CH 431: INORGANIC CHEMISTRY

Prof. Emily Que
Welch 1.316
Tues, Thurs 11:00am-12:15 pm
UT-Austin Fall 2016

More detailed course info will be made available throughout the semester on the Piazza site
https://piazza.com/utexas/fall2016/ch431/home

Syllabus

CHEMISTRY 431
INORGANIC CHEMISTRY
Fall 2016

Lecture schedule: TTh, 11:00 am-12:30 pm Welch 1.316

Instructor: Prof. Emily Que, emilyque@cm.utexas.edu, Welch 4.314

Office hours: Tuesday 12:30-1:30 pm, Thursday 4:30-5:30 pm or by appointment.

Teaching assistants:

Spencer Kerns	spencer.kerns@utexas.edu
Kanchan Aggarwal	kanchan.uta@utexas.edu
José Enriquez	jsenriquez@utexas.edu
Rahul Kadakia	rkadakia@utexas.edu

TA office hours in Welch 2.306:
Th 12:30-1:30 pm
Mon TBD
Wed 5-6 pm
Friday 4-5 pm

Laboratory: Welch 5.140

Monday 2-5 pm	50615, Spencer Kerns
Monday 6-9 pm	50635, Spencer Kerns
Tuesday 2-5 pm	50620, Kanchan Aggarwal
Tuesday 6-9 pm	50640, Kanchan Aggarwal
Wednesday 9-12 pm	50605, Rahul Kadakia
Wednesday 2-5 pm	50625, José Enriquez
Thursday 2-5 pm	50630, José Enriquez
Friday 1-4 pm	50610, Rahul Kadakia

Syllabus

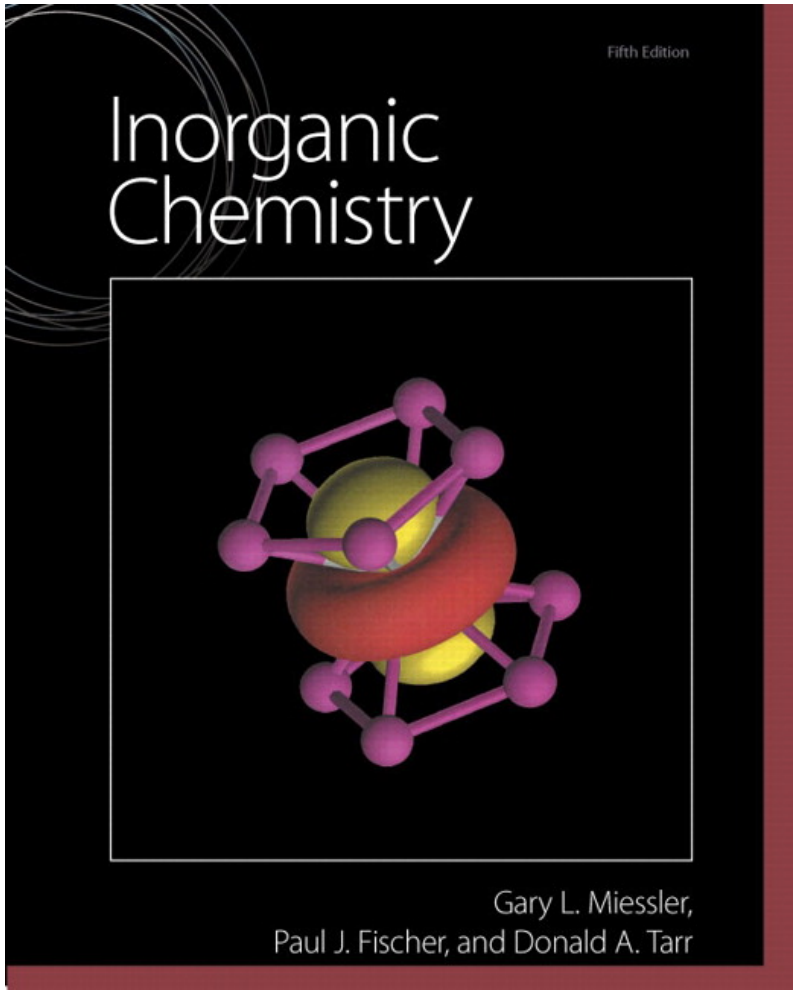
- **Attendance Policy:** Lecture attendance is strongly encouraged, as notes provided on the Piazza site may not fully recapitulate the material discussed in class.

- ***You are required to attend, on time your assigned laboratory period.*** Tardiness and absences will affect your laboratory grade as detailed in the Laboratory Manual available on Piazza.
  - The beginning of each laboratory session will include essential info about the experiment including introductory material and SAFETY considerations. Missing this portion of the lab session is unacceptable. Please respect your TAs and classmates and show up on time.

Syllabus

- **Textbook**: Miessler, Fischer, and Tarr "Inorganic Chemistry" 5th edition.
  - Older versions of this text may be used, but understand that there may be differences between the versions.
  - Suggested reading and problem sets will be posted to Piazza
- **Molecular Model Kit:**
  - The specified kit is good for inorganic and organic chemistry ($23)

https://www.amazon.com/Molymod-MMS-009-Molecular-Inorganic-Chemistry/dp/B005RUTZ8Q/ref=sr_1_1?ie=UTF8&qid=1471718230&sr=8-1&keywords=molymod+inorganic+organic+student+set



Syllabus

- **Supplemental resources:**
  - Other inorganic text books (Housecroft and Sharpe, Shriver and Atkins)
  - CH301 and CH302 websites!!!
    - https://ch301.cm.utexas.edu/
    - https://ch302.cm.utexas.edu/
  - Chemistry Wiki courtesy of UC Davis
    - http://chem.libretexts.org/Core/Inorganic_Chemistry

Syllabus

- **Webpage and Email Policy**
- We will be using Piazza for the main course website and online class discussion: https://piazza.com/utexas/fall2016/ch431/home

- *If you have questions regarding course material or logistics, submit them to the course website and not to me via personal email. I consider such questions to be public and will ask you to repost them to Piazza so that your colleagues can benefit from the discussion. Please check the website regularly! Announcements relevant to exams and other course logistics will be posted as well as periodic class polls.*

- Private emails: please include CH431 in the subject line

- *Canvas will be used, but only for quizzes and grades.*

Syllabus

- **Lecture Notes:**
  - Lecture notes will be a combination of PowerPoint and handwritten notes displayed using the document camera. PowerPoint notes will typically be uploaded prior to lecture to facilitate your note taking. Document camera notes will be uploaded after lecture. Periodically, I will post a summary that identifies the key concepts of the material covered in class. Context for understanding these notes is critical and I encourage you to take your own notes during class to supplement these materials.

- *I also encourage you to ask questions during class.* If you are having trouble understanding a concept, then I can guarantee that you're not the only one in the room with that question.

Syllabus

- **Homework problems:**
- Suggested homework problems from MFT and supplementary problem sets will be posted on the Piazza site.
- It is your responsibility to keep up with the material using these problems as a guide to test your understanding, however we will not be grading homework questions.

Syllabus

- **Grades**: Your grades will be based on performance in both the lecture and laboratory portions of the course.
- Online quizzes: 10% of total grade
- 2 Midterm exams, 15% of total grade each, (30% of total grade)
- Final exam 25% of total grade
- Lab (35% of total grade): Your lab grade will comprise 30% of your total grade. This grade will come from pre-labs, lab reports and a final project.

Syllabus

- **Online quizzes**:

- 10 online quizzes will be administered to assess your understanding of the material. They will be posted on Fridays and due the following Wednesday. Quiz feedback will be given at the beginning of class each Thursday.

- These will be administered on the course **Canvas** site.
- https://utexas.instructure.com/courses/1172966

- Quiz due dates: 7-Sep, 12-Sep, 21-Sep
  5-Oct, 12-Oct, 19-Oct, 26-Oct
  9-Nov, 16-Nov, 30-Nov

Syllabus

- **Midterm 1 date**: Tuesday, September 27, in lecture.
- **Midterm 2 date:** Tuesday November 1, in lecture.
- **Final exam date**: Monday, December 12, 2:00-5:00 pm

- We will hold two evening review sessions prior to each exam to help you prepare. Scheduling to be determined.

Syllabus

- **Laboratory:** More detailed information will be given to you during lab check-in (Aug 29-Sep 2)

  - **Lab reports and Final Project:** Lab reports will be due at the beginning of your lab section one week after an experiment is completed. Lab report expectations are covered in your laboratory manual and will be further explained by your TA. A Final Project at the end of the semester will consist of a short PowerPoint presentation on a special topic of interest related to Inorganic Chemistry. Details to follow.

Syllabus

- Starting rubric for assignment of course grade:
  - A ≥ 90
  - A- ≥ 85
  - B+ ≥ 80
  - B ≥ 75
  - B- ≥ 70
  - C+ ≥ 65
  - C ≥ 60
  - C- ≥ 55
  - D ≥ 45
  - F < 45
- This rubric is subject to change, any changes will be in favor of better grades.

Preliminary lecture schedule

Week	Date	Quiz?	Lecture Topics	MFT
1	25-Aug		Syllabus, introduction	Ch 1
2	30-Aug 1-Sep		Atomic structure and bonding	Ch 2,3
3	6-Sep 8-Sep	due 7-Sep	Symmetry and Group Theory	Ch 4
4	13-Sep 15-Sep	due 12-Sep		
5	20-Sep 22-Sep	due 21-Sep	Review for Midterm 1	
6	**27-Sep**	**Midterm 1**		
	29-Sep		Molecular Orbital Theory	Ch 5
7	4-Oct 6-Oct	due 5-Oct		
8	11-Oct 13-Oct	due 12-Oct	Coordination chemistry: structures and bonding	Ch 9,10,11
9	18-Oct 20-Oct	due 19-Oct		
10	25-Oct 27-Oct	due 26-Oct	Review for Midterm 2	
11	**1-Nov**	**Midterm 2**		

11	3-Nov		Reactions of Coordination complexes	Ch 12
12	8-Nov 10-Nov	due 9-Nov		
13	15-Nov 17-Nov	due 16-Nov	Organometallic Chemistry	Ch 13,14
14	22-Nov			
	24-Nov	Thanksgiving, no class		
15	29-Nov 1-Dec	due 30-Nov	Bioinorganic Chemistry	Ch 16
			Review for Final	
Finals week	**12-Dec**	**Final 2:00-5:00 pm**		

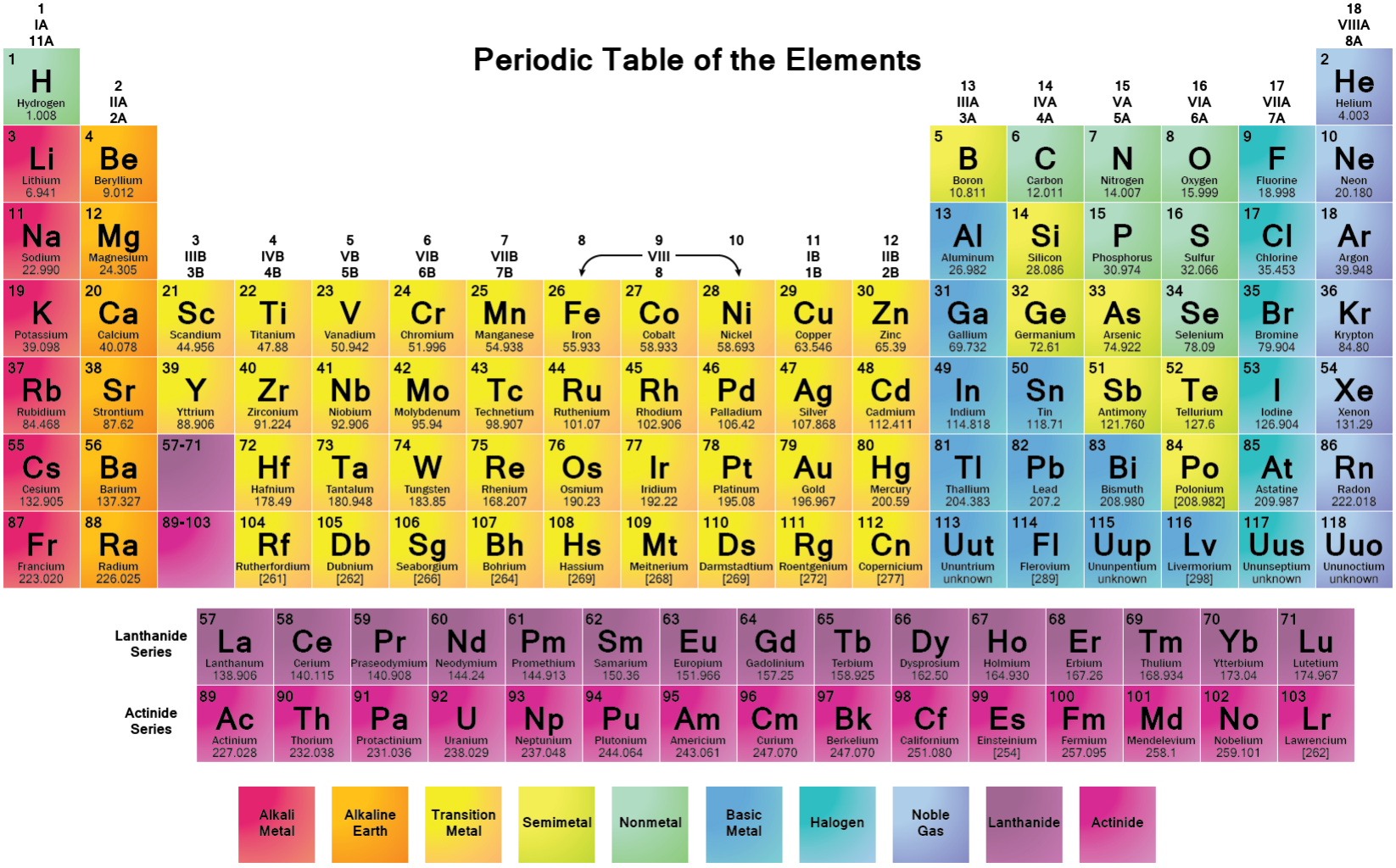
Essentially three major sections:
Fundamentals of structure and bonding
Chemistry of coordination compounds
Applications of coordination compounds

Laboratory Schedule

See lab manual and Piazza site for more specific details for each section.

Week	Dates	Activity
1	24-Aug - 26-Aug	No lab
2	29-Aug - 2-Sep	Lab check-in, pre-lab and lab report expectations
3	5-Sep - 9-Sep	At home activity: how to search the scientific literature using SciFinder
4	12-Sep - 16-Sep	Thermochromism lab
5,6	19-Sep - 23-Sep 26-Sep - 30-Sep	Symmetry lab
7	3-Oct - 7-Oct	Electron paramagnetic resonance lab
8	10-Oct - 14-Oct	Cobalt Crystal field theory lab
9,10, 11,12	17-Oct - 21-Oct 24-Oct - 28-Oct 31-Oct - 4-Nov 7-Nov - 11-Nov	Ferrocene lab Molybdenum lab (see lab manual for specific lab schedule for each section)
14	21-Nov - 25-Nov	No lab, Thanksgiving
15	28-Nov - 2-Dec	Final project presentations

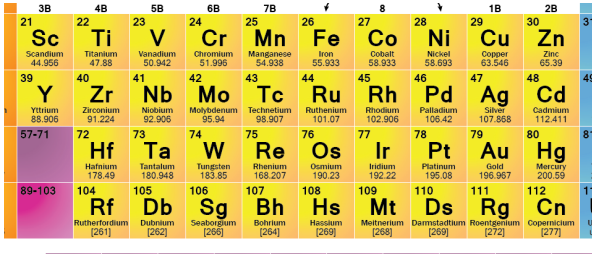
WHAT IS INORGANIC CHEMISTRY?



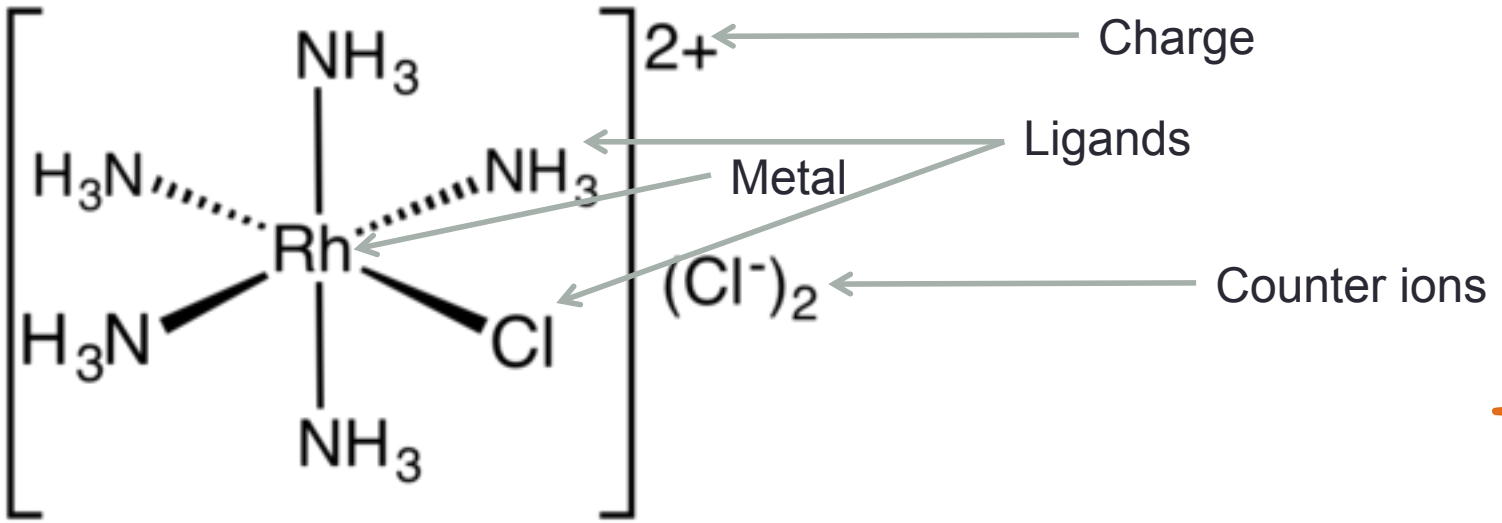
Inorganic chemistry encompasses the entire periodic table.
This course will mainly focus on the chemistry of transition metals

Some basic terminology

- This class will *mainly* focus on the chemistry of transition metals (d-block elements!)



- Transition metal ions can form bonds with other species to form coordination complexes (think Lewis acid-Lewis base interaction)



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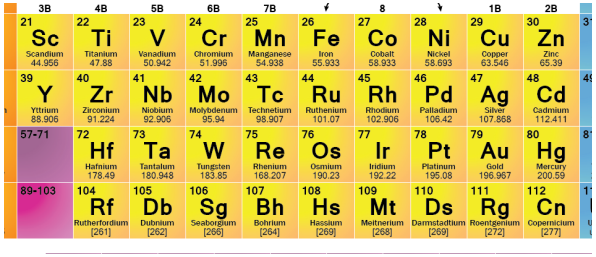

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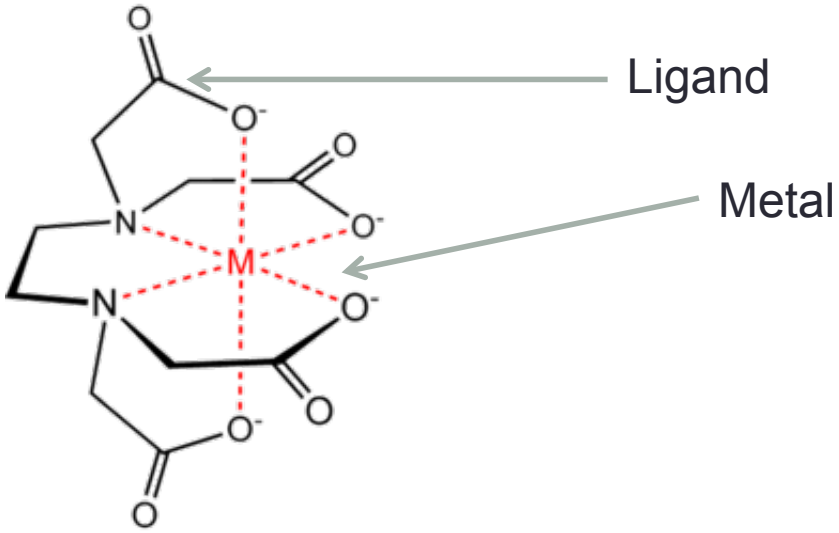
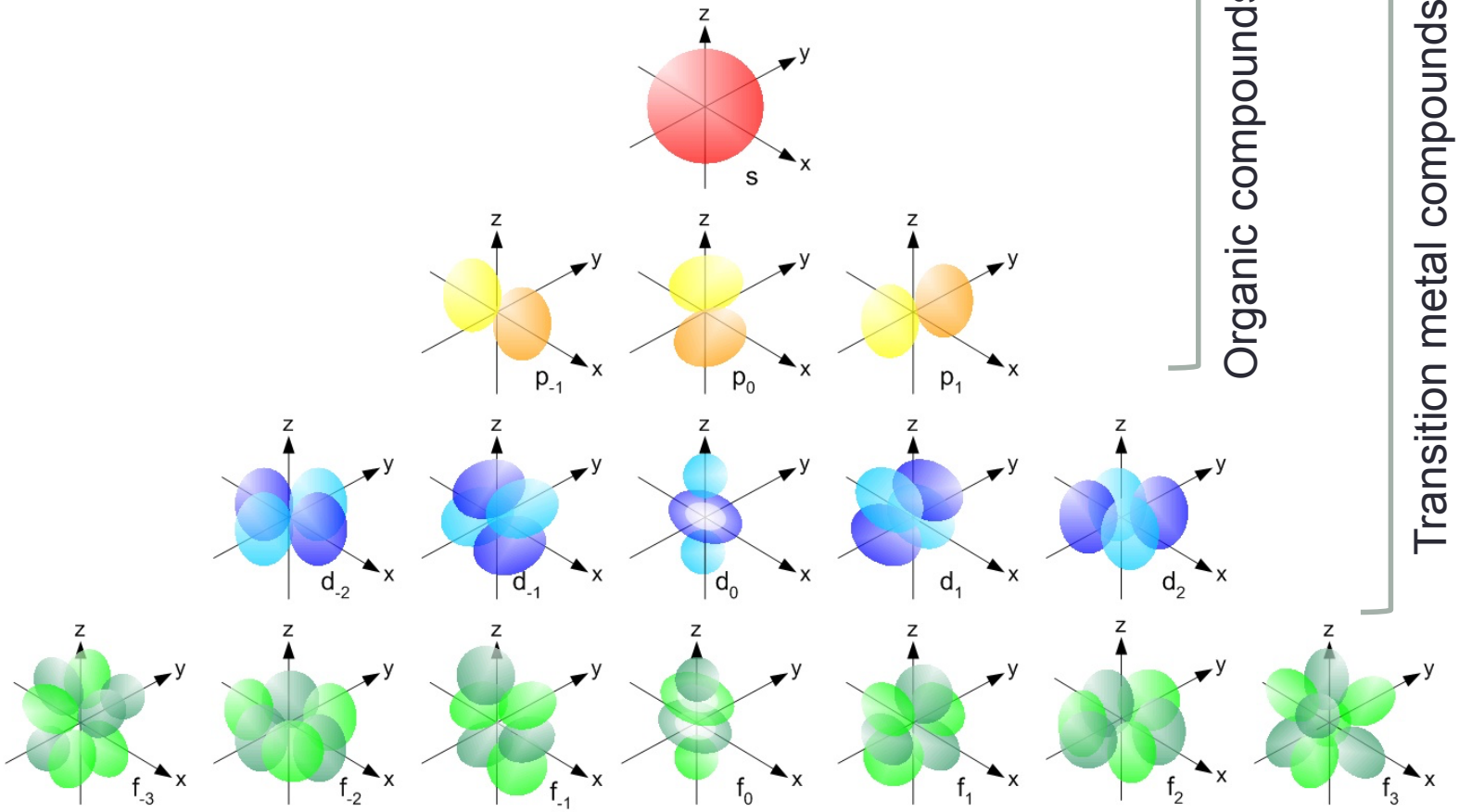


COMPARISON OF INORGANIC AND ORGANIC CHEMISTRY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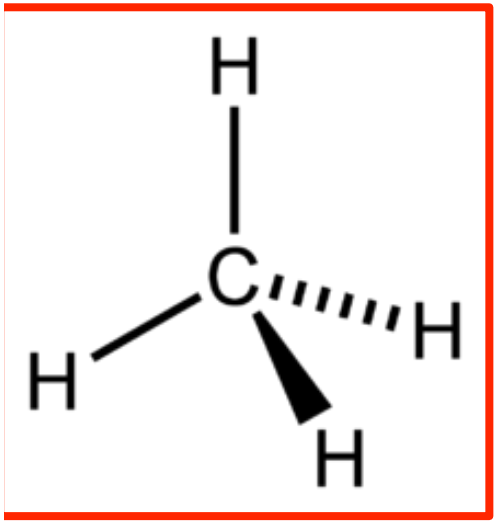
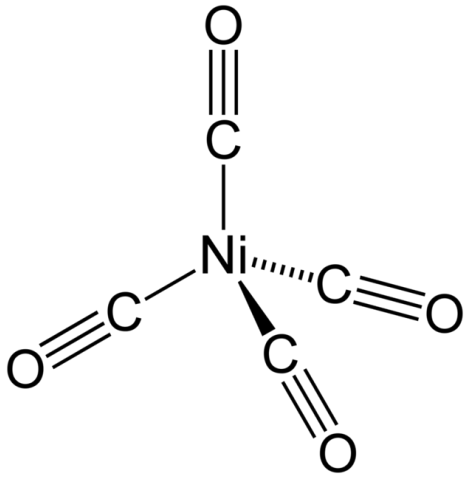
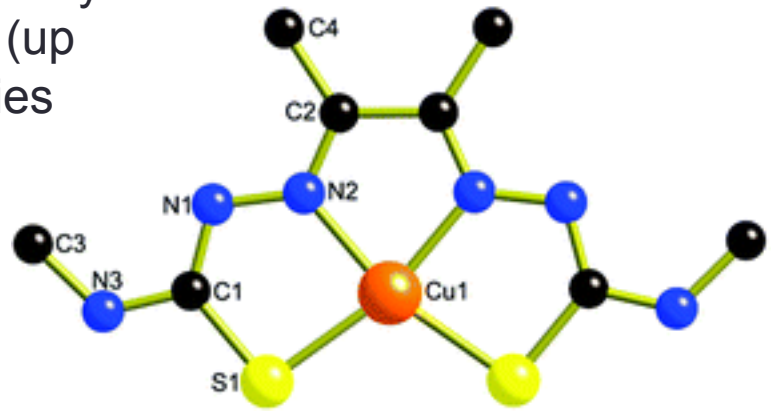
Organic compounds
Transition metal compounds
Lanthanide and actinide compounds



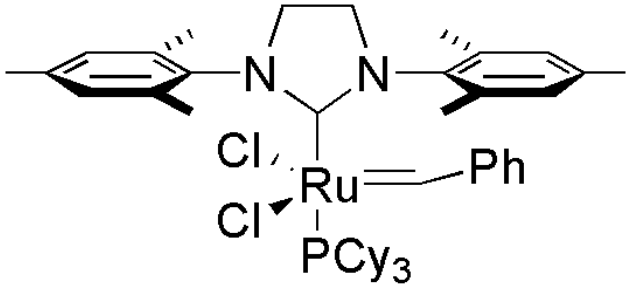
Organic chemistry:
C with max 4 bonds

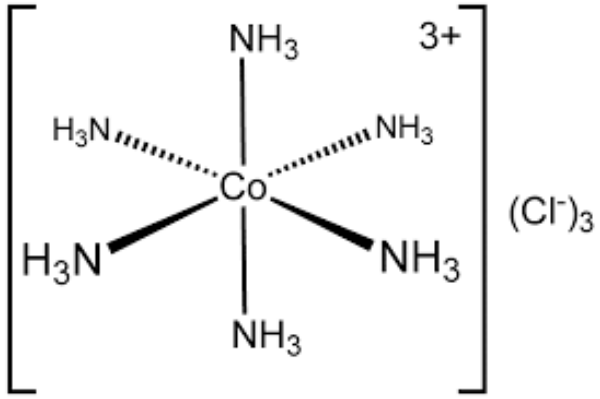
Inorganic chemistry: a variety of coordination numbers (up to 9 or 10!) and geometries

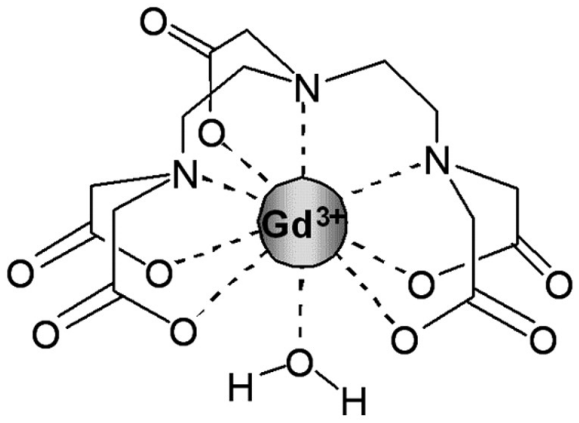




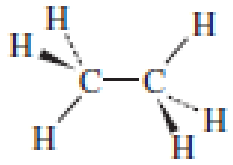
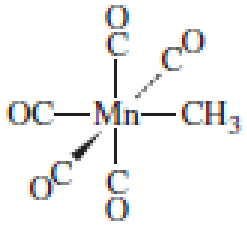
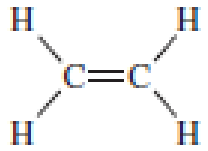
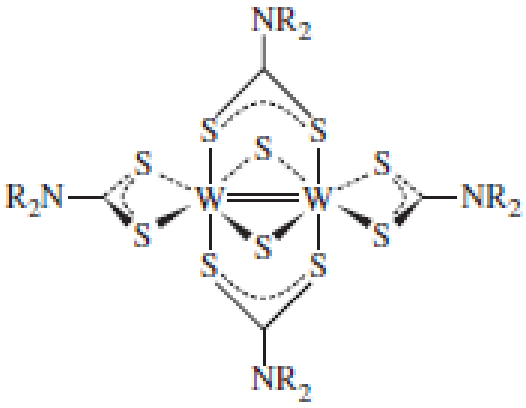
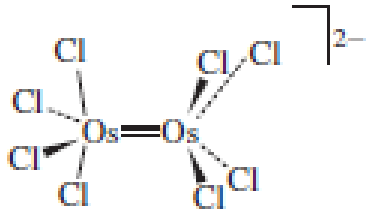
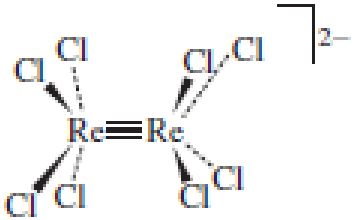
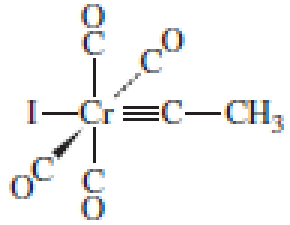
$Cu^{II}(atsm)$







$GdDTPA(H_2O)^{2-}$

Organic	Inorganic	Organometallic
	F—F	
	O=O	
	N≡N	
		

Three-dimensional perception helps!

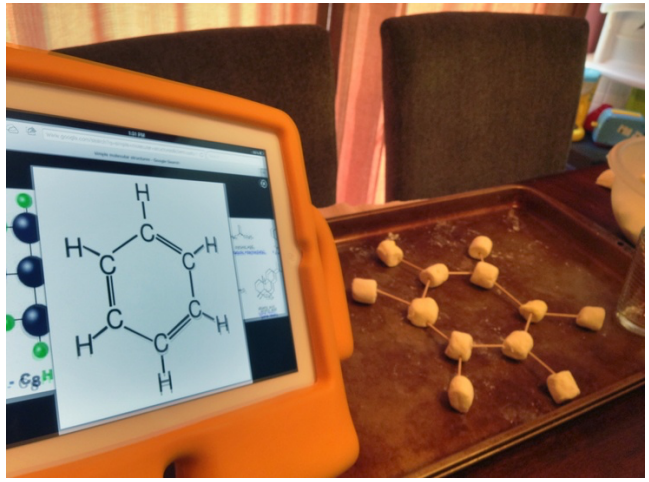
- Use online tools (such as

http://symmetry.otterbein.edu/gallery/index.html

- Use molecular model kits!!!

https://www.amazon.com/Molymod-MMS-009-Molecular-Inorganic-Chemistry/dp/B005RUTZ8Q

- Or creative alternatives



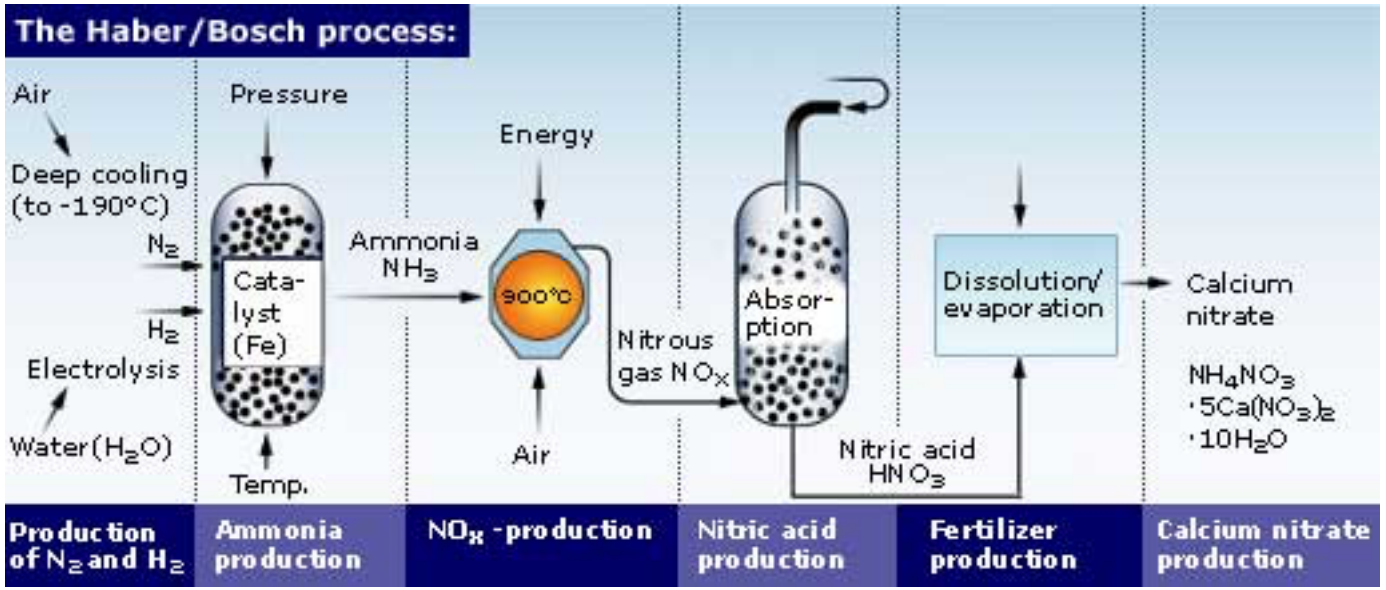
INORGANIC CHEMISTRY IS EVERYWHERE

Haber Bosch Process

- Industrial process that uses an **Fe-based inorganic catalyst** to promote the following reaction:

$$3H_2 + N_2 \rightarrow 2NH_3$$

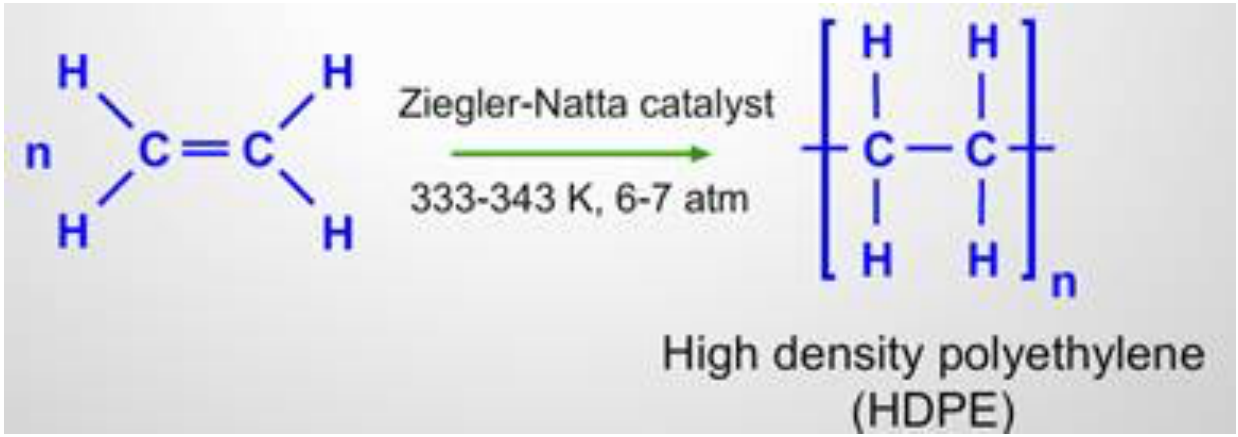
- Revolutionized the production of ammonia for use in fertilizer
  - 500 million tons produced each year
  - Enabled rapid expansion of agricultural industry

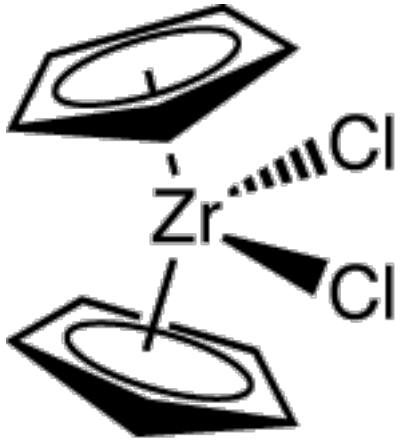


https://haberbosch.wordpress.com/the-process/

Ziegler Natta polymerization

- Industrial process for the production of polymers such as polyethylene
  - Heterogeneous catalysts based off of Ti
  - Homogeneous catalysts based off of complexes of Ti, Zr, Hf
- ~100 million metric tons of plastics produced using this and related processes
- 1963 Nobel Prize





Solar cells

- Inorganic materials (e.g. silicon-based materials) are essential components of commercial solar cells

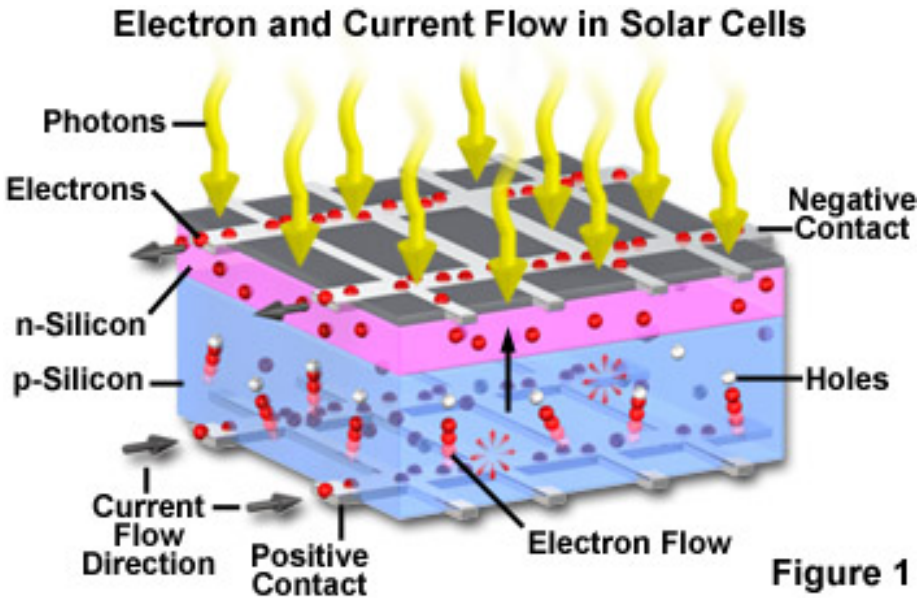
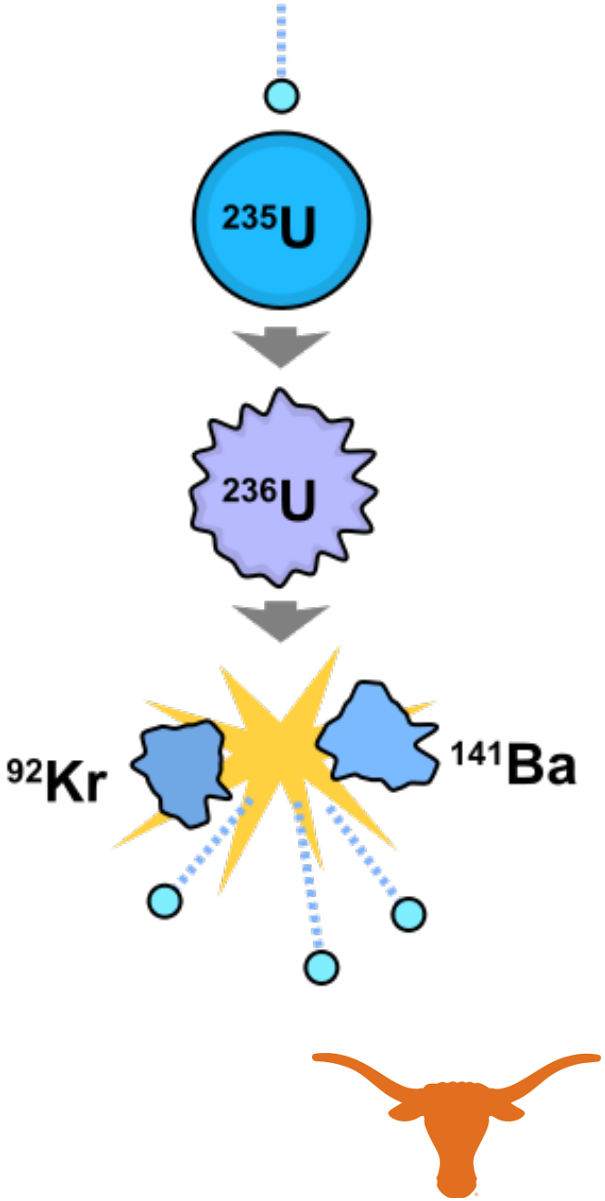


Figure 1

Nuclear energy

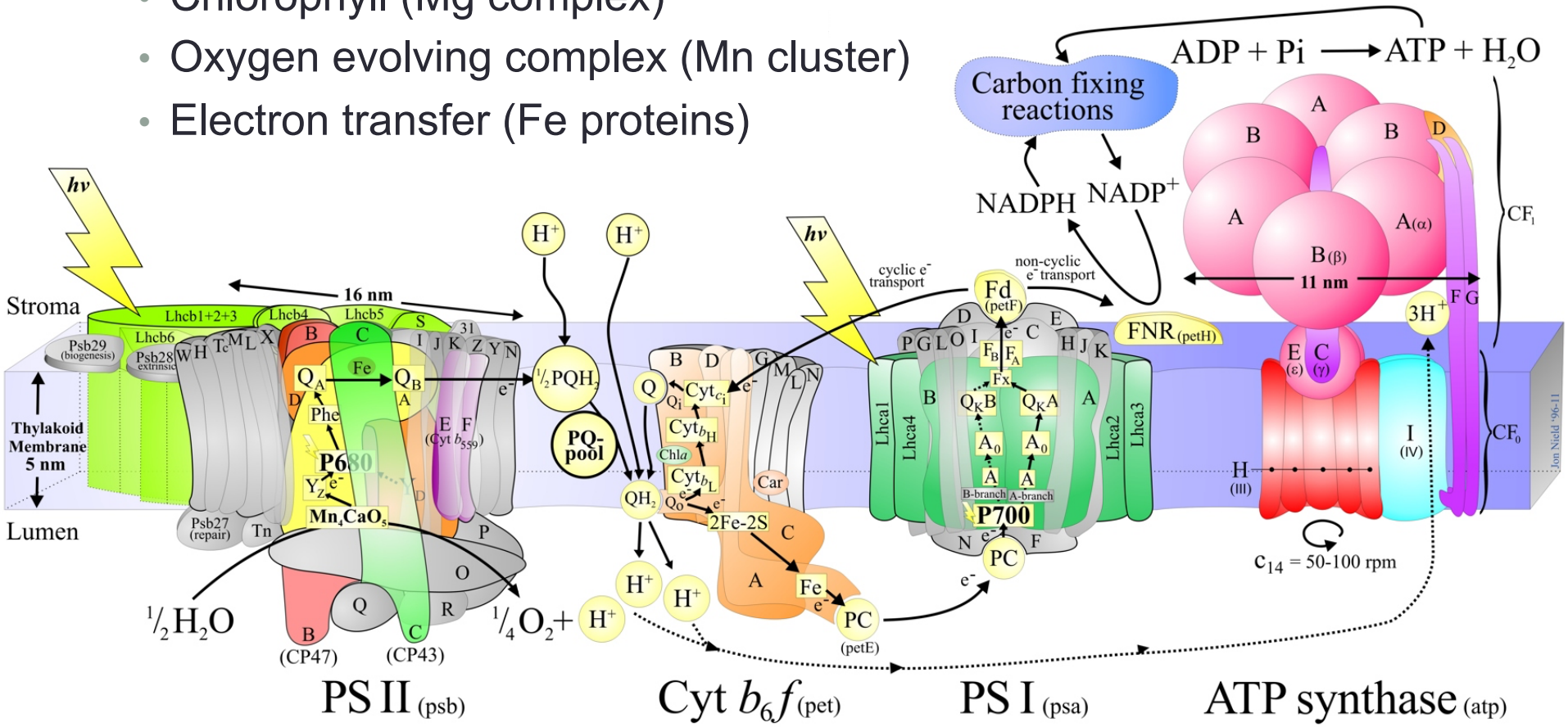
- Nuclear reactors convert the energy released by controlled nuclear fission into thermal energy for further conversion to mechanical or electrical forms.

- There are 450 nuclear power reactors that are used to generate electricity in about 30 countries around the world



Photosynthesis

- A number of inorganic complexes are used during this important biological process
  - Chlorophyll (Mg complex)
  - Oxygen evolving complex (Mn cluster)
  - Electron transfer (Fe proteins)

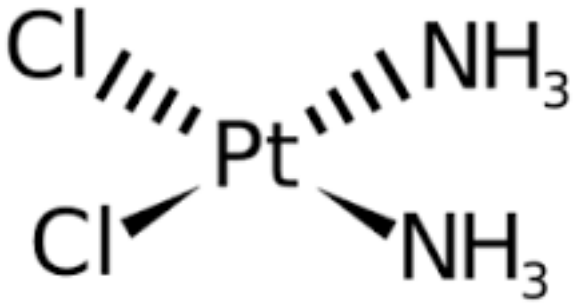


Cis-platin

- Chemotherapy used for the treatment of a variety of cancers including including sarcomas, some carcinomas (*e.g.*, small cell lung cancer, and ovarian cancer), lymphomas, bladder cancer, cervical cancer…

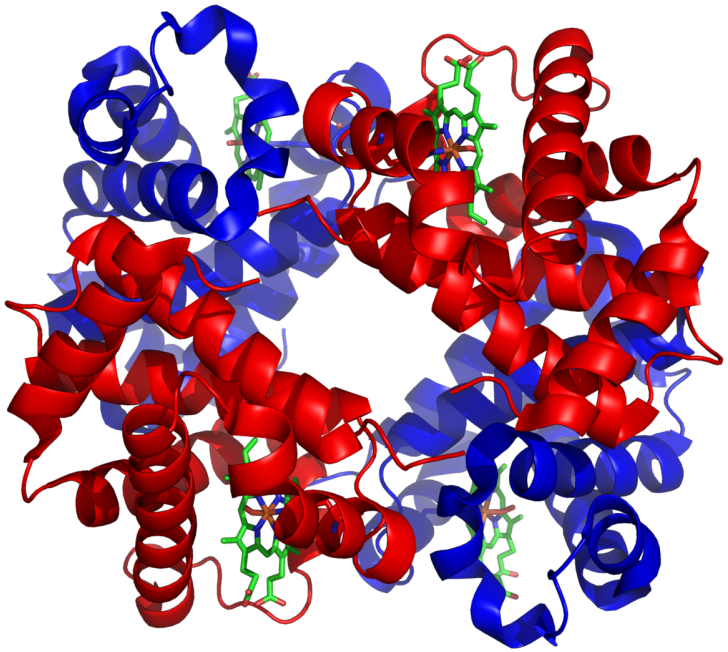
- Improved cure rate of testicular cancer from

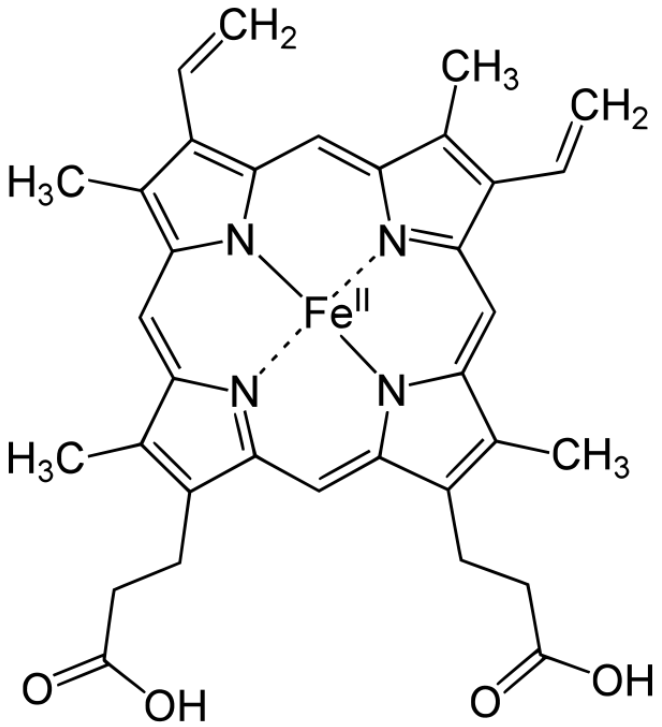
  10% to 85%



Hemoglobin

- Metalloprotein that carries oxygen throughout the body
- At its core, an Fe ion bound by a heme ligand. Interactions between Fe center and O_2 enable the transport of this gas





COURSE STRUCTURE

1) Fundamentals of atomic and molecular structure
   Orbitals, Symmetry, Bonding
2) Transition metal chemistry
   Structure, Reactivity, and Properties of transition metal complexes
3) Applications of transition metal chemistry
   Organometallic chemistry/catalysis, bioinorganic chemistry

The next few weeks:

- Review of atomic orbitals, periodic trends, bonding (Chapter 2)
- Bonding basics, Lewis dot structures, VSEPR (Chapter 3)
- …Symmetry and Group Theory (Chapter 4)