# Phys538/Chem538: POLYMER SCIENCE
# Mechanics of plastics, gels, and cells

**TEXTBOOKS:**
*Fundamentals of Polymer Science, An Introductory Text*, P.C. Painter and M.M Coleman, 2nd ed. (CRC Press, 1997) **(required)**
*Mechanics of the Cell*, D. Boal (Cambridge University Press) **(optional)**
*Physical Biology of the Cell*, Rob Phillips, Jane Kondev, and Julie Theriot (Taylor and Francis, inc) **(optional)**

**TIME AND PLACE:**
Spring 2016, TTh 17.30-18.45 room 147 (Physics building)

**PREREQUISITES:**
(Chemistry 200 or 202) and credit or concurrent registration in (Physics 360 or Chemistry 400B or Mechanical Eng. 350 or Mechanical Eng. 352).

**INSTRUCTOR:**
Prof. Arlette Baljon, room 136 (Physics building) abaljon@mail.sdsu.edu.
Office hours: Th 14.00- 16.00 or by appointment.

**GRADING:**
Computational project (20%), Tests (28%/40%), Quiz 12%(1.5 point each/drop one).
Scale: A: 85% B: 75% C: 65% D: 55% partial grades given.

**COURSE OUTLINE:**

**Introduction and polymer synthesis**
- What is polymer science?
- Basic definitions
- Step-growth and chain polymerization
- Kinetics of polymerization
- Statistics of polymerization

**Microstructure**
- Conformations and configurations of polymer chains
- Random walks and random flights
- Polymer morphology
- Gelation and percolation

**Crystallization, melting and the glass transition**

- Review of basic thermodynamics
- Some statistical mechanics
- The crystalline melting temperature
- Kinetics of polymer crystallization: nucleation
- The glass transition.

**Thermodynamics of polymer solutions and blends**

- Polymer excluded volume
- The free energy of mixing
- Flory-Huggins theory
- Phase separation
- Theta solvents

**Mechanical and rheological properties**

- Stress-strain behavior
- Viscosity of polymer melts
- Viscoelasticity: some simple models
- Relaxation in polymers
- Time-temperature superposition principle

**Physical properties of Biopolymers**

- Elasticity, entropy, and bending energy of biopolymer
- Helix and coil formation
- DNA and RNA
- PRC and electrophoresis

**Molecular motors**

- The cytoskeleton
- Molecular motor proteins: myosin and kinesin
- Thermal ratchets
- Growth through dynamic instability
- Treadmilling

| **Week of:** | **Tuesday** | **Thursday** |
|---|---|---|
| Jan 21 | | Lecture Chap 1 Painter |
| Jan 26/28 | No class | Lecture Chap 2 Painter |
| Febr 2/4 | Lecture Chap 3 (A-B), Chap 4 (A-C) Painter | Problem session 1: read Painter Chap 1 and Chap 2 (till page 47), 3 (A-B), Chap 4 (A-C). |
| Febr 9/11 | Lecture Chap 4 (E)/7 Painter | Lecture Chap 7/8 Painter |
| Febr 16/18 | Problem session 2: read | Lecture Chap 8 Painter |

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| | Painter Chap 4 (E), 7 | |
| Febr 23/25 | Test I: Painter Chaps. 1, 2 (till page 47), 3(A-B), 4 (A,B,C,E), 7 and material from problem sessions 1-2 | Lecture Chap 8 Painter |
| March 1/3 | No class | Lecture Chap 8/9 Painter |
| March 8/10 | Lecture Chap 9 Painter | Lecture Chap 9/10 Painter |
| March 15/17 | Lecture Chap 11 Painter | Problem session 3: read Painter Chap 8, 9, 10 (A-B) |
| March 22/24 | Lecture Chap 11 Painter | Lecture Chap 11 Painter/Review oral presentation skills. |
| April 5/7 | Problem session 4: read Painter Chap. 11 (A-F) | Lect Biopolymers |
| April 12/14 | No class: Lect Biolpolymers online | No class: Lect Biopolymers online |
| April 19/21 | No class: Lect Biopolymers online | No class: Lect Biopolymers online |
| April 26/28 | Test II: Painter Chaps. 8, 9,10 (A-B),11 (A-F) and material from problem sessions 3-4 | Lect Biopolymers |
| May 3/5 | Presentations | Presentations |
| May 12 4:30-6:30 | Presentations (instead of final) | |
| May 16 | | Test III Biopolymers (take home) …..submission by email allowed. |

Note that there is no class on Jan 26 and March 1: instead I will meet with each of you individually during the week of April 4 to discuss the final presentation.

**Presentations:**

Each student has to give a 7-8 min (PPT) presentation on a topic related to the class material. Students should pay attention to oral presentation skills and review what they have been taught in lower division. Handouts will be available on Bb and in late March there will be brief discussion in class. All students will meet with the instructor for about 10 min during the week of April 5 to discuss the topic selection. Please think it over during the break and come with suggestions!

**Student learning outcomes:**

Polymer Science is an interdisciplinary field in which chemists, physicists, engineers, and biologists closely collaborate. It is a relative young field, actively explored in cutting edge 21th century research. Upon completion of the course students should be able to:

1) Describe the **basic properties of polymers**: both at rest and under stress.
2) Apply this understanding to analyze the properties of **polymers in the human body** (e.g. DNA and proteins).

3) Select the appropriate strategies and content knowledge **to solve (textbook and real-world) problems**.
4) Thereby sharing their own views based on their disciplinary background while working in **interdisciplinary teams** with students from other backgrounds (Physics, Chemistry, Engineering).
5) Research a topic related to the class content and present it to the other students, keeping in mind the **oral presentation skills** learned as a lower division student.