Nylon/Polymer Remote Lab

This week, we will be exploring the world of polymers, including the synthesis of Nylon 6,6. You will NOT be working with a lab notebook (no prelab, observations, etc.). The reaction to synthesize Nylon-6,6 is described on the following page. After you provide the missing structures, you can see the complete transformation that will be demonstrated in the following "Lab Video." This is a very cool lab demonstration, and we get to avoid using some very noxious reagents and intermediates.

Additional videos and resources are provided below.

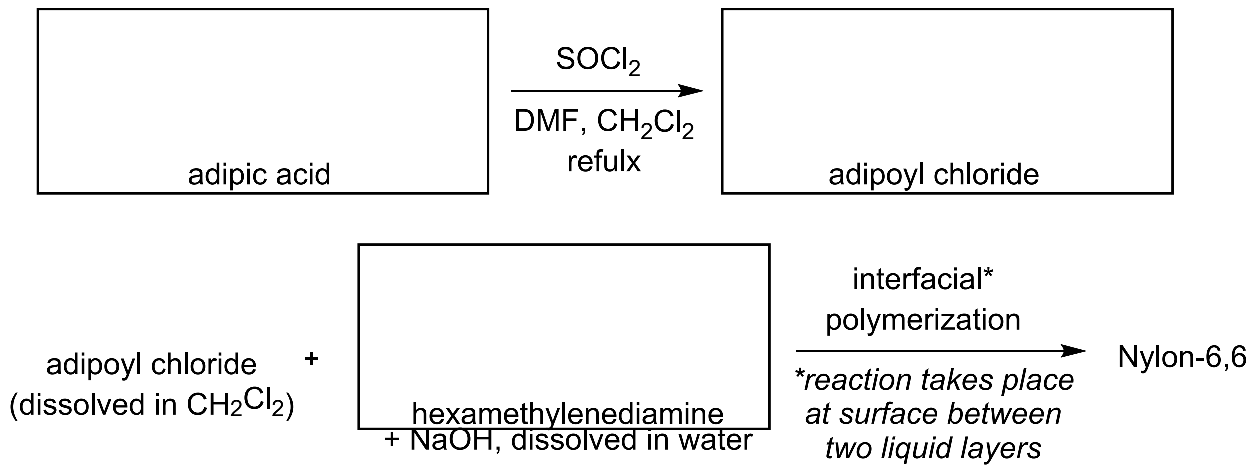
- CrashCourse Introduction to Polymers video (10 min)
- Introduction to Nylon (website with nice 3D models)
- Demonstration of complete lab procedure from Case Western: Lab Video (13 min)
- Additional, short videos of nylon demonstrations:
    - pink version (VERY cool side view)
    - crazy classroom demo (from the good old days - no goggles or fume hood!)
- Biodegradable polymer brain cancer treatment animation

Lab Report questions can be found on the following three pages.

Questions to answer for “Nylon Synthesis” lab report

Name:________________________________

1. The video demonstration shows the preparation of adipoyl chloride, and its reaction with hexamethylenediamine. Before watching the video, draw the missing structures below.



2. What is the purpose of using the Bunsen burner at the beginning of the procedure?

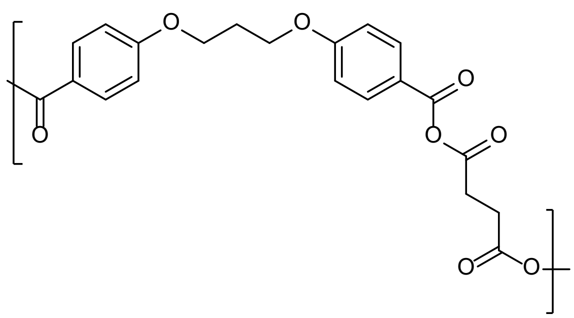
3. What is the purpose of NaOH during the polymerization of Nylon-6,6?

4. Draw an example of an azo dye, and explain why it is a colored compound.

5. Draw the structures of Nylon-6, Nylon-6,6 and Nylon-6,10. Label each drawing and identify each as a copolymer or homopolymer.

6. Consider the following carboxylic acid derivatives, arranged alphabetically: acid chloride, amide, anhydride, ester. These are all electrophiles that can undergo nucleophilic attack, resulting in acyl substitution. Arrange them in the order of reactivity toward nucleophilic attack, from **most reactive** to **least reactive** (label clearly), and explain why the least reactive derivative is such a poor electrophile. Use drawings to support your answer. (see Starkey Ch. 3.11 and Klein Ch. 20.7) This overview of structure vs. reactivity will help you answer the questions that follow.

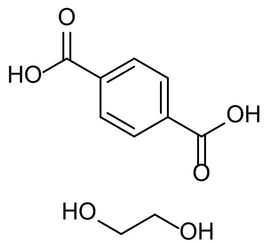
7. Polyanhydride polymers are biodegradable. Gliadel™ is a product used to treat brain cancer. After a surgery to remove a tumor, polymer wafers embedded with the anti-cancer drug, Carmustine, are placed in the are where the tumor was. As the polymer breaks down over time, the drug is released. Provide a mechanism for the reaction that the related polymer shown would have with water, and explain why such polymers degrades so easily. Animation to illustrate how the wafers work: https://gliadel.com/hcp/moa.php



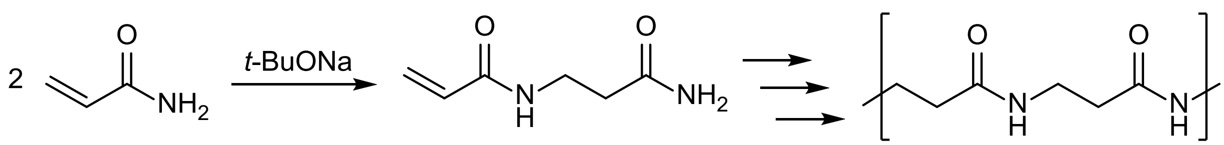
8. Polyamide polymers are very stable, and hydrogen bonding between the polymer strands contributes to their strength and durability. Kevlar™ is five times stronger than steel, and is used in bullet-proof vests. Draw three chains of Kevlar™ and show the hydrogen bonds that serve as crosslinks between the chains.

9. There has been much concern in recent years about the environmental effects of long-living plastics and microplastics. Draw the structure of polyethylene and explain why it does not easily degrade.

10. The monomers shown combine to give a polymer. Draw at least two repeating units of the resulting polymer. Would this be described as a condensation polymer? Explain.



11. Propose a mechanism for the following dimerization (which would lead to the polymer shown).



12. The polymerization above requires the addition of a radical inhibitor, to prevent a radical polymerization. What polymer would be formed under radical conditions? Propose a mechanism, using R· as the radical initiator. (See "Radical Polymerization" on Wikipedia for a good overview.)