



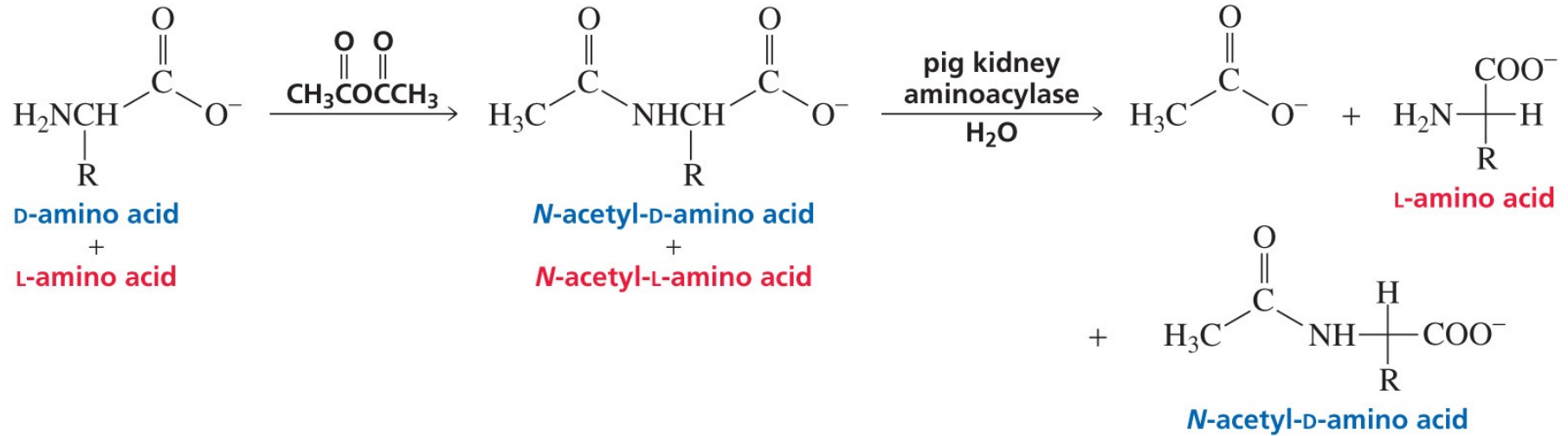
# Chem 109 C

## Bioorganic Compounds

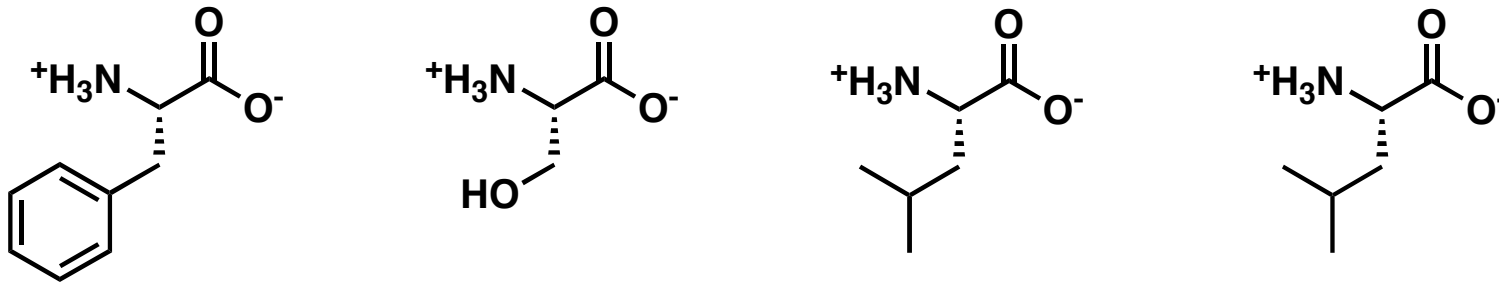
**Armen Zakarian**  
**Office: Chemistry Bldn 2217**

<http://labs.chem.ucsb.edu/~zakariangroup/courses.html>

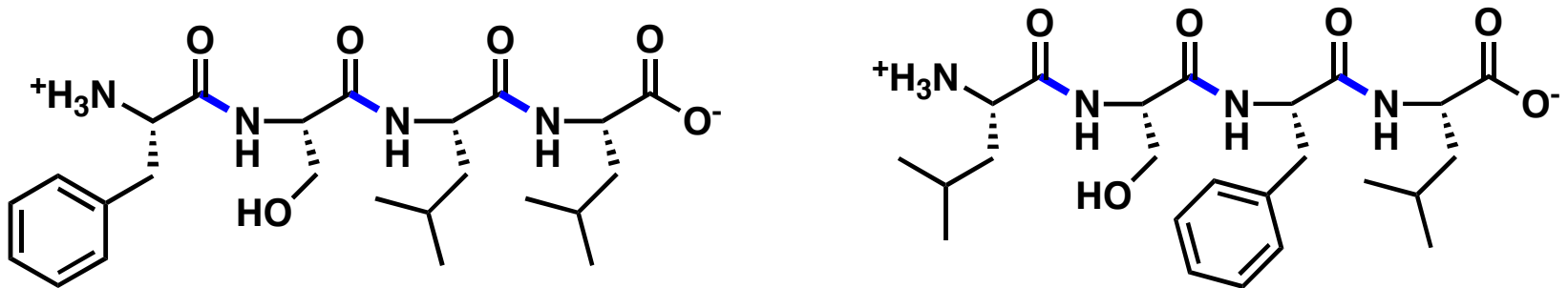
# Amino acids: Resolution of Racemates



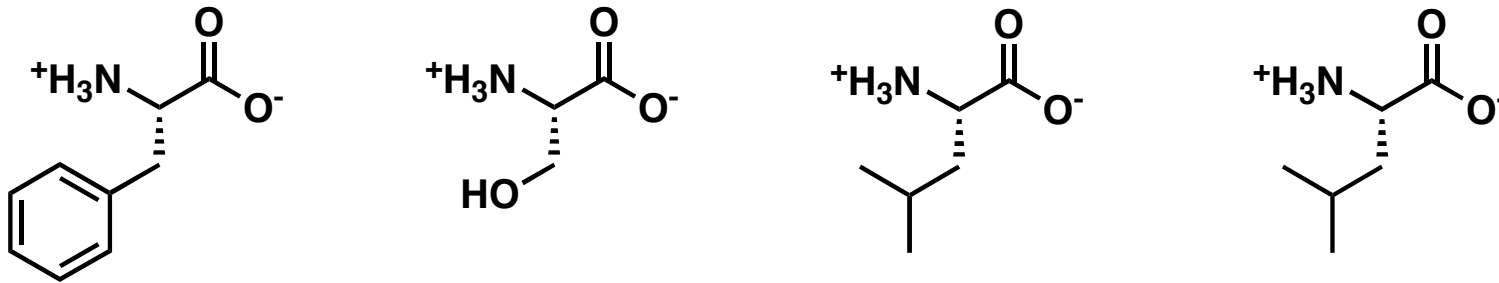
# Peptides/Proteins: **Peptide Bonds**



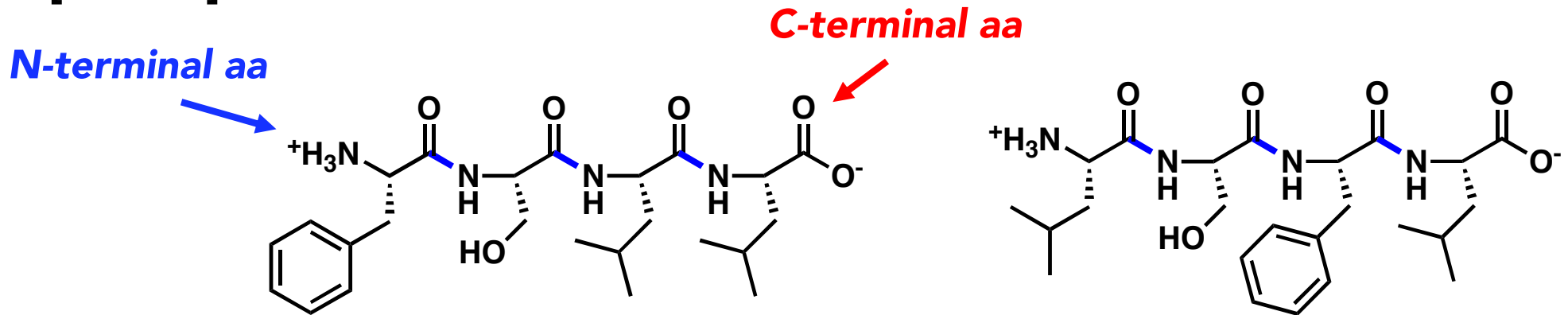
**peptides: formed from simple amino acids through peptide [amide] bonds**



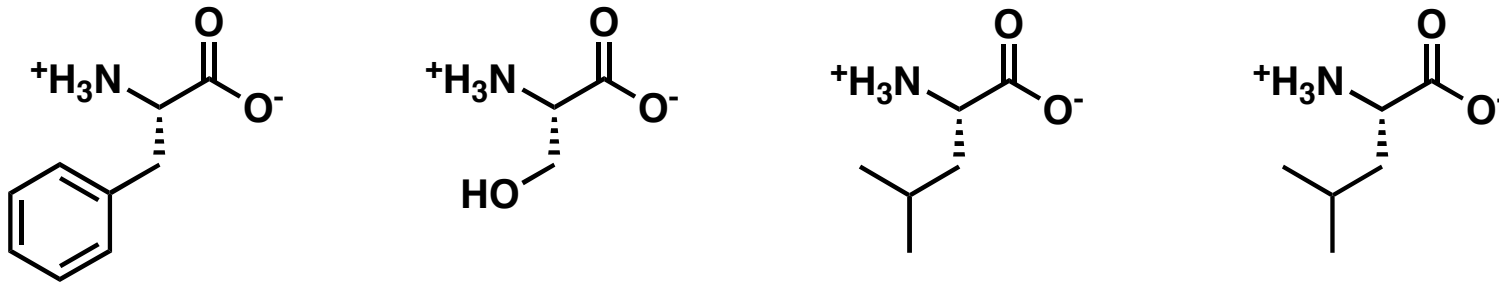
# Peptides/Proteins: **Peptide Bonds**



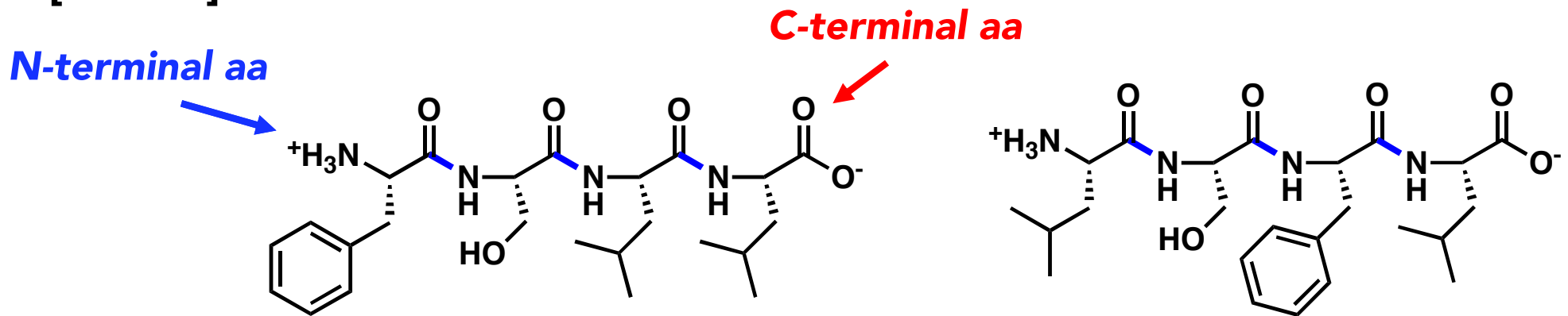
peptides: formed from simple amino acids through peptide [amide] bonds



# Peptides/Proteins: Peptide Bonds



peptides: formed from simple amino acids through peptide [amide] bonds

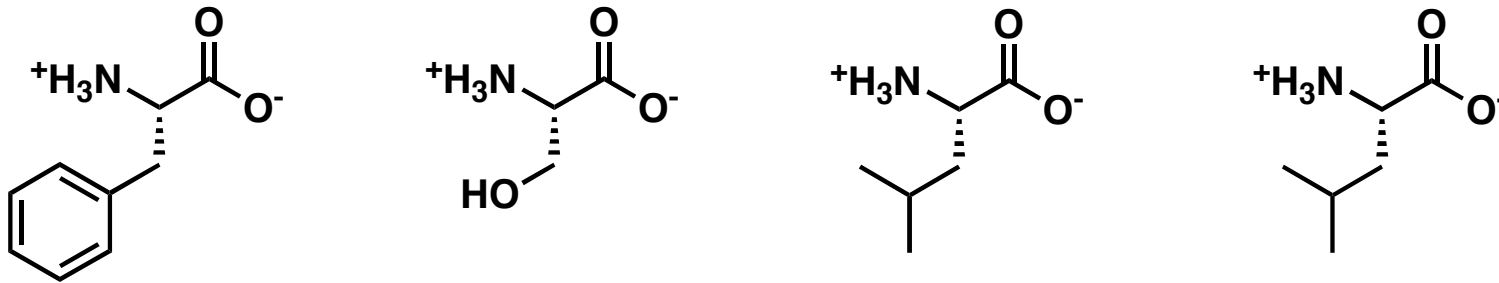


if sequence  
known

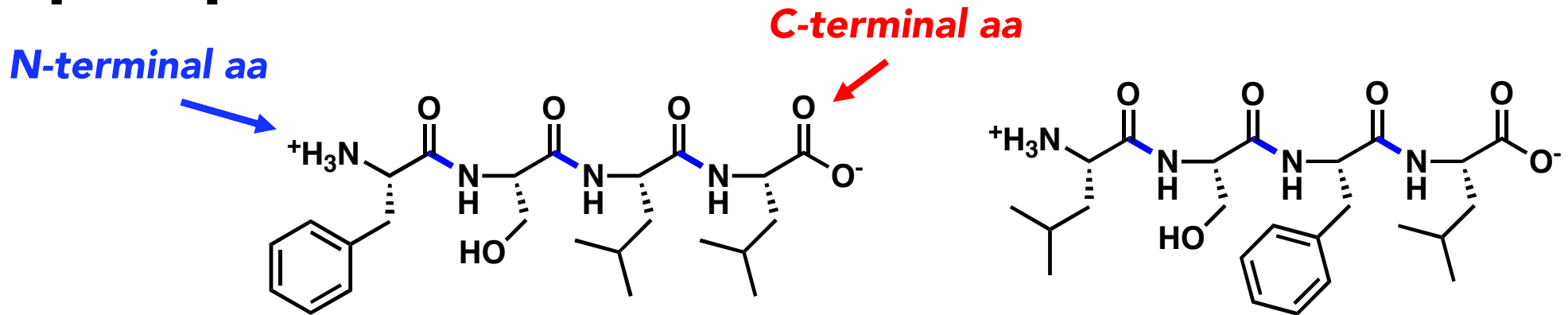
Phe-Ser-Leu-Leu  
FSLL

Leu-Ser-Phe-Leu  
LSFL

# Peptides/Proteins: Peptide Bonds



peptides: formed from simple amino acids through peptide [amide] bonds



if sequence  
known

Phe-Ser-Leu-Leu  
FSLL

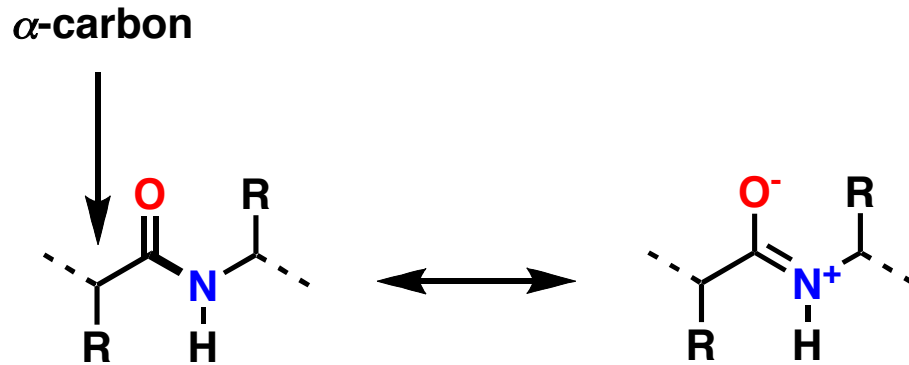
Leu-Ser-Phe-Leu  
LSFL

if sequence  
unknown

Leu, Phe, Ser

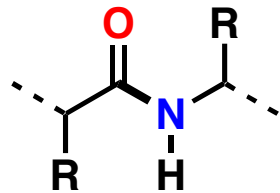
Leu, Phe, Ser

# Peptides/Proteins: Peptide Bonds

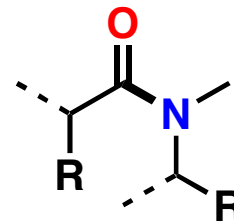


peptide bond:

- about 40% double bond character
- restricted rotation
- s-trans is more stable

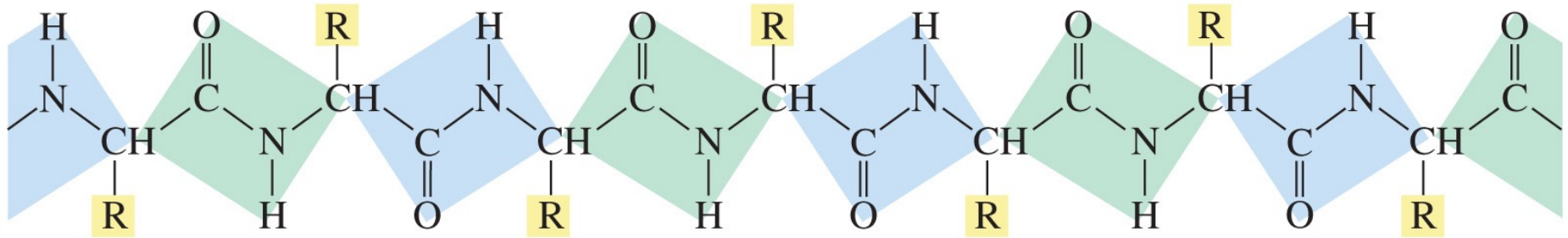


s-trans  
strongly FAVORED



s-cis  
strongly disfavored

# Peptides/Proteins: **Peptide Bonds**



- colored squares - planar
- where is free rotation?



# Peptides/Proteins: **Peptide Bonds**

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## **PROBLEM 26**

**Draw the tetrapeptide Ala-Thr-Asp-Asn and indicate the peptide bonds**

# Peptides/Proteins: **Peptide Bonds**

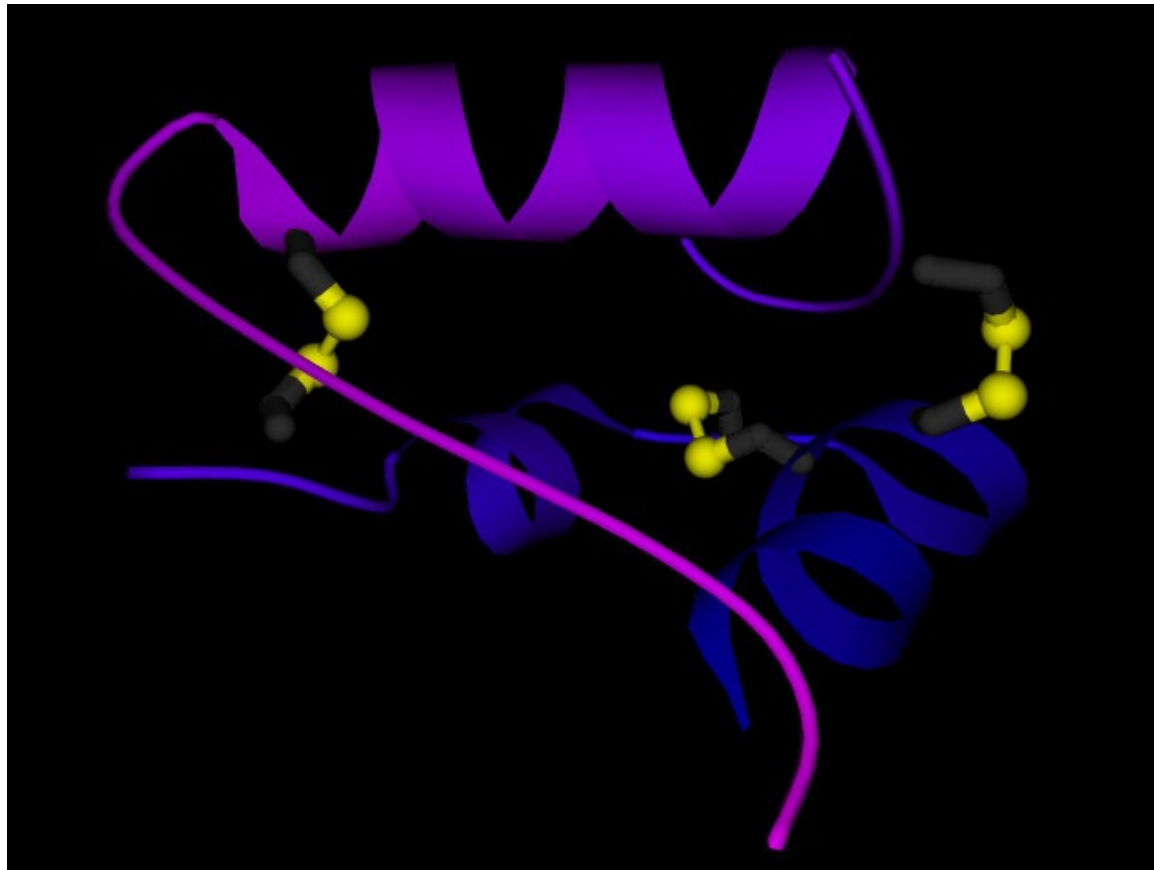
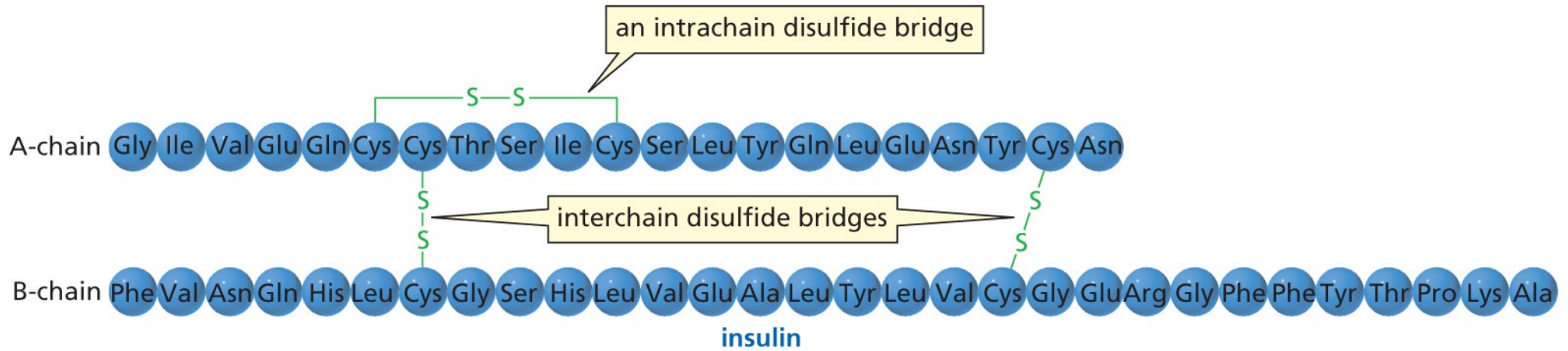
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## **PRACTICE PROBLEM**

Using the three-letter abbreviations, write the six tripeptides consisting of Ala, Gly, and Met



# Peptides/Proteins: Disulfide Bonds



# Peptides/Proteins: **Some Interesting Peptides**

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## endorphines:

Tyr-Gly-Gly-Phe-Leu  
**leucine enkephalin**

Tyr-Gly-Gly-Phe-Met  
**methionine enkephalin**

# Peptides/Proteins: **Some Interesting Peptides**

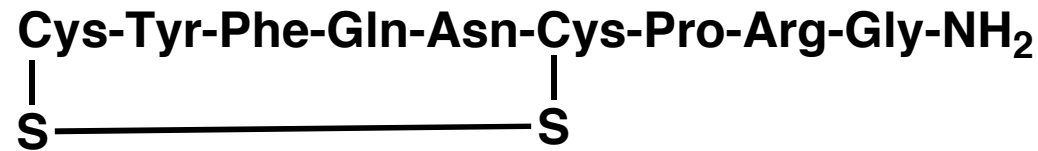
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## endorphins:

Tyr-Gly-Gly-Phe-Leu  
leucine enkephalin

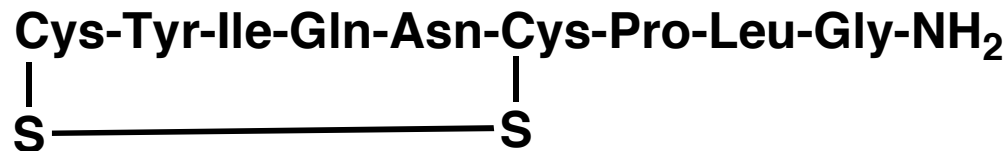
Tyr-Gly-Gly-Phe-Met  
methionine enkephalin

## fight-or-flight hormone:



vasopressin

## social bonding hormone:



oxytocin

# Peptides/Proteins: **Chemical Synthesis**

➤ **N-protection**

➤ **C-activation**

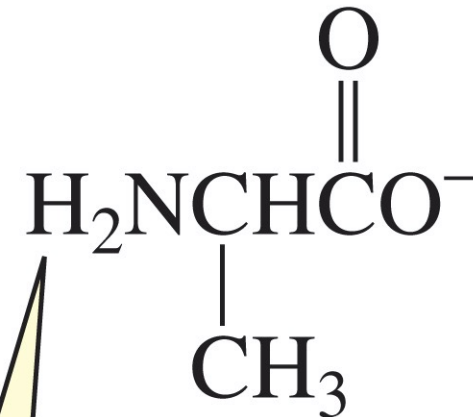
glycine

alanine

1. protect



2. activate



3.

peptide bond is formed between these groups

# Peptides/Proteins: **Chemical Synthesis**

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## Making Gly-Ala

### Step 1. Protect N of Gly



# Peptides/Proteins: **Chemical Synthesis**

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## Making Gly-Ala

**Step 1. Protect N of Gly**

**Step 2. Activating N-protected Gly**

# Peptides/Proteins: **Chemical Synthesis**

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## **Making Gly-Ala**

**Step 1. Protect N of Gly**

**Step 2. Activating N-protected Gly**

**Step 3. Adding Ala**

# Peptides/Proteins: **Chemical Synthesis**

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## Making Gly-Ala

**Step 1. Protect N of Gly**

**Step 2. Activating N-protected Gly**

**Step 3. Adding Ala**

**Step 4. Deprotection**

**N-terminal aa**  **C-terminal aa**

# Peptides/Proteins: **Chemical Synthesis**

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overall yield for the attachment of amino acids:

	number of amino acids							
	2	3	4	5	6	7	8	9
overall yield	80%	64%	51%	41%	33%	26%	21%	17%

# Peptides/Proteins: **Chemical Synthesis**

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## **PRACTICE PROBLEM**

**Show the steps in the synthesis of Leu-Phe-Lys-Val**

# Peptides/Proteins: **Chemical Synthesis**

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## **PRACTICE PROBLEM**

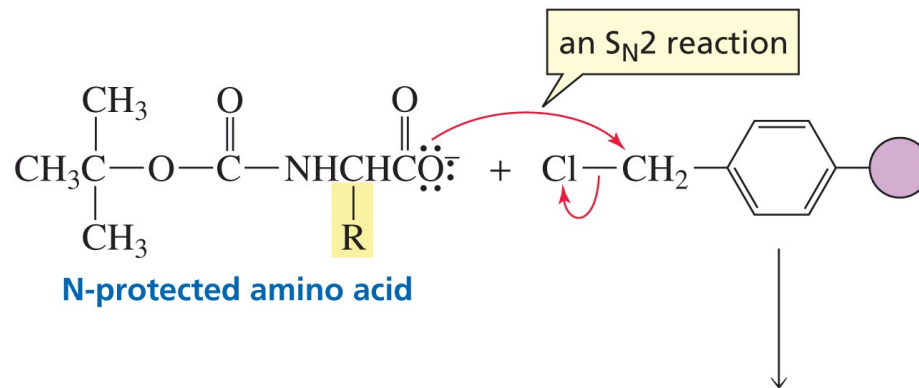
Calculate the overall yield of bradykinin when the yield for the addition of each amino acid to the chain is 70%.

**Arg-Pro-Pro-Gly-Phe-Ser-Pro-Phe-Arg**

# Peptides/Proteins: **Chemical Synthesis**

## Merrifield automated synthesis

Merrifield automated solid-phase synthesis of a tripeptide



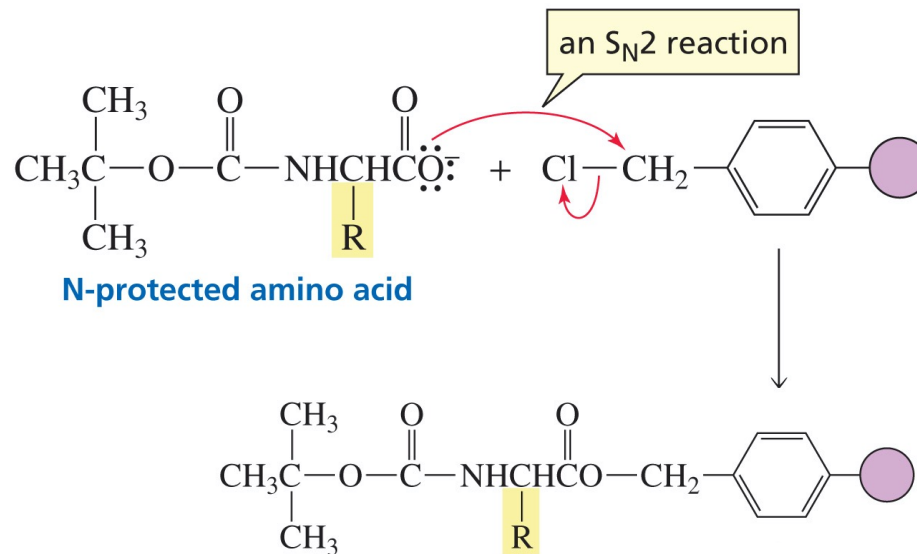
### ***overview of the Merrifield automated synthesis:***

- **synthesis on solid support, >98% yield per a.a.**
- **C to N terminus**
- **nonapeptide bradykinin synthesized in 4 h and 85% overall yield**
- **limitation: up to a 100 amino acids**

# Peptides/Proteins: Chemical Synthesis

## Merrifield automated synthesis

Merrifield automated solid-phase synthesis of a tripeptide

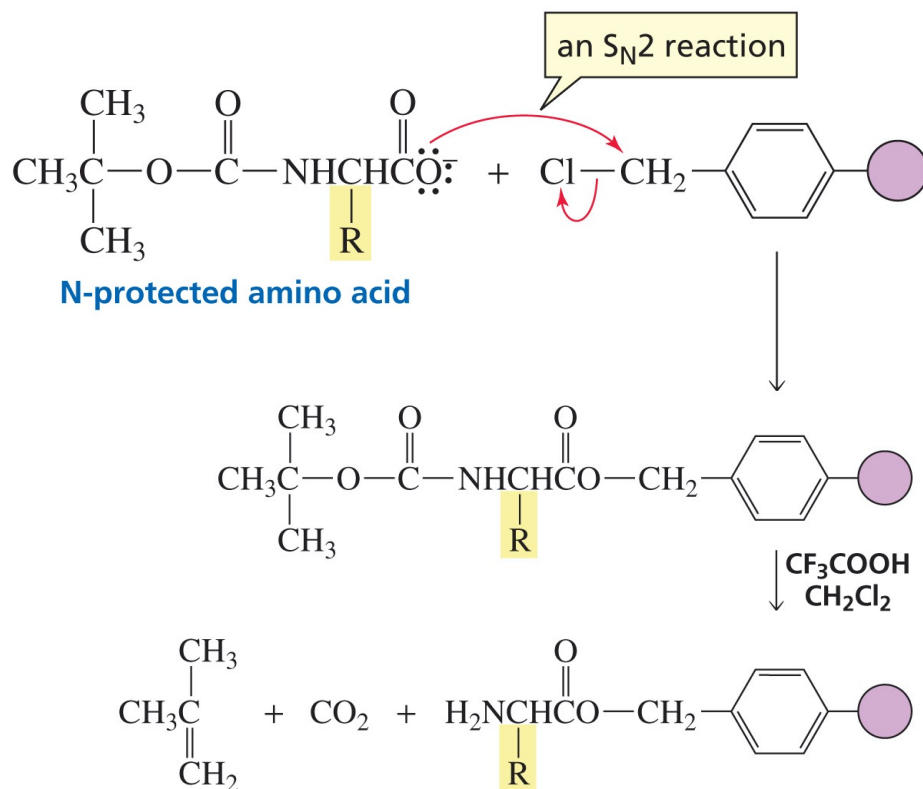




# Peptides/Proteins: Chemical Synthesis

## Merrifield automated synthesis

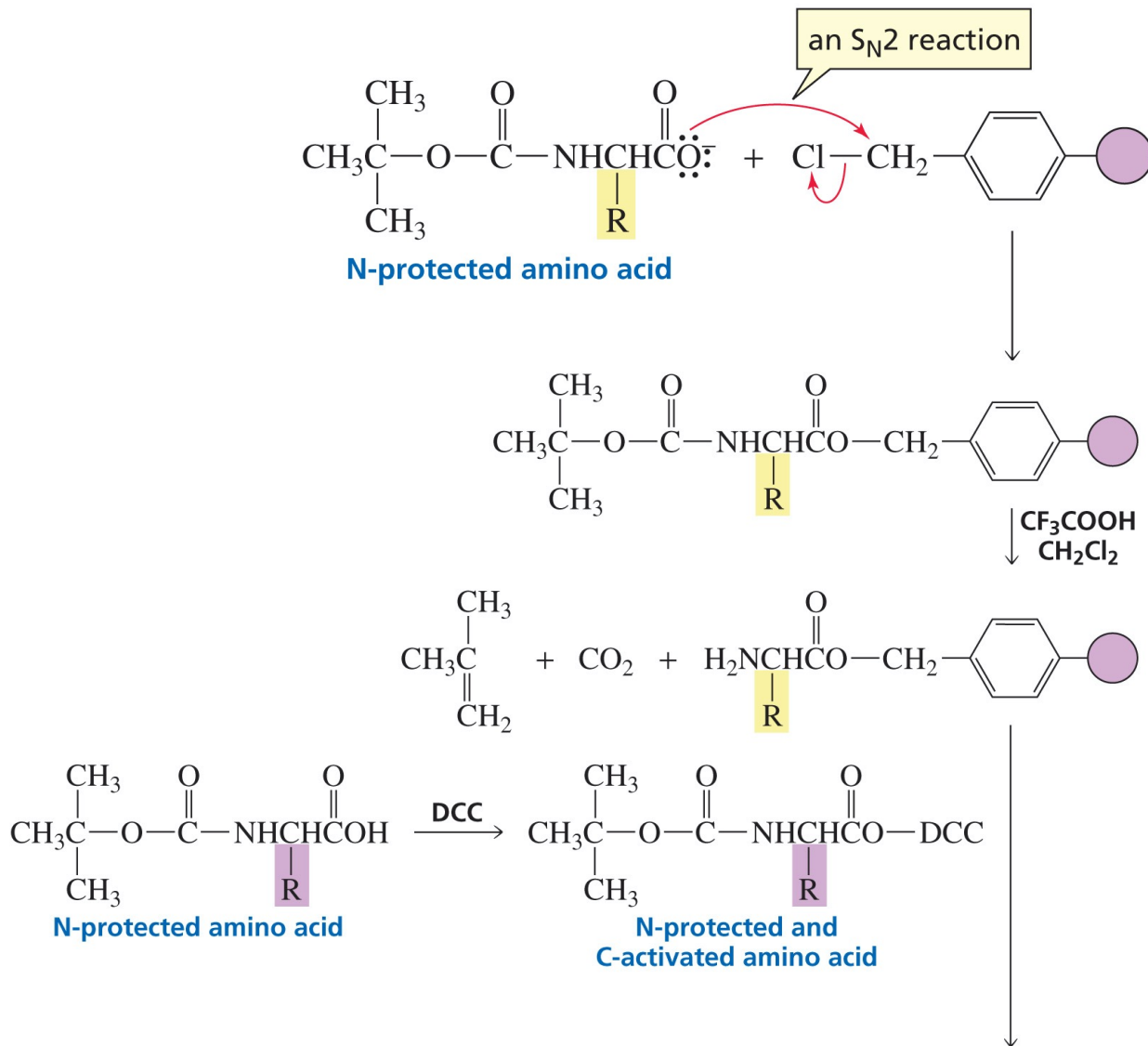
Merrifield automated solid-phase synthesis of a tripeptide



# Peptides/Proteins: **Chemical Synthesis**

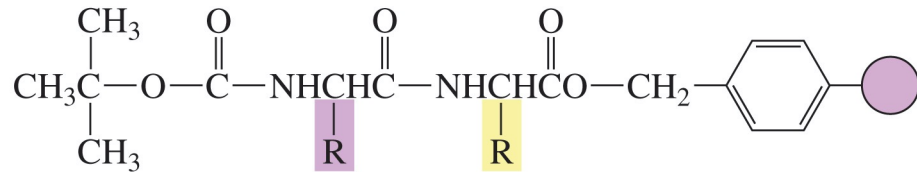
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Merrifield automated solid-phase synthesis of a tripeptide



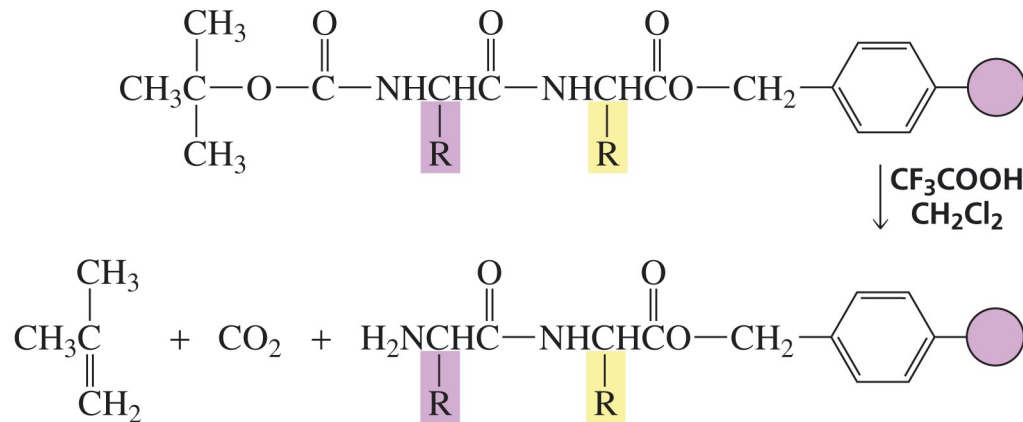
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## Merrifield automated synthesis



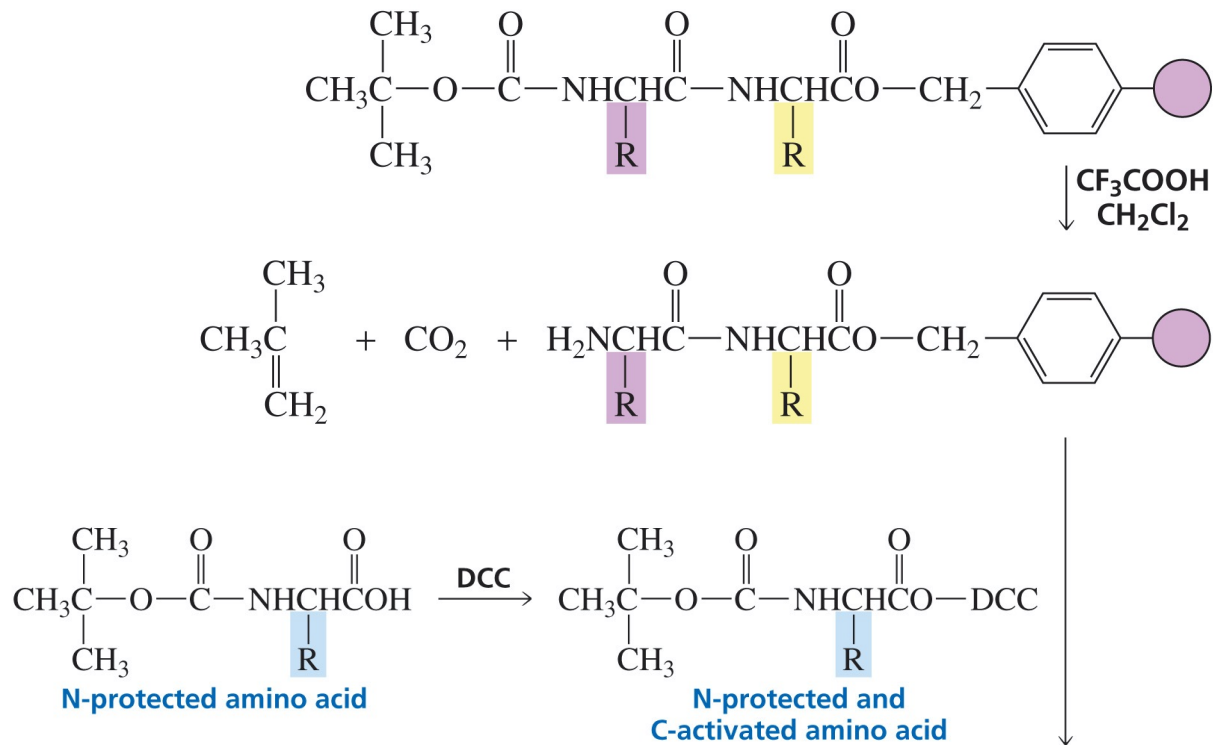
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## Merrifield automated synthesis



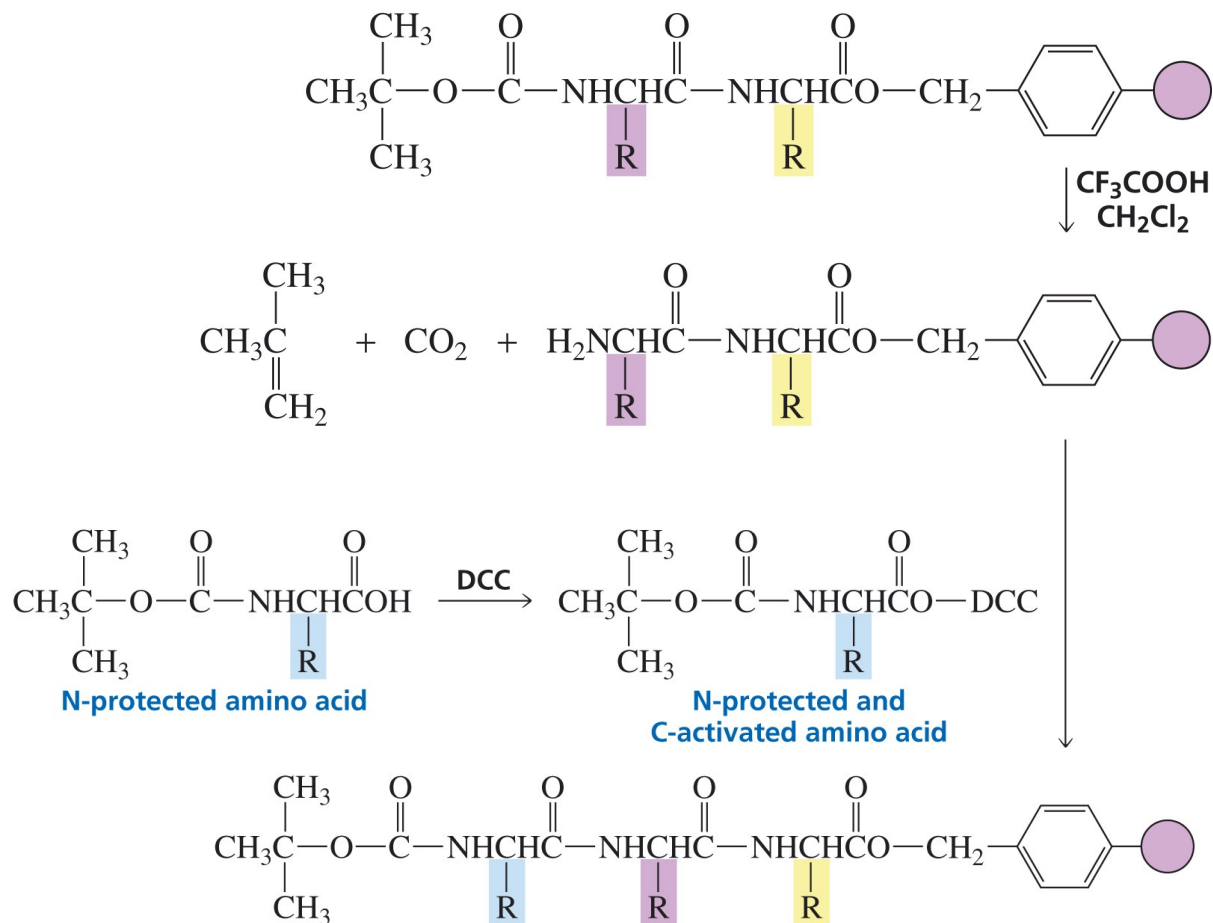
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## Merrifield automated synthesis



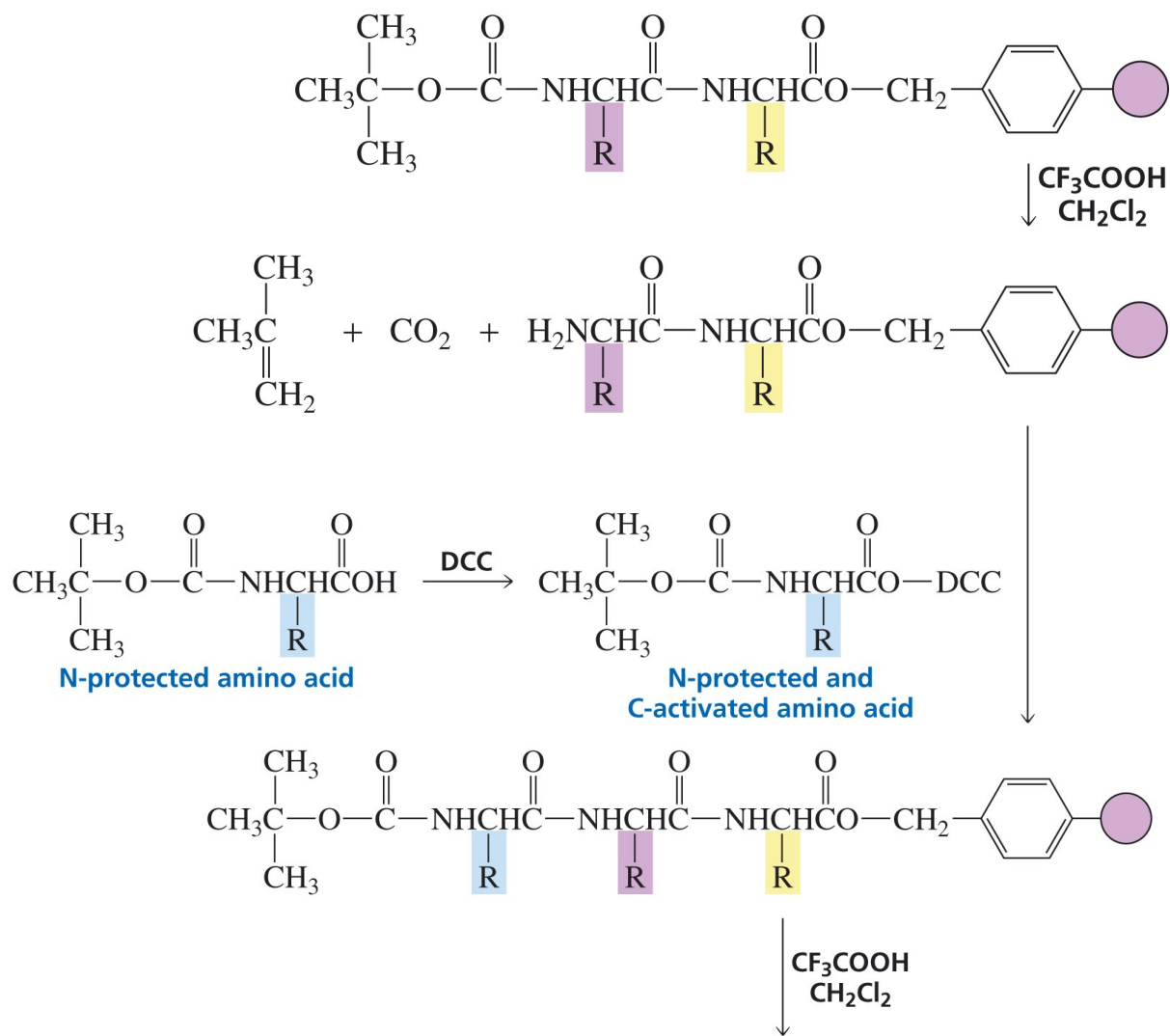
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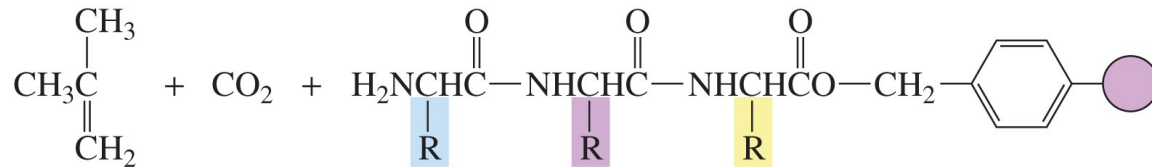
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## Merrifield automated synthesis



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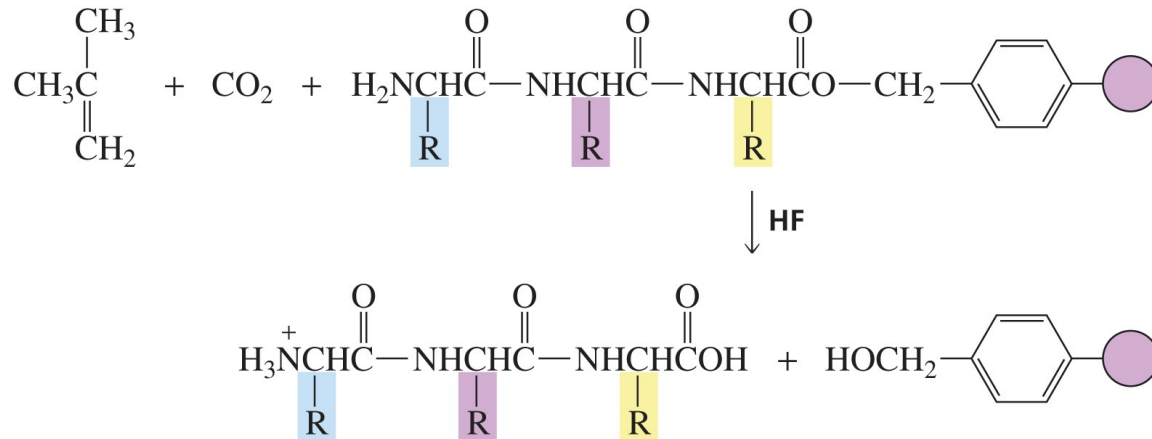
## Merrifield automated synthesis





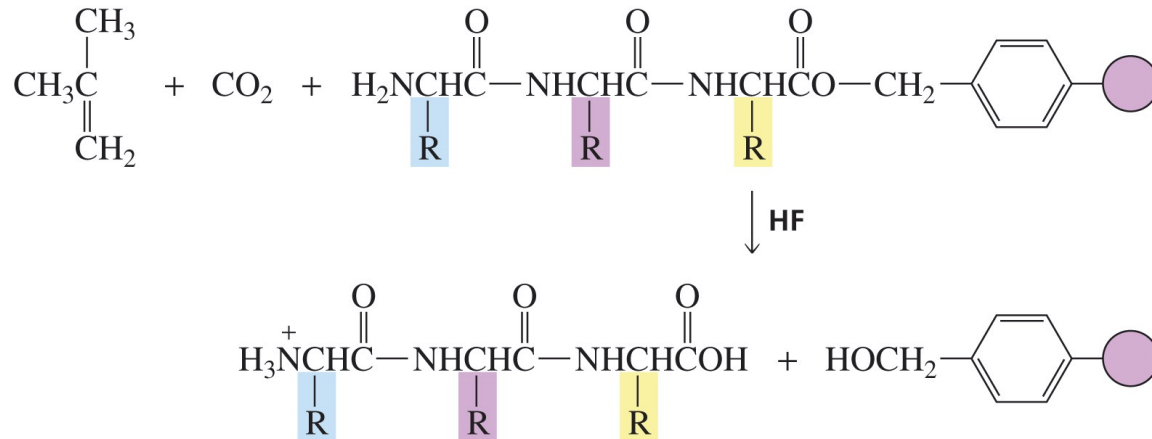
# Peptides/Proteins: **Chemical Synthesis**

## Merrifield automated synthesis



# Peptides/Proteins: **Chemical Synthesis**

## Merrifield automated synthesis



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Friday, October 14, WEBB 1100, 9 – 9:50 am

- **Chapter 20. Carbohydrates.**

**All Sections except 20.13, 20.17, 20.19**

- **Chapter 21. Amino acids, Proteins.**

**All sections Up to 21.11, including 21.11**

**structures of carbohydrates (except glucose, mannose, and galactose) and amino acids will be provided**

**pKa of side-chains will be provided**