SI Leader Introduction - Madison Ruggiero

Hi everyone I'm a junior biochemistry major and I'm super excited to work with you all! I took Ochem II last spring and I was an SI Leader for this course this past fall. This course can seem intimidating, but I know anyone can succeed if you consistently set aside time to review and put in the effort. I am here to help you in any way I can, please come see me in weekly discussion sessions!

What to expect from SI Sessions?

- The purpose of SI sessions is to facilitate active learning, put effective study strategies into practice, help students become more self-sufficient learners, and to build community by collaborating with your peers.

- The role of an SI Leader is to help you think for yourselves as you solve problems, so I may not answer your questions directly and instead redirect you to your peers, resources, or ask you another question.

Why should you attend SI Sessions?

- You will collaborate with your peers in a peer-led discussion group which is proven to be very effective for learning. Additionally, you may find people to create study groups with outside of class which can be very helpful (and was my favorite part of Ochem II).

When will SI Sessions be held?

- SI Sessions are held twice a week for an hour each. Each weekly session will be identical, so there is no need to attend more than one session a week (but you are still welcome to attend both if you'd like).

- SI Sessions begin next week (1/22) and we will cover material from the previous week's lectures.

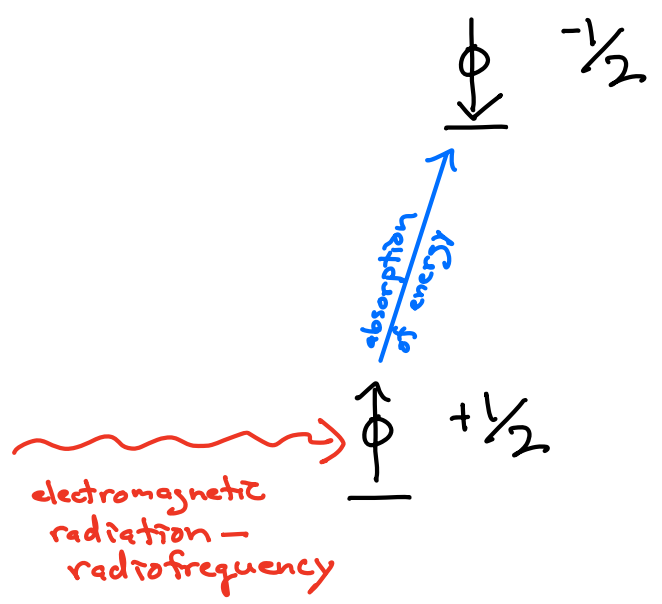*- Specific times and rooms will be announced before next week.*

A) Moving charge generates a magnetic field
   Moving magnetic fields cause charges to move

B) Atomic nuclei, just like electrons, can have a quantum mechanical property called "spin"
   → Can be thought of as the positively-charged protons of the atomic nucleus "spinning" to create a small magnetic moment

C) ^1H → spin of ½

NMR experiment → place sample of a molecule in a very strong magnetic field

$\downarrow\!\!\!\!\phi$ $-½$

absorption of energy

$\uparrow\!\!\!\!\phi$ $+½$

electromagnetic radiation — radiofrequency

The energy absorption/nuclear spin flipping phenomenon is called "Resonance"

The ^1H nucleus of spin state $+½$ absorbs a quanta of energy of precisely the correct frequency and the nucleus is "excited" to the $-½$ spin state

In the classic ¹H-Nuclear Magnetic Resonance (¹H-NMR) experiment:

1. A sample of the molecule of interest is placed in solvent (the solvent has deuterium atoms in place of H atoms so the solvent molecules will not show up in the spectra.
2. The solution is put in a spinning tube in a very strong magnetic field.
3. The sample is exposed to radiofrequency irradiation and if it is of exactly the right frequency, energy is absorbed and spins flip from +1/2 to -1/2 spin states (the energy absorption/spin flipping process is called resonance).
4. The absorbed energy is plotted on the spectra as a function of wavelength, normalized by using the parts per million (ppm) scale.
5. ¹H nuclei in different functional groups come into resonance at different and characteristic values of ppm and adjacent ¹H nuclei split signals in predictable ways, allowing for chemical structures to be determined based on ¹H NMR spectra.

The old way to carry out an NMR experiment:

1. Scan wavelengths (ex. High to low wavelengths) of radiofrequency electromagnetic radiation.
2. Measure absorbance during the scan and plot the amount of energy absorbed versus wavelength using the normalized ppm scale.
3. This is NOT used any more.

What we did not tell you: After a nuclear spin is flipped back from +1/2 to -1/2, it will relax back to the +1/2 spin state and EMIT a photon of the same wavelength it absorbed in the first place.

How modern NMR works:

1. The sample is irradiated with all wavelengths simultaneously with a short blast. All of the ¹H spins are flipped at once.
2. The sample is monitored for emitted photons as the ¹H nuclear spins "relax" back to the +1/2 spin state.
3. The emitted photons are analyzed using a technique called Fourier Transform (FT) to extract frequency and intensity information.
4. The frequency and intensity information is plotted on the ppm scale.
5. This process is repeated hundreds or thousands of times with the same sample to dramatically improve signal-to-noise.
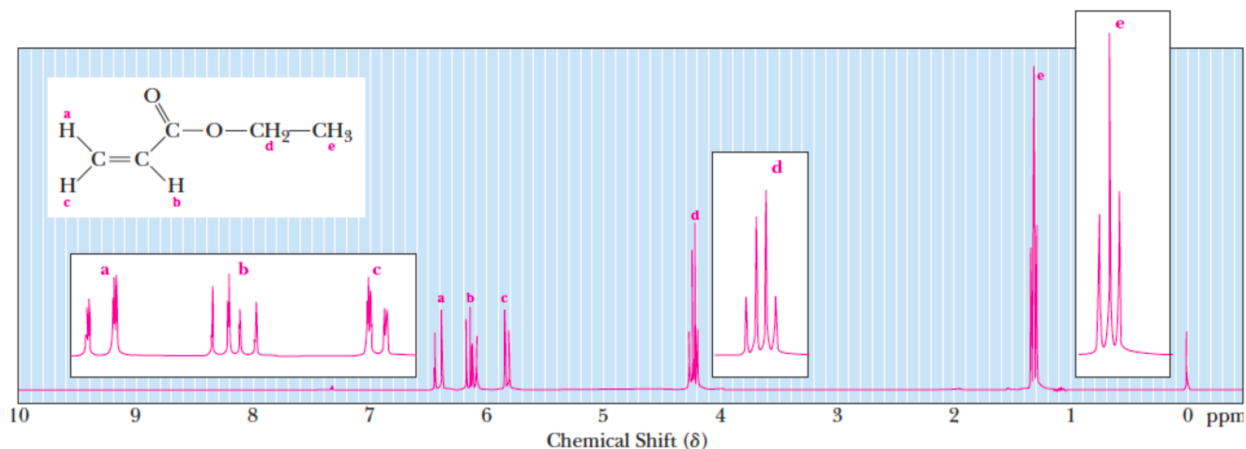

Figure 13.21
300 MHz ¹H-NMR spectrum of
ethyl propenoate.

MRI – N~~uclear~~ Magnetic Resonance Imaging – Produces a 3-d image inside the body.
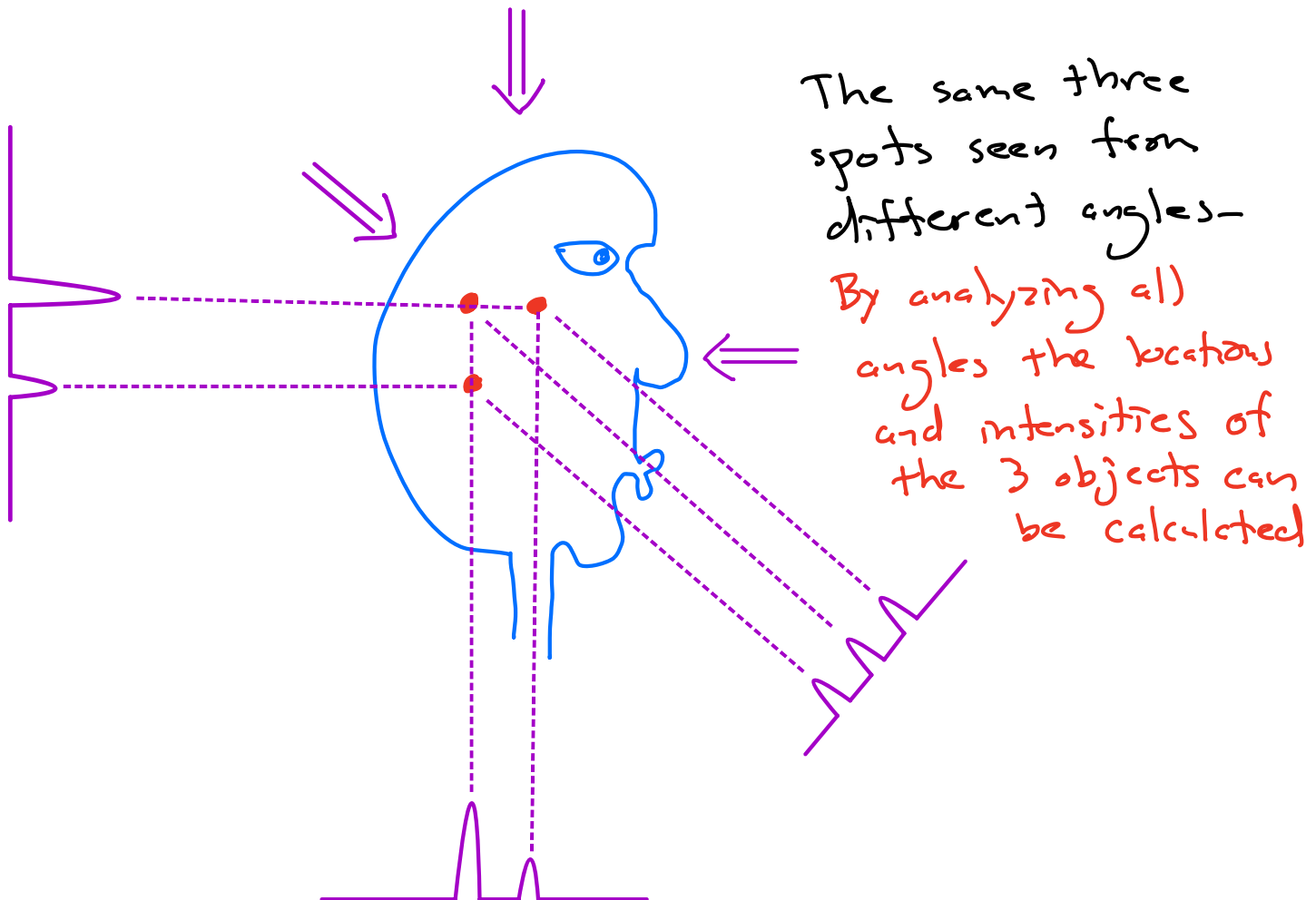
MRI is similar in approach, but complementary to, a CAT scan, which uses X-rays for imaging.

MRI is therefore safer than a CAT scan (no X-rays or other damaging radiation is used). Radiofrequency electromagnetic radiation does not cause DNA damage or any other kind of damage.

MRI primarily visualizes soft-tissue and especially cancer tumors while a CAT scan primarily visualizes bones or Calcium based dyes drunk to visualize the digestive tract.

MRI uses the same principles and NMR.
1) The patient is placed in a very strong magnetic field. Creating this very strong magnetic field is technically very demanding, explaining MRI machines are so expensive (~ 0.5 – 1.5 $ million)
2) The patient is irradiated with radiofrequency electromagnetic radiation.
3) The flipping (resonance) of 1H nuclear spins is monitored – Actually emitted photons are measured using the FT method.
4) Magnetic field gradients are used to gain imaging information. The magnetic field gradients are rotated around a central point and measurements are taken at each angle around 360° to gain 2-dimensional information. This technique is called **tomography**.

The same three spots seen from different angles—

By analyzing all angles the locations and intensities of the 3 objects can be calculated

The overall MRI imaging approach involves looking at each 2-dimensional slice. ✓

Each slice is added to give a 3-dimensional stack (analogous to stacking DVD's or CD's). ✓

Each slice is shaded to indicate differences in the amount of ^{1}H atoms in different areas/tissues. ✓

Water and fat have the highest density of ^{1}H atoms, so these are primarily being monitored in an MRI image.

The popular medical diagnostic technique of magnetic resonance imaging (MRI) is based on the same principles as NMR, namely the flipping (i.e. resonance) of nuclear spins of H atoms by radio frequency irradiation when a patient is placed in a strong magnetic field. Magnetic field gradients are used to gain imaging information, and rotation of the gradient around the center of the object gives imaging in an entire plane (i.e. slice inside patient). In an MRI image, you are looking at individual slices that when stacked make up the three-dimensional image of relative amounts of H atoms, especially the H atoms from water and fat, in the different tissues [Memorize the preceding passage, as it will be worth 14 points on the next midterm. No I am not kidding, I just gave you 14 points right there.]

m- m...

he's about to say his first words

The popular medical diagnostic technique of magnetic resonance imaging (MRI) is based on the same principles as NMR, namely the flipping (i.e. resonance) of nuclear spins of H atoms by radio frequency irradiation when a patient is placed in a strong magnetic field. Magnetic field gradients are used to gain imaging information, and rotation of the gradient around the center of the object gives imaging in an entire plane (i.e. slice inside patient). In an MRI image, you are looking at individual slices that when stacked make up the three-dimensional image of relative amounts of H atoms, especially the H atoms from water and fat, in the different tissues.
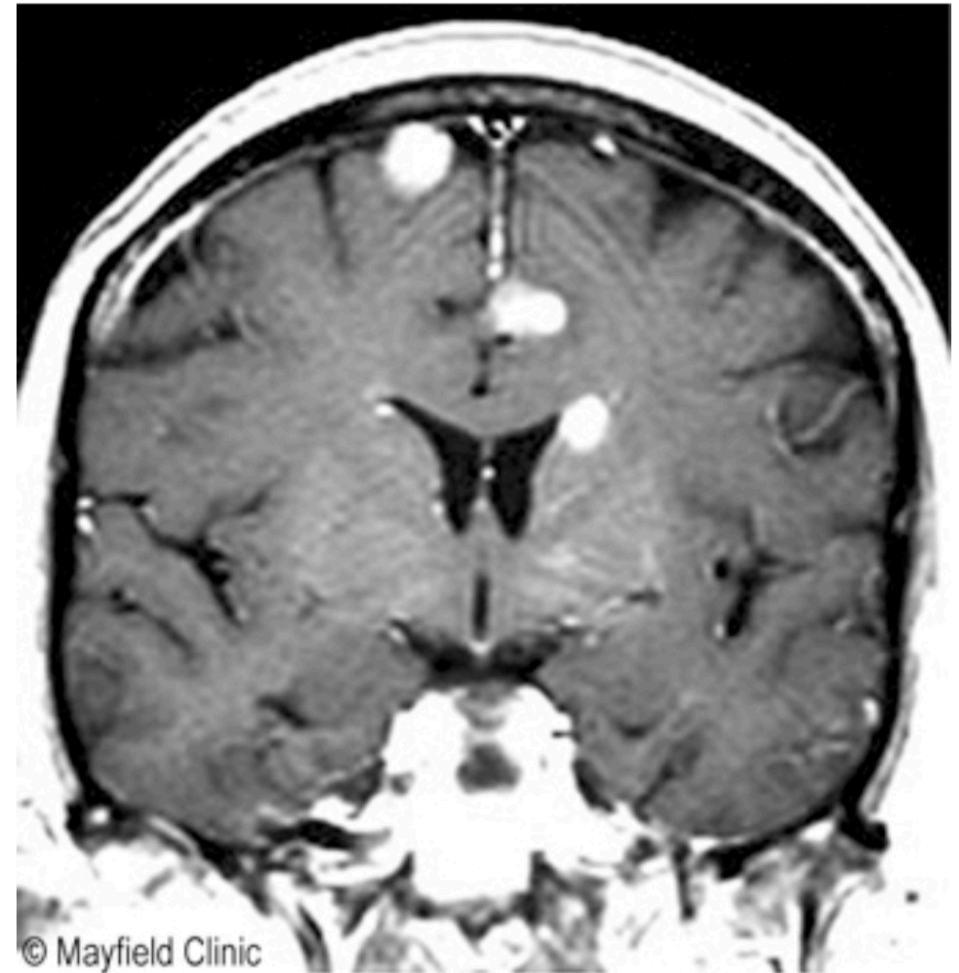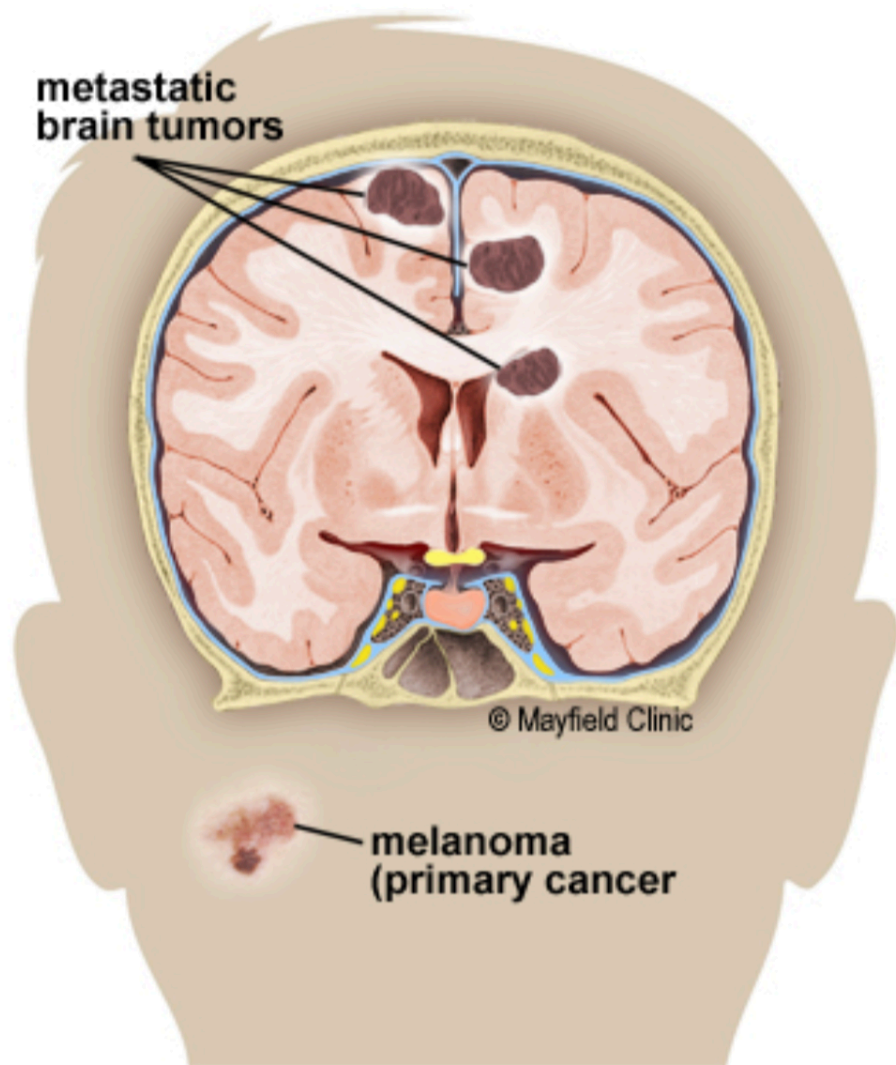
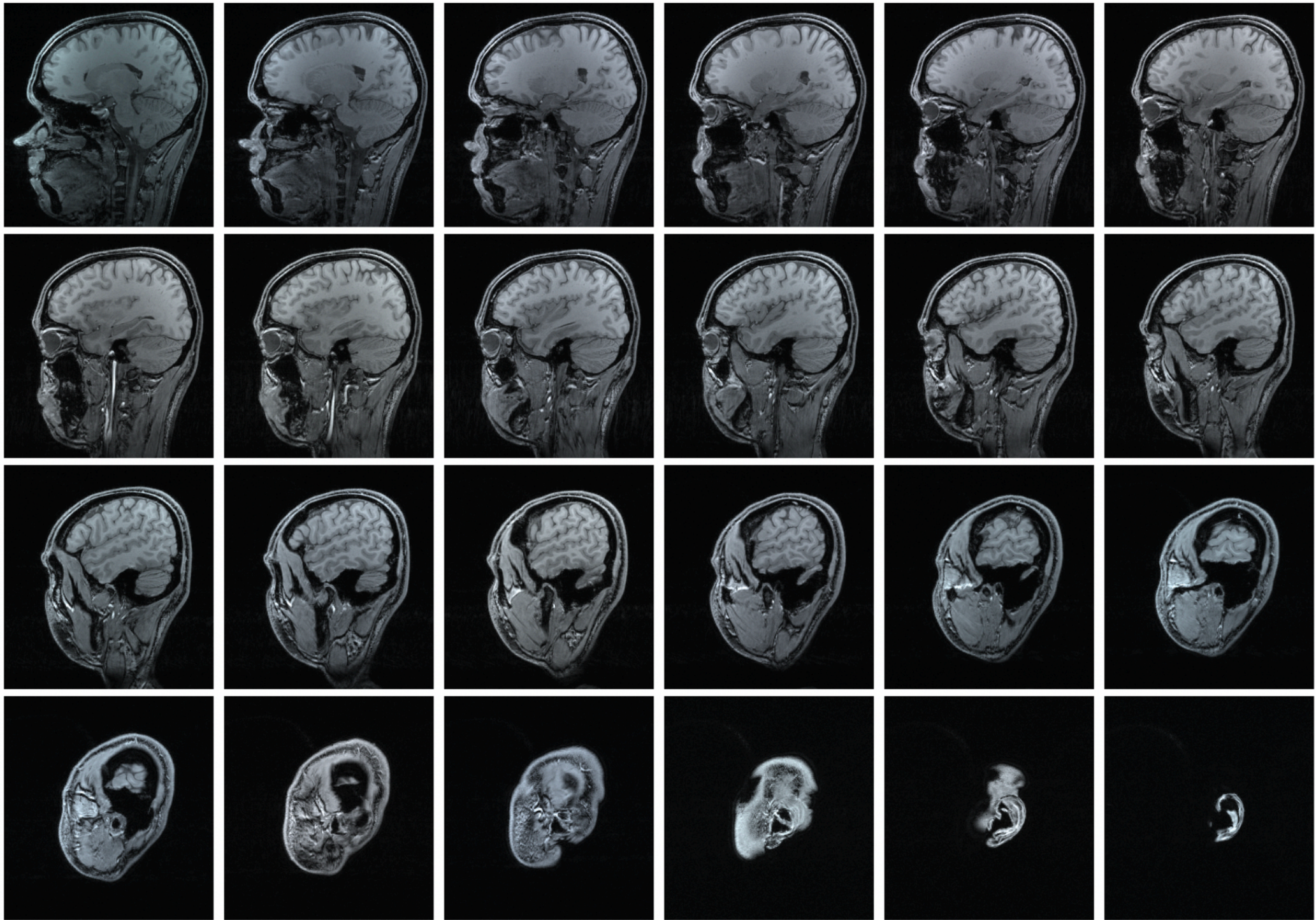**Figure 1. Illustration and MRI of multiple metastatic brain tumors that have spread from the melanoma skin cancer on the face.**
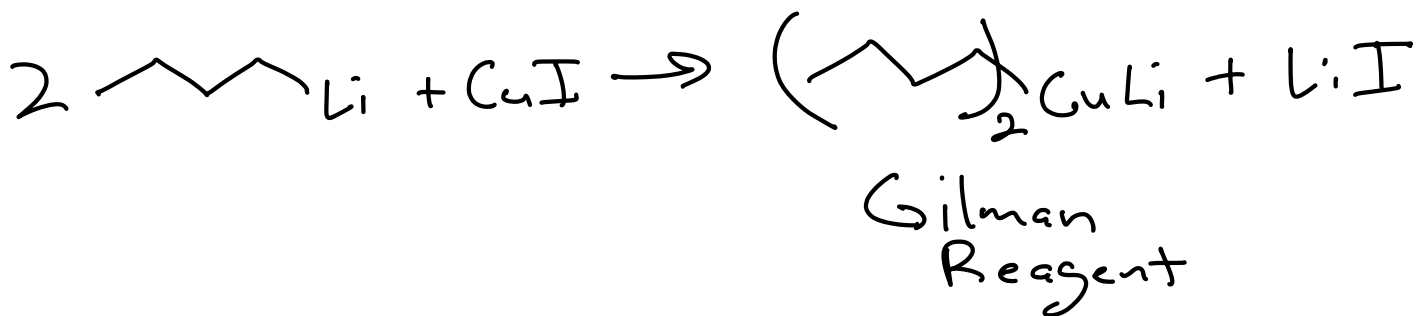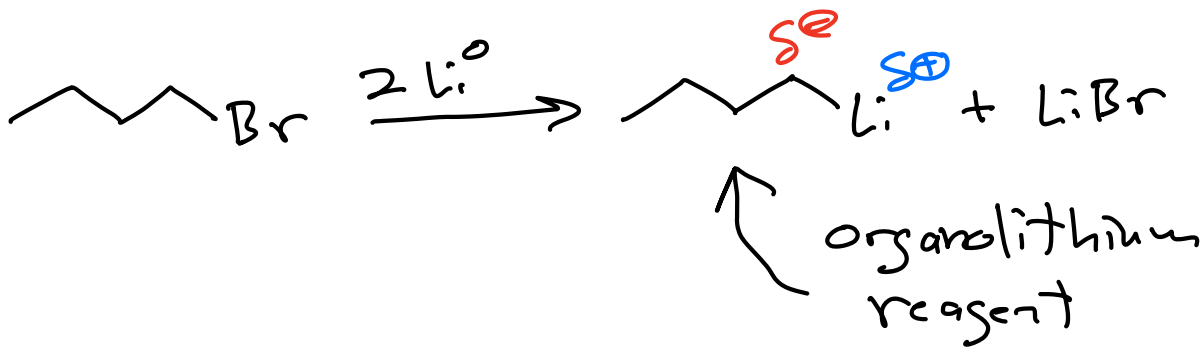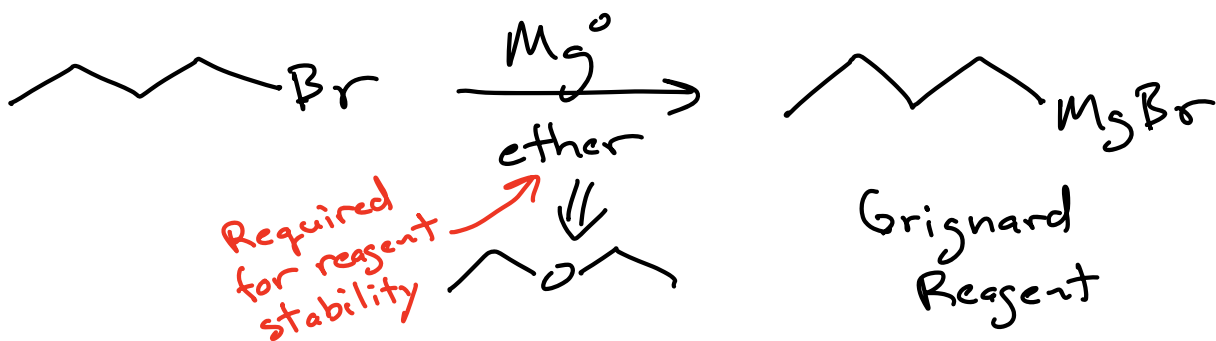
Image 13-16: MRI images of a normal ACL (between white lines), ruptured ACL (ligament not clearly visible), bone marrow oedema (white arrows) and anterior tibial translation.

Preparation of Organometallic Reagents

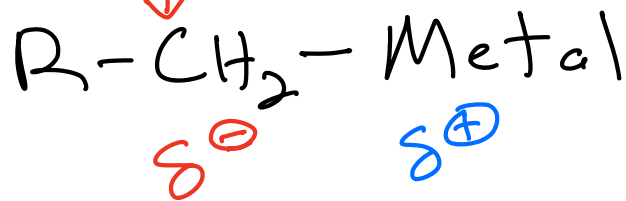C-metal bonds are more ionic than pure covalent bonds like C-C bonds

→ C—metal bond!

Prepared from haloalkanes

$$\text{/\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!Br} \xrightarrow[\text{ether}]{Mg^0} \text{/\!\!\!\!\!\!\!\!\!\!\!\!MgBr}$$

Grignard Reagent

Required for reagent stability

$$\text{/\!\!\!O\!\!\!\backslash}$$

$$\text{Br} \xrightarrow{2\,Li^0} \overset{\delta\ominus}{\text{/}}\,\overset{\delta\oplus}{Li} + LiBr$$

organolithium reagent

$$2\,\text{/\!\!\!\!\!\!\!Li} + CuI \longrightarrow \left(\text{/\!\!\!\!\!\!\!}\right)_2 CuLi + LiI$$

Gilman Reagent

You are not responsible for these mechanisms!

$$R-CH_2-Metal$$

$\delta\ominus$ $\delta\oplus$
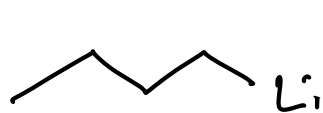
The C-metal bond is polarized
so the majority of electron
density is on C.

⟹ The carbon atom of organometallic
reagents is nucleophilic!

The electron density of the C-metal
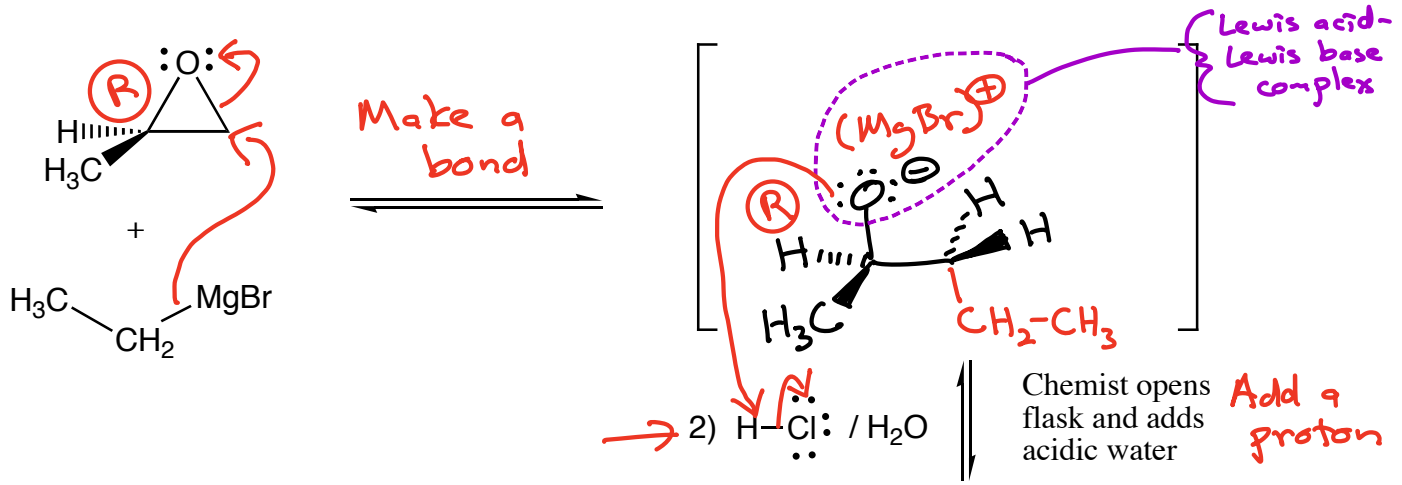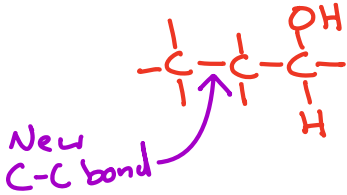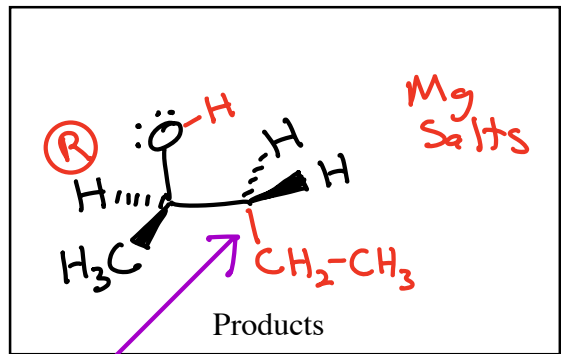bond acts as a __source__ for an arrow!

Think of this as

$\sim\sim$ Li   ⟹ $\sim\sim$ $\overset{\ominus}{:}$ Li$\oplus$

Organolithium and Gilman reagents react the same way as Grignard reagents in this reaction.

Grignard Reagent Reacting with an Epoxide

Make a bond

(MgBr)⊕ — Lewis acid-Lewis base complex

2) H—Cl: / H₂O → **Add a proton**

Chemist opens flask and adds acidic water

Key Recognition Element (KRE):

There is a new C-C bond that is two carbon atoms away from an OH group

New C-C bond

New C-C bond!

Products

Mg Salts

1) CH₃CH₂MgBr
2) HCl / H₂O

HO⌁

New C-C bond!

1) CH₃CH₂MgBr
2) HCl / H₂O

H₃C **Chiral** CH₃

(a single stereoisomer)

1) CH₃CH₂MgBr
2) HCl / H₂O

Meso — not chiral

Racemic Mixture