

Chemistry 668

# Biophysical Spectroscopy

## Syllabus

- Fall 2017 -

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<b>LECTURES:</b>	8:50 – 9:40 a.m. Mon, Wed, Fri, rm. 2373 Chemistry (typically two lectures/week, often on Mon and Wed, unless otherwise stated). See schedule below for details.
<b>LECTURER:</b>	Prof. Silvia Cavagnero Office: 5351 Chemistry Phone: 262-5430 Email: cavagnero@chem.wisc.edu
<b>OFFICE HOURS:</b>	After class: 9:40 - 10:40 a.m., and by appointment

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**Credits: 2-3:** The variable number of credits provides interested students with the opportunity of earning one extra credit by composing a written report on a biological problem-solving case study using biophysical spectroscopy, due at the end-of-the-semester.

**Textbook:** W.W. Parson “*Modern Optical Spectroscopy with Exercises and Examples from Biophysics and Biochemistry*”, 2<sup>nd</sup> edition, Springer-Verlag, Berlin 2015

**Other Useful Books:**

*Physical Chemistry and Spectroscopic Techniques:*  
I. Tinoco, K. Sauer, J.C. Wang, J.D. Puglisi “*Physical Chemistry, Principles and Applications to Life Sciences*”, Prentice Hall 2002  
D. Sheehan “*Physical-Biochemistry-Principles and Applications*”, 2<sup>nd</sup> ed., Wiley 2008 (ebook)  
I.N. Serdyuk, N.R. Zaccai, J. Zaccai, “*Methods in Molecular Biophysics*”, Cambridge Un. Press, 2007  
C.R. Cantor, P.R. Schimmel “*Biophysical Chemistry, Vol. II “Techniques for the Study of Biological Structure and Function*”, W.H. Freeman 1980

*Fluorescence:*  
J. R. Lakowicz “*Principles of Fluorescence Spectroscopy*”, 3<sup>rd</sup> ed., Springer 2006 (ebook)

*Optics and Microscopy:*  
D.B. Murphy “*Fundamentals of Light Microscopy and Electronic Imaging*”, 2<sup>nd</sup> ed., Wiley-Liss 2013 (ebook)  
Molecular Expression web site:  
<http://micro.magnet.fsu.edu/>, and  
Nikon online tutorials: [www.microscopyu.com](http://www.microscopyu.com)

Single-Molecule Techniques:

YouTube lecture on superresolution microscopy by Xiaowei Zhuang (parts 1 and 2).

NMR Spectroscopy:

G.S. Rule, T.K. Hitchens “*Fundamentals of Protein NMR Spectroscopy*”, Springer 2005

Protein-Protein Interactions:

P. Schuck “*Protein Interactions - Biophysical Approaches for the Study of Complex Reversible Systems*” (vol 5) Springer 2007 (ebook)

General Physical Chemistry:

P. Atkins, J. de Paula “*Physical Chemistry*”, 9<sup>th</sup> Ed., W.H. Freeman, 2009

I. Levine “*Physical Chemistry*”, 6<sup>th</sup> Ed., McGraw-Hill, 2008

D.A. McQuarrie, J.D. Simon “*Physical Chemistry: A Molecular Approach*”, University Science Books, 1997

K.E. van Holde, W.C. Johnson, P.S. Ho “*Physical Biochemistry*”, Prentice Hall, 1998

NOTE: The above books that are available in ebook format can be accessed via the UW-Madison CATALOG at [www.library.wisc.edu](http://www.library.wisc.edu). The other books are on reserve at the Chemistry or Steenbock Library.

**Grading scheme:**

2-credits:      30% attendance and participation to class  
                         30% homeworks and literature assignments  
                         40% oral or poster presentation

3-credits:      30% attendance and participation to class  
                         30% homeworks and literature assignments  
                         20% oral or poster presentation  
                         20% written report

**Poster and oral presentations:**

10 min oral presentations to be delivered to the class either during class or as a Biophysical Spectroscopy poster session. The oral presentations will be in class as outlined in the schedule below. The poster session will be during the last week of classes (see schedule below). Student evaluation will be based on the quality of the slides, ability to integrate spectroscopic insights and problem-solving strategies, oral delivery and effectiveness in answering questions. Please select your favorite presentation delivery style (oral presentation or poster) at the end of the first class.

**Lecture schedule:**

Wed 9-6-17      Introduction to Spectroscopy: choosing the right technique(s) to solve biological problems

*(NOTE: class will be on Wed and Fri this week)*

Fri 9-8-17 Introduction to Spectroscopy: basic principles (foundations of quantum mechanics)

Mon 9-11-17 Introduction to Spectroscopy: basic principles (interaction of light with matter)

*(NOTE: there will be three lectures on Mon, Wed, Fri this week)*

Wed 9-13-17 Introduction to Spectroscopy: basic principles (sensitivity and resolution), and Electronic absorption: basic principles

Fri 9-15-17 Electronic absorption: basic principles and applications

Mon 9-18-17 *No class*

Wed 9-20-17 *No class*

Fri 9-22-17 *No class*

Mon 9-25-17 Electronic absorption: more applications

*(NOTE: there will be three lectures on Mon, Wed, Fri this week)*

Wed 9-27-17 Fluorescence spectroscopy: general principles

Fri 9-29-17 Fluorescence spectroscopy: general principles

Mon 10-2-17 Fluorescence spectroscopy: lifetimes and spectral shifts

Wed 10-4-17 Fluorescence spectroscopy: principles of energy transfer and distance-dependent quenching

Fri 10-6-17 *No class*

Mon 10-9-17 Fluorescence spectroscopy: applications of energy transfer and principles of anisotropy

Wed 10-11-17 Fluorescence spectroscopy: more anisotropy principles and applications

Fri 10-13-17 *No class*

Mon 10-16-17 General principles of microscopy and molecular imaging (Campagnola)

Wed 10-18-17 Single-molecule fluorescence microscopy: wide field illumination, PALM /

FPALM / STORM, TIRF

Fri 10-20-17	<i>No class</i>
Mon 10-23-17	Single-molecule fluorescence microscopy: applications to biology: class discussion based on literature reading
Wed 10-25-17	How do ion channels work? Insights from fluorescence (Chanda)
Fri 10-27-17	<i>No class</i>
Mon 10-30-17	Problem solving using el. absorption and fluorescence: class discussion
Wed 11-1-17	Circular dichroism: principles
Fri 11-3-17	<i>No class</i>
Mon 11-6-17	<i>No class</i>
	<i>(NOTE: class will be on Wed and Fri this week)</i>
Wed 11-8-17	Circular dichroism: applications
Fri 11-10-17	X-ray crystallography: basic principles and applications (Forest)
Mon 11-13-17	X-ray spectro-microscopy: principles and applications (Gilbert)
	<i>(NOTE: there will be three lectures on Mon, Wed, Fri this week)</i>
Wed 11-15-17	Dynamic and static light scattering: principles and applications (Murphy)
Fri 11-17-17	Small angle X-ray scattering (SAXS)
Mon 11-20-17	NMR spectroscopy: basic principles
Wed 11-22-17	<i>No class (Thanksgiving break)</i>
Fri 11-24-17	<i>No class (Thanksgiving break)</i>
Mon 11-27-17	NMR spectroscopy: selected applications
Wed 11-29-17	ESR spectroscopy: basic principles and applications
Fri 12-1-17	<i>No class</i>
Mon 12-4-17	Cutting-edge techniques: single-particle electron microscopy
	<i>(NOTE: there will be three lectures on Mon, Wed, Fri this week)</i>
Wed 12-6-17	Multi-technique approaches to study protein-protein interactions

Fri 12-8-17                      Problem solving in biology using multiple techniques: class discussion

Mon 12-11-17                    Student **oral presentations**

Wed 12-13-17                   Student **oral presentations**

On this day there will also be the student **poster presentations**

(12 - 4 pm, Shain Atrium)

### WRITTEN REPORT DUE DATE

This note is directed to the students taking the course for 3 credits: the **written report** is due on Fri Dec 15 by 9 pm.