**Chemistry 20B Syllabus: Winter 2016**

**http://www.nano.ucla.edu/_psw/chem20bw16.html**

**Lectures:** MWF 9-9\(^{50}\) AM and 12-12\(^{50}\) PM Young Hall CS24  
**Instructor:** Prof. Paul S. Weiss  
**Textbook:** *Principles of Modern Chemistry*, 7\(^{th}\) edition, Oxtoby, Gillis, & Campion  
**Discussion:** Location & time for your Section on MyUCLA

### Lecture Dates:  
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<th>Week</th>
<th>Date(s)</th>
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<td>Week 1</td>
<td>4-8 Jan</td>
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<td>Ch. 9</td>
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<td>Week 2</td>
<td>11-15 Jan</td>
<td>Non-Ideal Gases, Bulk Properties of Gases/Liquids/Solids), Phase Transitions, Phase Diagrams</td>
<td>Ch. 9/10</td>
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<td>Week 3</td>
<td>Mon 18 Jan</td>
<td>No lecture – Martin Luther King Jr. Day - Holiday</td>
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<td>20-22 Jan</td>
<td>Solutions, Acid-Base Titrations, Redox Titrations</td>
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<td>20 Jan</td>
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<td>Week 4</td>
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<td>Solutions and Vapor Mixtures, Osmotic Pressure, Thermodynamics</td>
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<td>Week 5</td>
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<td>Conservation of Energy, Heat Capacity, Calorimetry, Thermochemistry, Reversible Reactions</td>
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<td>Week 6</td>
<td>8-12 Feb</td>
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<td>Week 7</td>
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<td>17-19 Feb</td>
<td>Chemical Thermodynamics &amp; Equilibrium, cont., Equilibrium, Law of Mass Action, Thermodynamic Equilibrium</td>
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<td>Week 8</td>
<td>22-26 Feb</td>
<td>Reaction Quotient, Reaction Direction Classifications of Acids/Bases</td>
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<td>Week 9</td>
<td>29 Feb-4 Mar</td>
<td>Equilibrium of Weak Acids/Bases, Buffers, Titrations, Solid Equilibria + Kinetics</td>
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<td>Midterm 3</td>
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<td>Week 10</td>
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<td>Electrochemistry and Energy + Nuclear</td>
<td>Ch. 17 + 19</td>
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<td>Sat 12 March</td>
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Version date 11 March 2016
Learning in Chem 20B
This is an exciting course for many reasons. We are able to cover many of the highlights of chemistry in a relatively informal way. This introduction is meant to guide you through many future years of scientific thinking and discussion, citizenship, and possibly even more chemistry.

Much of what you learn, you will learn on your own or from each other. This will allow us to have a higher level of discussion in class. This will require work on your part. Please be prepared for it and budget the time for it. Anticipate that the lectures, the readings, and the homeworks will be complementary rather than overlapping. You will be responsible for the material from all of these sources. Similarly, your participation in class is required both for discussions and for the education of your classmates, TAs, and professor.

Grading
Midterms: top two of three at 20% each
Final 30%
Homework 30% total = 10% creative problems + 10% graded problems + 10% submitted

Homework is due each lecture and will be returned in discussion section or Monday lecture.
Do the reading and homework in advance of lecture to prepare for a higher level discussion in class.
In addition to the assigned problem, for each homework, write and answer a problem that captures a key concept from the previous topic or lecture. These will always be graded. The best problems will be assigned to future classes, and your biography (and “vintage”) will be given.
Check the syllabus frequently, as we will update readings, homeworks, and other links.
(When the next lecture date is in green, those assignments are finalized.)

No notes, calculators, computers, phones, smart watches, connected devices, etc. are allowed during exams. A periodic table and needed formulas and constants will be provided.
Exam regrade requests will be considered for one week after the exam is returned and the entire exam paper will be regraded.
Please coordinate special exam requirements with your TA at the beginning of the quarter (i.e., during the first week).

It is inadvisable but ok to miss one midterm without an excuse, but then the two taken will both count towards your grade.
Makeup exams, when necessary because of two exams (both) missed with approved excuses, will be conducted as private oral exams with Prof. Weiss.

Letter grades will be determined based on student performance after the final exam is given.

Office Hours
Prof. Paul Weiss, in 3041 Young Hall
Wednesday/Friday 10:30-11:30 AM
(NB- On crowded days, we may move to 3056 Young Hall)
Prof. Weiss is often available on iChat/AIM/etc. as PSWeiss
TA Office Hours – announced in sections and on course web site: http://bit.ly/chem20Bw16
Reading and homework
(Updated frequently, not finalized until the upcoming lecture date is in green)

Please complete readings prior to coming to lecture.
Turn in homework in lecture, in the folder for your section.
If you are not going to make it to lecture, email your homework to your TA prior to lecture.
Late homework will not be accepted without a TA-approved excuse.

All readings will come from Principles of Modern Chemistry, by Oxtoby, Willis, & Campion, 7th edition, unless otherwise specified.
Older editions may also be used, however the chapters and problems will vary, so be sure to get the correct readings and problems from the current edition for assignments.

For Lecture 1, Monday 4 January
Review Chapters 1-8

For Lecture 2, Wednesday 6 January
Reading:
9.1 The Chemistry of Gases
9.2 Pressure and Temperature of Gases
9.3 The Ideal Gas Law

Additional assignment:
Choose your favorite energy unit and learn the conversions (to two significant figures) to:
   kcal/mole, kJ/mole, J, eV, cm⁻¹

Problems:
9.14, 9.18, 9.20, 9.62, 9.64

Many experiments use gas manifolds to transfer gases from one reaction vessel to another. Knowing the volume of such manifolds can be crucial. Bulb A was filled with 556 mL of N₂ gas. When opened to the glass manifold, the pressure read (at location P) was 266 torr. When opened to the empty bulb B, with a volume of 549 mL, the pressure read was 198 torr. What is the available volume in the glass manifold assuming ideal gases?

Create and solve your own original problem that captures a key concept from the previous topic or lecture. (The best problems will be assigned to future classes with your biography.)
For fun (not required):
http://bit.ly/1St91NM
A prank in the periodic table from a great UCLA chemistry alumnus

*Deflategate*, the New England Patriots, and the Ideal Gas Law, from Chad Orzel
http://bit.ly/1Ou1M6N

Four new elements in the periodic table!
http://bbc.in/1RmmDJP (BBC)

For **Lecture 3, Friday 8 January**
Reading:
9.4 Mixture of Gases
9.5 Kinetic Theory of Gases
9.6 Real Gases

Problems:
9.34, 9.40, 9.44, 9.70, 9.86
Create and solve your own original problem that captures a key concept from the previous topic or lecture.

For **Lecture 4, Monday 11 January**
Reading:
10.1 Bulk Properties of Gases, Liquids, and Solids: Molecular Interpretation
10.2 Intermolecular Forces: Origins in Molecular Structure

Problems:
9.48, 9.80, 9.90, 10.6, 10.16
Create and solve your own original problem that captures a key concept from the previous topic or lecture.

For fun (not required):
*Scientific American* discussion of North Korea’s test of what might not have been a hydrogen bomb:
http://bit.ly/1OSiHSD

*Quanta* (http://bit.ly/1mLf04f) article on George Church’s left-handed world (more on George later this quarter):
http://bit.ly/1mLf04f

A chemistry song from my friend and colleague, Dr. (Col. Hon.) Chuck Martin at the University of Florida
http://bit.ly/1mzngop
NB- Paul was in the audience at the club with Prof. Martin’s students for this performance after I gave a talk in his department.

For Lecture 5, Wednesday 13 January – updated
Reading:
10.3 Intermolecular Forces in Liquids
10.4 Phase Equilibrium

Ice skating text box, describing why the reduction in friction when skating is not due to pressure-induced melting.
http://bit.ly/1N1WbiD

Problems:
10.8, 10.15, 10.16, 10.20, 10.23, 10.28
Create and solve your own original problem that captures a key concept from the previous topic or lecture.

For fun (not required) and to help you decide if you want to attend any of the upcoming microbiome festivities
Rob Knight of UCSD’s TED talk on the microbiome (http://bit.ly/1nc56t4)

Thursday 14 January (not required, only if you are interested) POSTPONED, stay tuned
Microbiome discussions and atmospheric chemistry talk:
If you are interested in the microbiome, mentioned in the first lecture, one of the key figures in the field, we will host Prof. Kim Prather of UCSD and Scripps Institute of Oceanography will be on a panel moderated by Paul on Thursday 14 February 12-2 PM and will be speaking at 4 PM, all at CNSI.
To attend the panel, please register here:
http://bit.ly/1ITA4jr by sending an RSVP to cnsievents@cnsi.ucla.edu
Here is the microbiome technology roadmap that we co-wrote and published in ACS Nano:
http://bit.ly/1InRFjn

For Lecture 6, Friday 15 January
Reading:
10.5 Phase Transitions
10.6 Phase Diagrams

Problems:
10.34, 10.38, 10.46, *10.48, 10.50
For 10.46, replace 195.45 K (the normal melting point) with 63.29 K (from page A.47 in your book)
Create and solve your own original problem that captures a key concept from the previous topic or lecture.

For Lecture 7, Wednesday 20 January
Reading:
11.1 Composition of Solutions
11.2 Nature of Dissolved Species
Problems:
11.1, 11.3, 11.4, 11.6, 11.9, 11.13
Create and solve your own original problem that captures a key concept from the previous topic or lecture.

For fun (not required):
Microbiome webinar (will also be archived) on Tuesday 19 January with Janet Jansson of PNNL, Rob Knight of UCSD, and Jeff Miller of UCLA (all coauthors of our technology roadmap)
http://bit.ly/1lpJuUa

Our colleague and friend Prof. Paula Hammond of MIT will be visiting us in a couple of weeks, but on Tuesday 19 January, she is on a panel at Davos with Vice President Joe Biden and NIH Director Francis Collins on the cancer moonshot announced at the State of the Union Address:
bit.ly/1ZKgLAC

**Wednesday 20 January 5-7 PM MIDTERM #1**
Will cover through Friday 15 January class and assignments
Exam coverage is described in these slides and our first recaps are included as well:
http://bit.ly/w16recaps1to6

Rooms:
Sections 1A-1E will be in room WGYOUNG CS24
Sections 1F-1I, 3A-3D will be in room MOORE 100
Sections 3E-3I will be in room DODD 147
Any students who have special exam timing prearranged with Prof. Weiss and your TA, please come to CS24 to take the exam. (If you arrive after the agreed-upon time, you will not be allowed to take the exam.)
Note that no one will be allowed to leave from any room prior to 6 PM, even if you have completed the exam.
Results: Average = 62, standard deviation = 18

For **Lecture 8, Friday 22 January**
Reading:
11.3 Reaction Stoichiometry in Solutions: Acid–Base Titrations
11.4 Reaction Stoichiometry in Solutions: Oxidation–Reduction Titrations

Problems:
11.15, 11.20, 11.25, 11.28, 11.34, 11.39
Create and solve your own original problem that captures a key concept from the previous topic or lecture.

For **Lecture 9, Monday 25 January**
Reading:
11.5 Phase Equilibrium in Solutions: Nonvolatile Solutes
11.6 Phase Equilibrium in Solutions: Volatile Solutes
11.7 Colloidal Suspensions

Problems:
11.41, 11.48, 11.58, 11.62, 11.78, 11.83

Assign the formal oxidation state of each atom in these iron oxides and hydroxides:
- FeO
- Fe₂O₃
- Fe₃O₄
- Fe₄O₅
- Fe(OH)₂
- Fe(OH)₃

Which have mixed valence?

Create and solve your own original problem that captures a key concept from the previous topic or lecture.

For fun (not required):
See the video Pacific Light (at the bottom of the Wired article)
http://bit.ly/1ndJc8k

For Lecture 10, Wednesday 27 January
Reading:
12.1 Systems, States, and Processes
12.2 The First Law of Thermodynamics: Internal Energy, Work, and Heat

Problems:
12.2, 12.3, 12.6, 12.9, 12.10

Describe a system, process, or other example besides diabetes where osmotic pressure is important and describe the effect of osmotic pressure in your example.
Create and solve your own original problem that captures a key concept from the previous topic or lecture.

For Lecture 11, Friday 29 January
Reading:
12.3 Heat Capacity, Calorimetry, and Enthalpy
More on non-ideal mixtures and azeotropes here:
http://www.chemguide.co.uk/physical/phaseeqia/nonideal.html

Problems:
12.11, 12.12, 12.13, 12.14, 12.15

Create and solve your own original problem that captures a key concept from the previous topic or lecture.

For fun (not required):
A brinicle in the ocean reaching the sea floor
http://bbc.in/1Vy1ix2

For Lecture 12, Monday 1 February
Reading:
12.4 The First Law and Ideal Gas Processes

Problems: 12.17, 12.18, 12.19, 12.20, 12.22
Describe a situation or system where surface tension is important and how it is.

Create and solve your own original problem that captures a key concept from the previous topic or lecture.

**Tuesday 2 February** – PSW’s favorite holiday
For fun (not required), watch [http://bit.ly/1OtMgHT](http://bit.ly/1OtMgHT) to get you started. If you have not seen the rest, do!
NB- this clip is relevant to PSW’s and all your TAs’ research…

For **Lecture 13, Wednesday 3 February**
Reading:
12.5 Molecular Contributions to Internal Energy and Heat Capacity
12.6 Thermochemistry
Read the wikipedia page on heat capacity, which is free to use a little calculus, and gives a better explanation, in my opinion

Problems:
12.23, 12.26, 12.28, 12.30, 12.32
For the reaction
2Cu⁺ + Zn(s) → Zn²⁺ + 2Cu(s)
Calculate E°_{cell}, ΔG°, and K_{eq}
Create and solve your own original problem that captures a key concept from the previous topic or lecture.

If you are interested in nanobiotechnology, we are hosting an international symposium at the California NanoSystems Institute on Thursday 4 and Friday 5 February. Here is the agenda:
[http://bit.ly/1S73y00](http://bit.ly/1S73y00)

For **Lecture 14, Friday 5 February**
Reading:
(Review) 12.6 Thermochemistry
12.7 Reversible Processes in Ideal Gases
12.8 Distribution of Energy among Molecules


Here is the chart of solar cell efficiencies:
at the National Renewal Energy Laboratory

Recaps for lectures 7 to 13:
Recaps for lectures 14 to 17 and exam #2 review slides:
Problems:
12.42, 12.46, 12.52, 12.56, 12.58

Making a battery out of nickel and iron that proceeds by the following reaction:

$$\text{Ni}^{2+}(aq) + \text{Fe}(s) \rightarrow \text{Fe}^{2+}(aq) + \text{Ni}(s)$$

What are $\Delta G$ and $E_{\text{cell}}$ initially and after running the battery until the concentrations of the metal ions in solution are: $[\text{Ni}^{2+}] = 0.050 \text{ M}$ and $[\text{Fe}^{2+}] = 1.0 \text{ M}$.

You attempt to "recharge" your battery by adding $\text{Ni}^{2+}$ until it is 0.5 M (ignore any volume change due to the addition). What are the new $\Delta G$ and $E_{\text{cell}}$?

Create and solve your own original problem that captures a key concept from the previous topic or lecture.

For **Lecture 15, Monday 8 February**

Reading:
13.1 The Nature of Spontaneous Processes
13.2 Entropy and Spontaneity: A Molecular Statistical Interpretation
13.3 Entropy and Heat: Macroscopic Basis of the Second Law of Thermodynamics

Problems:
13.2, 13.4, 13.6, 13.8, 13.10

Create and solve your own original problem that captures a key concept from the previous topic or lecture.

Paul will lecture from the [International Conference on Nanoscience & Nanotechnology](http://www.ausnano.net) (ICCONN) in Canberra, Australia.

[Image: WE Moerner of Stanford was my colleague at IBM Almaden Research Center, then moved to UCSD before going to Stanford. He won the 2014 Nobel Prize in Chemistry (we knew that one was coming, even the Simpsons knew in 2010; Ben Feringa and Dick Zare are good friends, too) for his optical measurements of single molecules, which led to new understanding and to new superresolution microscopies. He gave the opening lecture at ICONN in Canberra.]

To find out more, read this [Popular account of the 2014 Nobel Prize in Chemistry](http://bit.ly/1nXjypu), or this [More technical account of the 2014 Nobel Prize in Chemistry](http://bit.ly/20QomLc)
For **Lecture 16, Wednesday 10 February** *(no office hours)*

Reading:
13.4 Entropy Changes in Reversible Processes
13.5 Entropy Changes and Spontaneity
13.6 The Third Law of Thermodynamics

Problems:
Choose a semiconductor and determine: a) its band gap, b) whether it has a direct or indirect band gap (for indirect band gap semiconductors, give both the direct and indirect band gap energies), c) a technological use of it, and d) whether that use is a potential application or current use. e) To what color(s) of light does the band gap(s) correspond?
Create and solve your own original problem that captures a key concept from the previous topic or lecture.

Paul will lecture from Griffith University in Brisbane, Australia where he is the Australian Nanotechnology Network Distinguished Lecturer

For **Lecture 17, Friday 12 February** *(no office hours)*

Reading:
13.6 The Third Law of Thermodynamics
13.7 The Gibbs Free Energy
13.8 A Deeper Look… Carnot Cycles, Efficiency, and Entropy

Problems:
13.25, 13.28, 13.34, 13.36, 13.40
Create and solve your own original problem that captures a key concept from the previous topic or lecture.

Paul will lecture from the University of Melbourne where he is the Australian Nanotechnology Network Distinguished Lecturer

**Monday 15 February**
**Special office hours 2-3 PM (check back for confirmation)**

**Tuesday 16 February, 6\(^{30}\)-8\(^{30}\) PM**
**39 Haines Hall**
**TA Review Session**

Recaps for lectures 7 to 13:
Recaps for lectures 14 to 17 and exam #2 review slides:
For **Lecture 18, Wednesday 17 February**
Reading:
14.1 The Nature of Chemical Equilibrium
14.2 The empirical Law of Mass Action
14.3 Thermodynamic Description of the Equilibrium State

Problems:
Create and solve your own original problem that captures a key concept from the previous topic or lecture.

**Thursday 18 February 5-7 PM Midterm #2**
Will cover through Friday 12 February class and assignments
BROAD 2160E Lecture 1 (*i.e.*, Sections 1A-*, for those in the 9 AM lecture section)
HUMANITIES A51 Sections 3A-3D
BUNCHE 2209A Sections 3E-3G
HUMANITIES 135 Sections 3H-3I

YOUNG 1044 For those preauthorized to start at 4:30 PM
HUMANITIES A51 For those preauthorized to start and/or to stay late

**Results:** Average = 79; standard deviation = 19; 25 scores ≥100

Here is the [notes page](http://bit.ly/24aXNmn) from the exam:

For **Lecture 19, Friday 19 February**
Reading:
14.4 The Law of Mass Action for Related and Simultaneous Equilibria
14.5 Equilibrium Calculations for Gas-Phase and Heterogeneous Reactions

Problems:
14.18, 14.20, 14.22, 14.28, 14.35
Create and solve your own original problem that captures a key concept from the previous topic or lecture.

For **Lecture 20, Monday 22 February**
Reading:
14.6 The Direction of Change in Chemical Reactions: Empirical Description
14.7 The Direction of Change in Chemical Reactions: Thermodynamic Explanation
14.8 Distribution of a Single Species between Immiscible Phases: Extraction and Separation Processes

Problems:
14.49, 14.54, 14.58, 14.65 14.73
Create and solve your own original problem that captures a key concept from the previous topic or lecture.
For **Lecture 21, Wednesday 24 February**

Reading:
Review 8.2-8.5 Metal Complexes
14.8 Distribution of a Single Species between Immiscible Phases: Extraction and Separation Processes
15.1 Classification of Acids and Bases
15.2 Properties of Acids and Bases in Aqueous Solutions
23.1-23.2 Polymers

Problems:
Create and solve your own original problem that captures a key concept from the previous topic or lecture.

Not required, but not so fun either – the Science Network interview with James Watson on the 60th anniversary of the publication of the structure of DNA with Francis Crick
http://bit.ly/1WEKPrq

For **Lecture 22, Friday 26 February**

Reading:
15.3 Acid and Base Strength
15.4 Equilibria Involving Weak Acids and Bases
15.5 Buffer Solutions
Understanding the X-ray diffraction pattern of DNA - [http://bit.ly/1QCKfIC](http://bit.ly/1QCKfIC) (you will have to download this article when you are on the UCLA network or using VPN)
18.1 Rates of Chemical Reactions
18.2 Rate Laws

Problems:
15.8, 15.17, 15.24, 15.28, 15.38, 18.2, 18.5
Create and solve your own original problem that captures a key concept from the previous topic or lecture.

For fun (not required):

Here is the original TV show, Vega, on a laser pointer demonstration to show the elements of the X-ray diffraction pattern of DNA, with Amand Lucas and (Sir) Harry Kroto:
http://www.vega.org.uk/video/programme/80

**5-7 PM Exam 3 Review Session**
CS24
For Lecture 23, Monday 29 February
Reading:
15.5 Buffer Solutions
15.6 Acid-Base Titration Curves
15.7 Polyprotic Acids
18.3 Reaction Mechanisms
18.4 Reaction Mechanisms and Rate
18.5 Effect of Temperature on Reaction Rates

Problems:
15.46, 15.48, 15.52, 15.58, 15.66, 18.25, 18.38, 18.48, 18.55
Create and solve your own original problem that captures a key concept from the previous topic or lecture.

Monday 29 February 5-7 PM Midterm #3
Will cover through Friday 26 February class and assignments
Sections 1A-1E will be in room YOUNG CS24
Sections 1F-1I, and 3A-3D will be in room MOORE 100
Sections 3E-3I will be in room LAKRETSZ 110 (Logan and Dominic)
Anyone with special time requirements noted in advance – email Paul + your TA
Early: come to 3056 Young Hall. Late come to CS24 Young Hall.
No one will be allowed to leave before 6:15 PM


For fun (not required):
Interview with Ned Seeman, the founder of DNA nanotechnology (making structures from DNA):
http://bit.ly/1Lhy1qp
DNA Origami Box http://www.nature.com/nature/journal/v459/n7243/pdf/nature07971.pdf

For Lecture 24, Wednesday 2 March
Reading:
16.1 The Nature of Solubility Equilibria
16.2 Ionic Equilibria between Solids and Solutions
16.3 Precipitation and the Solubility Product
18.8 Catalysis

Problems:
15.107, 15.117, 16.3, 16.11, 16.13
Create and solve your own original problem that captures a key concept from the previous topic or lecture.

For Lecture 25, Friday 4 March
Reading:
16.4 The Effects of pH on Solubility
16.5 Complex Ions and Solubility
16.6 A Deeper Look… Selective Precipitation of Ions

Problems:
16.32, 16.33, 16.39, 16.54, 18.49

Write the monomer, polymer, and indicate the repeat unit of poly(vinyl chloride). Is this an addition or condensation polymerization? If condensation, what is the other reaction product?

By what polymerization reaction are amino acids connected to form polypeptides and proteins?

Create and solve your own original problem that captures a key concept from the previous topic or lecture.

For Lecture 26, Monday 7 March
Reading:
17.1 Electrochemical Cells
17.2 Cell Potentials and the Gibbs Free Energy
17.3 Molecular Interpretation of Electrochemical Processes
17.4 Concentrations Effects and the Nernst Equation

Problems:
17.8, 17.24, 17.28, 17.30

Name one vitamin, draw its chemical structure, and briefly describe one aspect of what it does in terms of biological function (e.g., if it is part of a particular enzyme). Can you overdose on it (i.e., is it fat-soluble)?

Create and solve your own original problem that captures a key concept from the previous topic or lecture.

For Lecture 27, Wednesday 9 March
Guest Lecture from Prof. Anne Andrews: Electrochemical Measurements of Chemical Kinetics in the Brain
Reading:
17.5 Molecular Electrochemistry
Connection to Energy: Solar Energy Conversion
17.6 Batteries and Fuel Cells
17.7 Corrosion and Corrosion Protection
17.8 Electrometallurgy

Problems:
17.62, 17.72, 17.81, 17.104

Name one neurotransmitter, draw its chemical structure, and briefly describe one aspect of what it does in our brains (e.g., relation to behavior, mood, etc.)

Create and solve your own original problem that captures a key concept from the previous topic or lecture.

Thursday 10 March
5-7 PM Exam 3 Review Session
CS50

Version date 11 March 2016
For Lecture 28, Friday 11 March
Reading:
19.1 Radioactivity
19.2 Nuclear Structure and Nuclear Decay Processes
19.4 Kinetics of Radioactive Decay

In-Class Review Slides: bit.ly/20bW16FinalRev

Problems:
19.3, 19.4, 19.27
Create and solve your own original problem that captures a key concept from any time in the course.

Saturday 12 March, 3-6 PM
Final Exam
CS 24 Sections 1A-1G
CS 50 Sections 1H-1I & 3A-3E
CS 76 Sections 3F-3I