2.8 4 CP
Management of scientific data 2L + 2E	S2.9 4 CP

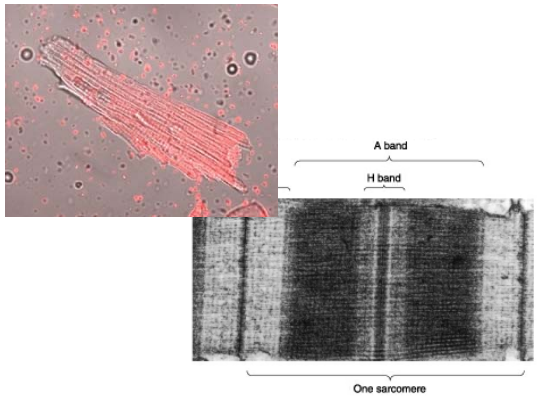
	12 CP
Specialization towards microscopy	
Biological microscopy 2L + 1E	S3.1 4 CP
Single-molecule microscopy 2L + 1E	S3.2 4 CP
Electron microscopy 2L + 1E	S3.3 4 CP
Nanooptics 2L + 1E	S3.4 4 CP
Specialization towards clinical applications	
Ophthalmoscopy 2L + 1E	S3.5 4 CP
Medical diagnosis and therapy 2L + 1E	S3.6 4 CP
Theranostics 2L + 1E	S3.7 4 CP
Biomaterials 2L + 1E	S3.8 4 CP
Specialization towards spectroscopy / diagnostics	
Chemometrics 2L + 1E	S3.9 4 CP
Microspectroscopy 2L + 1E	S3.10 4 CP
Mass Spectrometry Imaging 2L + 1E	S3.11 4 CP
Optical Sensors, Microfluidics 2L + 1E	S3.12 4 CP

Knowledge needed by physicists and chemists

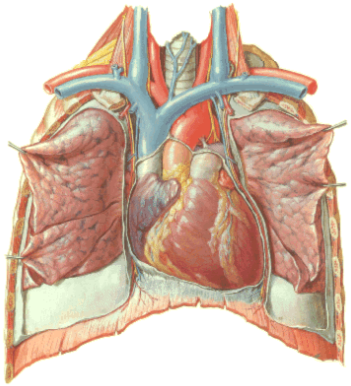
Cell biology



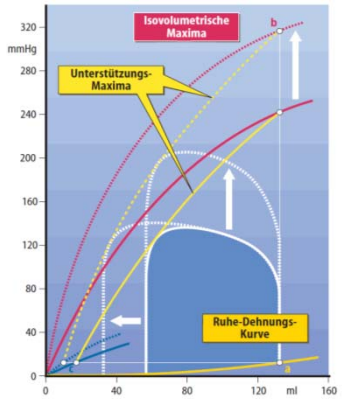
Histology



Macroscopic Anatomy

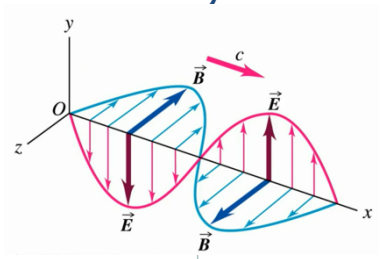


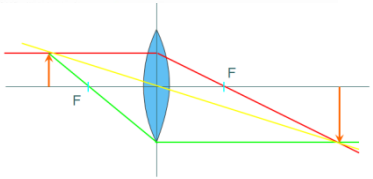
Physiology



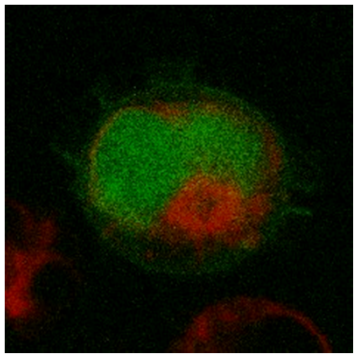
Knowledge needed by biologists

Physics

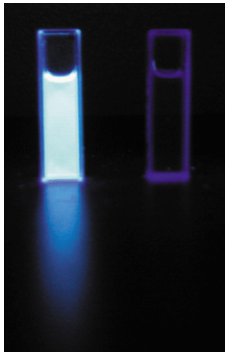


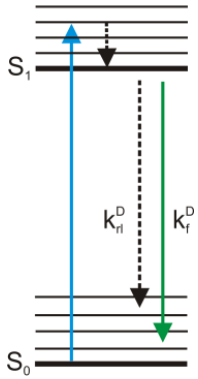


Programming + Image Processing



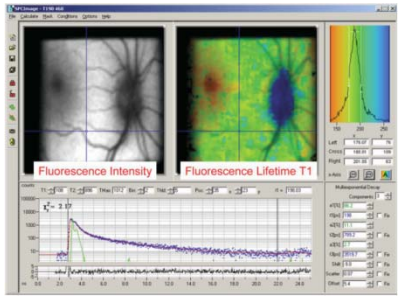
Physical Chemistry





Data analysis + Statistics

$$P_i(y_i \mid y_o(x_i)) = \frac{1}{\sigma_i\sqrt{2\pi}} \exp\left(-\frac{1}{2}\left(\frac{y_i - y_o(x_i)}{\sigma_i}\right)^2\right)$$



1st semester	30 CP
Adjustment & Fundamentals	

2nd semester	30 CP
Adjustment & Fundamentals	

Adjustment	16 CP
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Human Biology I (C/P) 4L + 2E	**A1.4** 8 CP

	8 CP
Optical Engineering (M/C) 2L + 1E	**A2.1** 4 CP
Light Matter Interaction (M/P) 2L + 1E	**A2.2** 4 CP
Human Biology II (C/P) 2L + 1E	**A2.3** 4 CP

Fundamentals	8 CP
Image Processing I (M/C/P) 2L + 1E	**F1.1** 4 CP
Biomedical Imaging I (M/C/P) 2L + 1E	**F1.2** 4 CP

	8 CP
Image Processing II (M/C/P) 2L + 1E	**F2.1** 4 CP
Biomedical Statistics (M/C/P) 2L + 2E	**F2.2** 4 CP

Participants in this Master's Programme

- B.Sc. Physics → Physical Chemistry + Human Biology
- B.Sc. Chemistry → Mathematical Methods + Physical Optics + Human Biology
- Medical Doctors → Mathematical Methods + Physical Optics + Physical Chemistry
- B.Sc. Biology, B.Sc. Biochemistry → Mathematical Methods + Physical Optics + Physical Chemistry + Human Biology (recommended, but not mandatory)
- B.Sc. Biotechnology, B.Sc. Biomedicine, Pharmacy, B.Sc. Electrical Engineering → Mathematical Methods + Physical Optics + Physical Chemistry + Human Biology

Some advices

Never regard study as duty but as an enviable opportunity to learn.

Albert Einstein

Study hard what interests you the most in the most undisciplined, irreverent and original manner possible.

Richard Feynman

Live as if you were to die tomorrow.
Learn as if you were to live forever.

Mahatma Gandhi