

Universidad Nacional Autónoma de México

Química Orgánica IV (1606)

Laboratorio

Semestre 2026 - 2

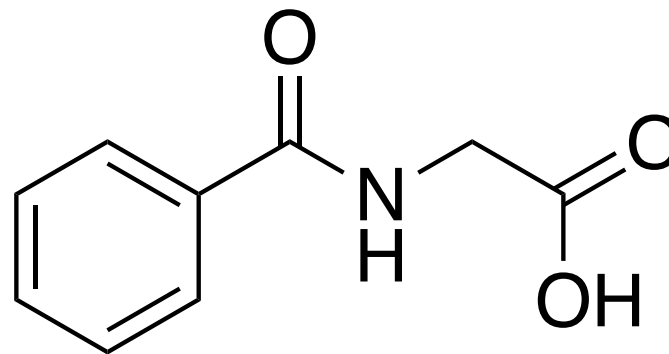


M. en C. Arturo García Zavala

Práctica 9

Aminoácidos y péptidos I

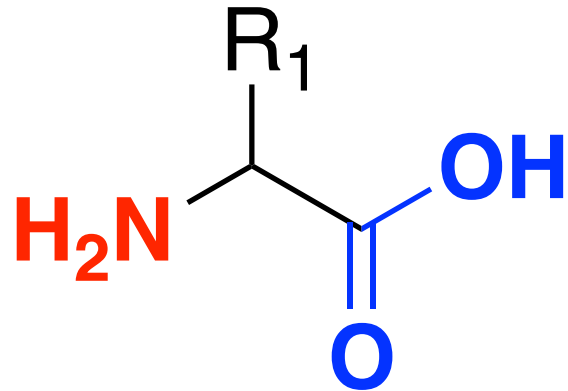
Síntesis del ácido hipúrico



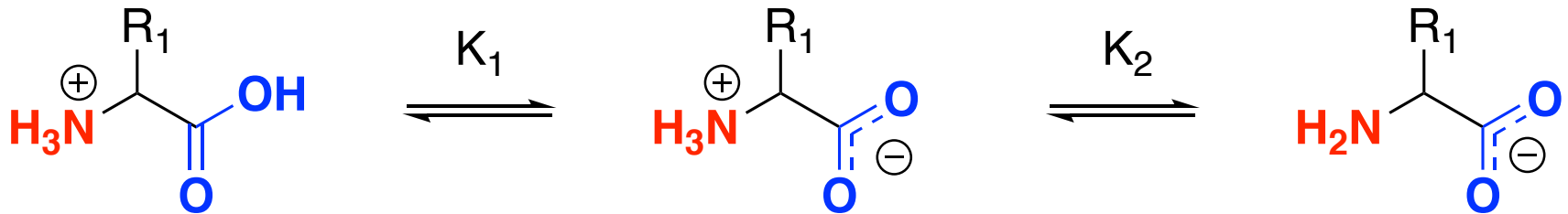
A1

20/04/2026

Aminoácidos



Moléculas que contienen el grupo **ácido carboxílico** y el grupo **amina**.



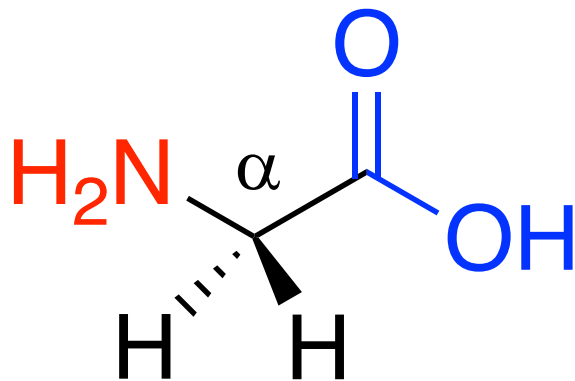
cación

zwitterión

anión

Alfa-aminoácidos

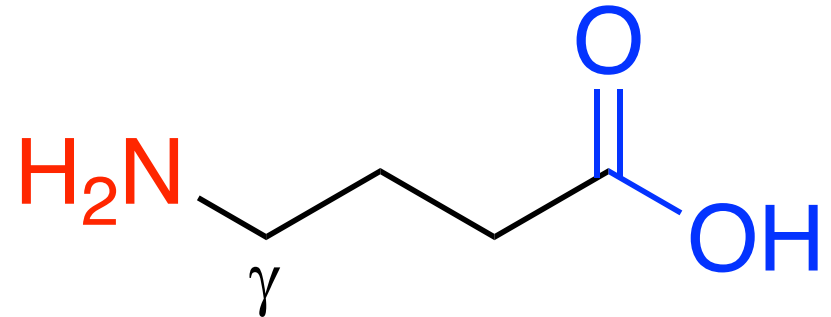
Grupo **ácido carboxílico** y el grupo **amina** se encuentran unidos al mismo átomo de carbono.



Glicina

Otros aminoácidos

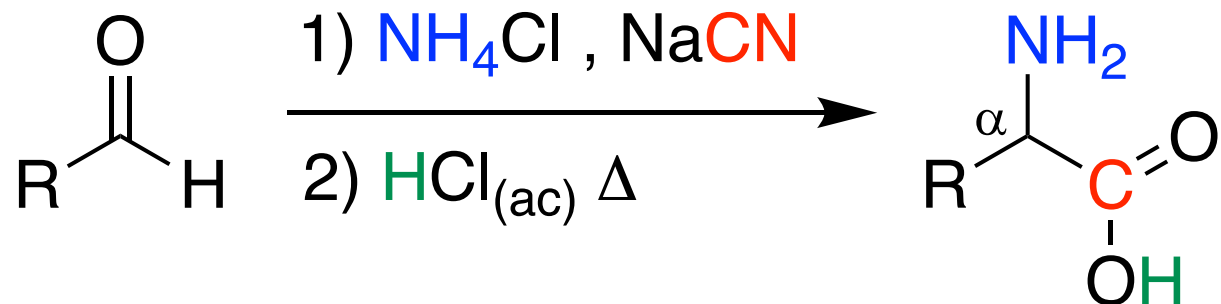
Grupo **ácido carboxílico** y el grupo **amina** se encuentran alejados.



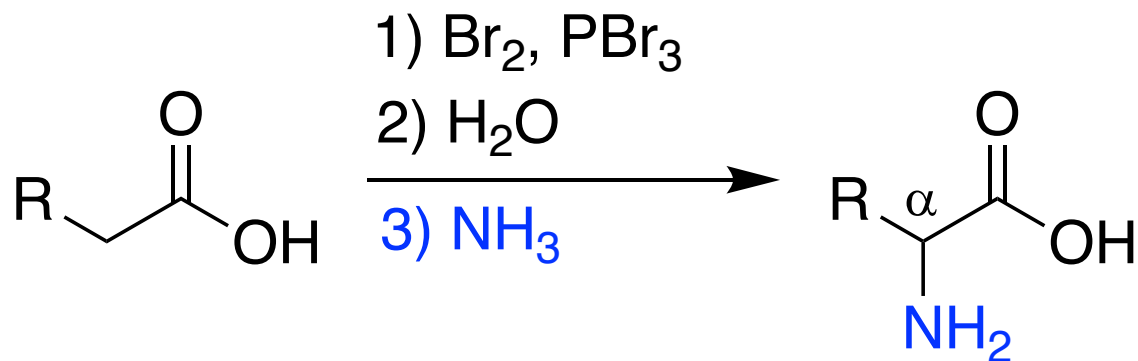
GABA
(neurotransmisor)

Síntesis de alfa-aminoácidos

Síntesis de Strecker

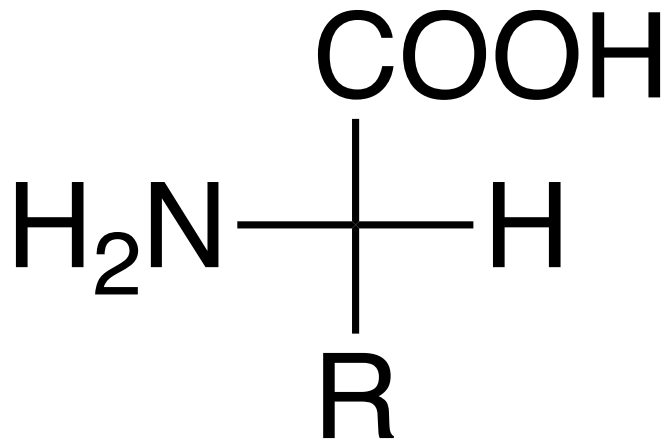


Síntesis de Hell-Volhard-Zelinsky (HVZ) con posterior S_N2



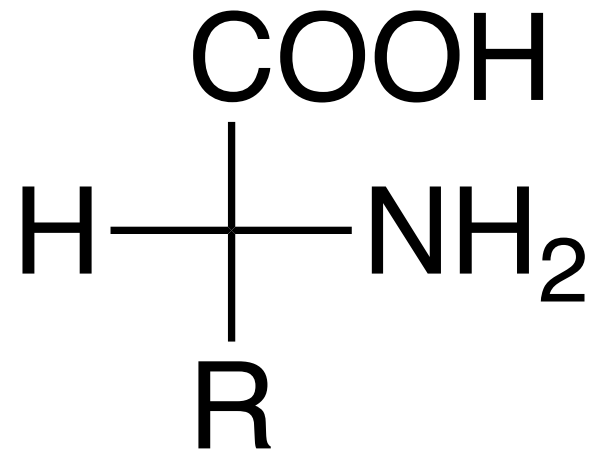
Isómería de los aminoácidos

Proyecciones de Fischer



L

Tienen el grupo amino del carbono alfa en el lado left



D

Tienen el grupo amino del carbono alfa en el lado derecho

A GUIDE TO THE TWENTY COMMON AMINO ACIDS

AMINO ACIDS ARE THE BUILDING BLOCKS OF PROTEINS IN LIVING ORGANISMS. THERE ARE OVER 500 AMINO ACIDS FOUND IN NATURE - HOWEVER, THE HUMAN GENETIC CODE ONLY DIRECTLY ENCODES 20. 'ESSENTIAL' AMINO ACIDS MUST BE OBTAINED FROM THE DIET, WHILST NON-ESSENTIAL AMINO ACIDS CAN BE SYNTHESISED IN THE BODY.

Chart Key: ● ALIPHATIC ● AROMATIC ● ACIDIC ● BASIC ● HYDROXYLIC ● SULFUR-CONTAINING ● AMIDIC ○ NON-ESSENTIAL ○ ESSENTIAL

Chemical Structure
single letter code
NAME **A**
three letter code
DNA codons

ALANINE **A**
Ala
GCT, GCC, GCA, GCG

GLYCINE **G**
Gly
GGT, GGC, GGA, GGG

ISOLEUCINE **I**
Ile
ATT, ATC, ATA

LEUCINE **L**
Leu
CGT, CTC, CTA, CTG, TTA, TTG

PROLINE **P**
Pro
CCT, CCC, CCA, CCG

VALINE **V**
Val
GTT, GTC, GTA, GTG

PHENYLALANINE **F**
Phe
TTT, TTC

TRYPTOPHAN **W**
Trp
TGG

TYROSINE **Y**
Tyr
TAT, TAC

ASPARTIC ACID **D**
Asp
GAT, GAC

GLUTAMIC ACID **E**
Glu
GAA, GAG

ARGININE **R**
Arg
CGT, CGC, CGA, CGG, AGA, AGG

HISTIDINE **H**
His
CAT, CAC

LYSINE **K**
Lys
AAA, AAG

SERINE **S**
Ser
TCT, TCC, TCA, TCG, AGT, AGC

THREONINE **T**
Thr
ACT, ACC, ACA, ACG

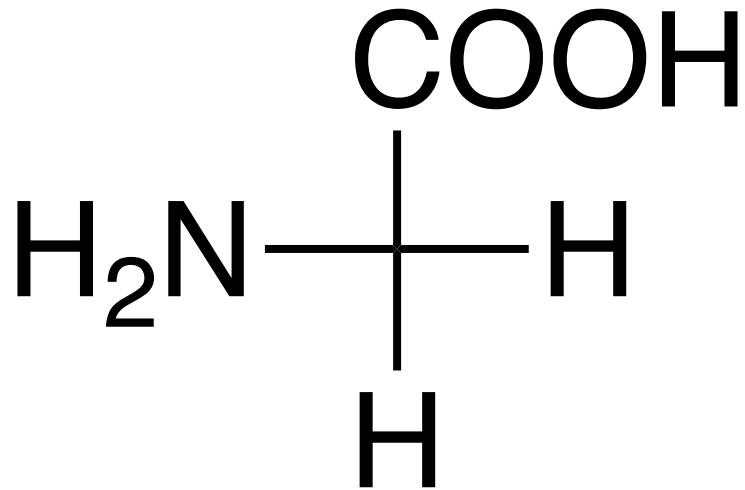
CYSTEINE **C**
Cys
TGT, TGC

METHIONINE **M**
Met
ATG

ASPARAGINE **N**
Asn
AAT, AAC

GLUTAMINE **Q**
Gln
CAA, CAG

Note: This chart only shows those amino acids for which the human genetic code directly codes for. Selenocysteine is often referred to as the 21st amino acid, but is encoded in a special manner. In some cases, distinguishing between asparagine/aspartic acid and glutamine/glutamic acid is difficult. In these cases, the codes asx (B) and glx (Z) are respectively used.



Nombre

Glicina

Código de una letra

G

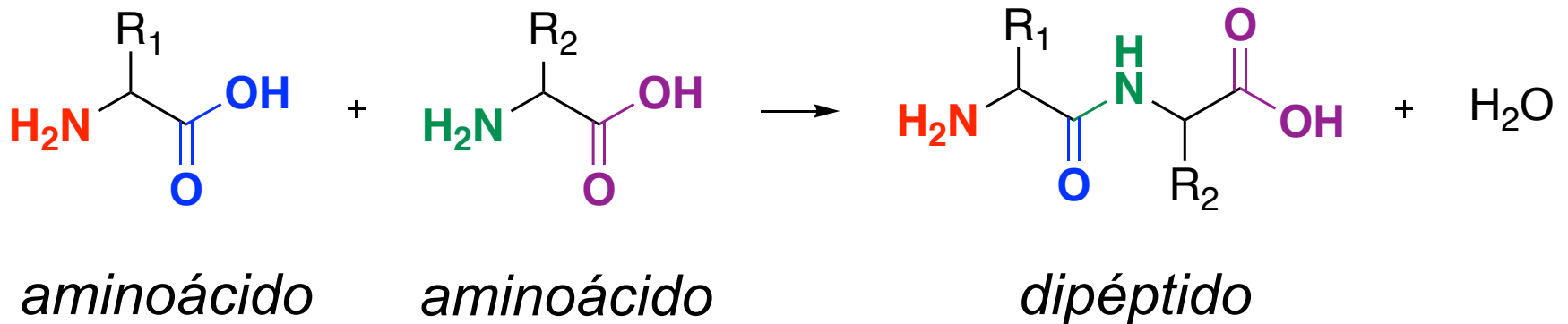
Código de tres letras

Gly

Enlace peptídico

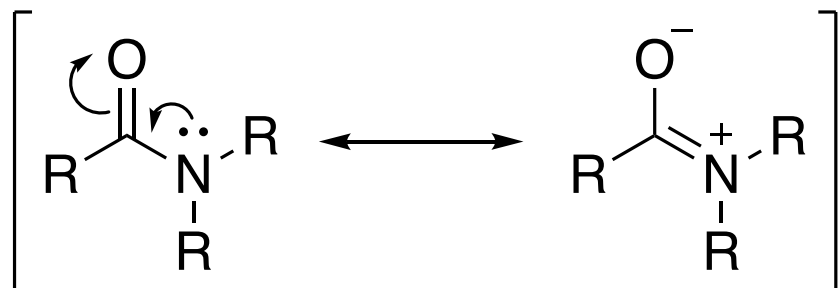
Fundamental para la formación de proteínas

Formación (en los ribosomas):

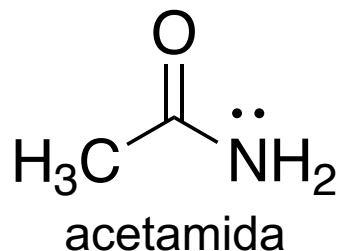
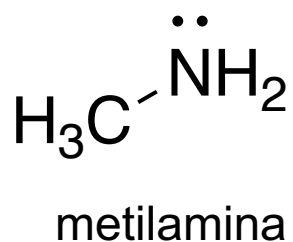
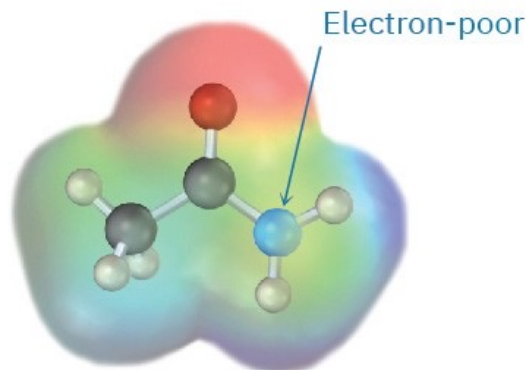
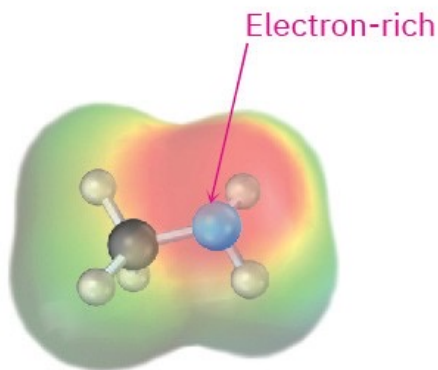


El enlace peptídico es un enlace tipo amida

Repaso: Propiedades químicas de las amidas



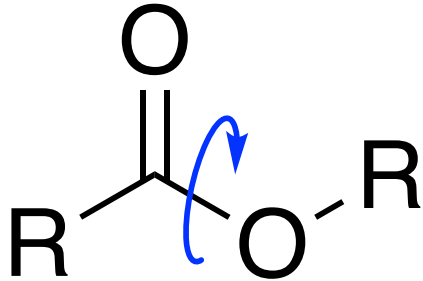
El nitrógeno de las amidas **no** es nucleofílico.



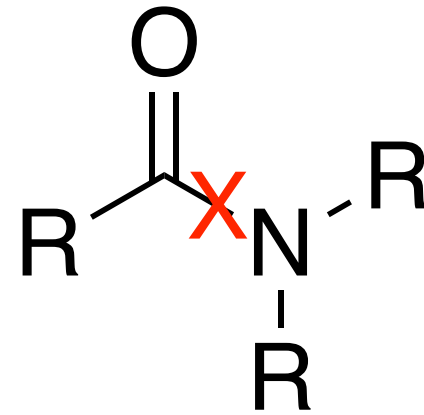
Estos átomos de nitrógeno son malas bases (no hay densidad electrónica).

Rigidez estructural

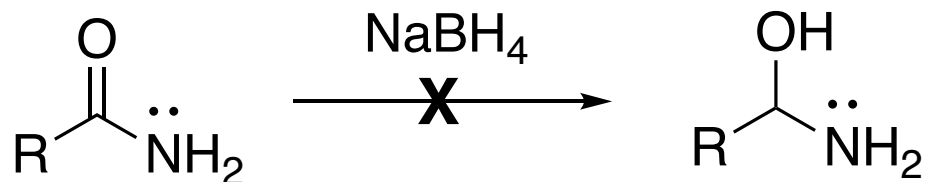
Éster
(Enlace rotatable)



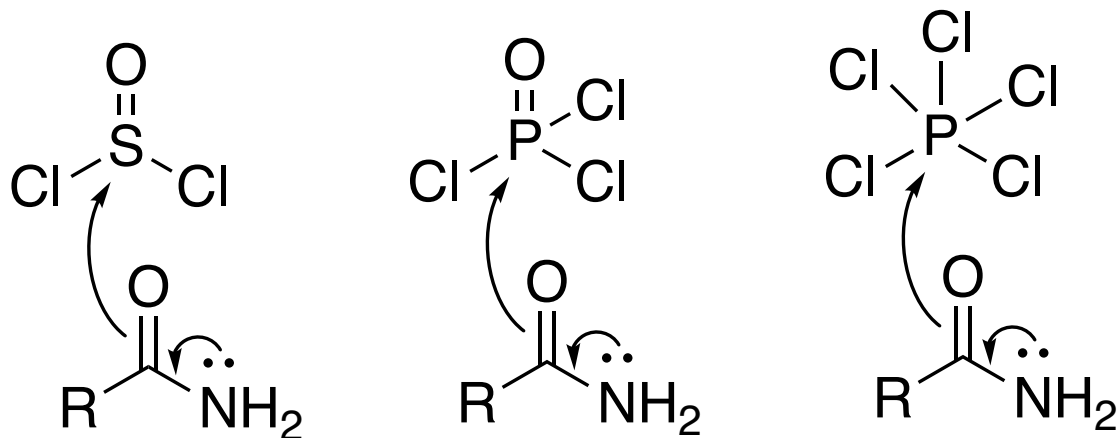
Amida
(Enlace rígido)



Consecuencias en la reactividad química de las amidas



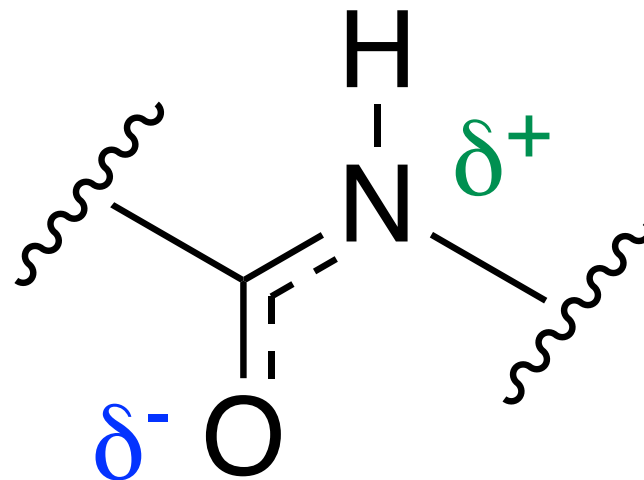
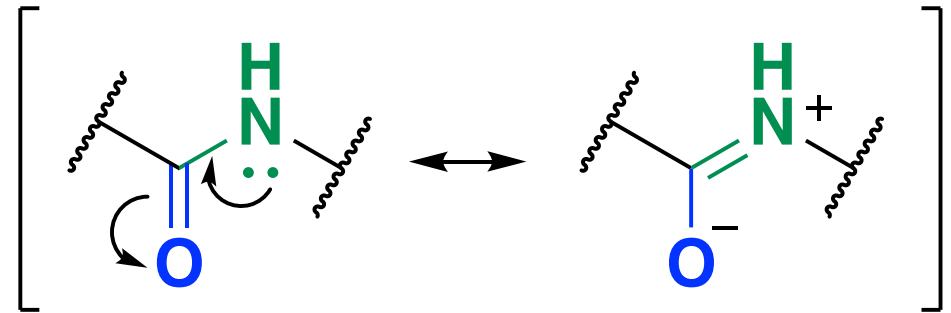
Su átomo de carbono no es muy electrofílico.



Reaccionarán como nucleófilos pero a través del átomo de oxígeno y solo frente a especies muy electrofílicas.

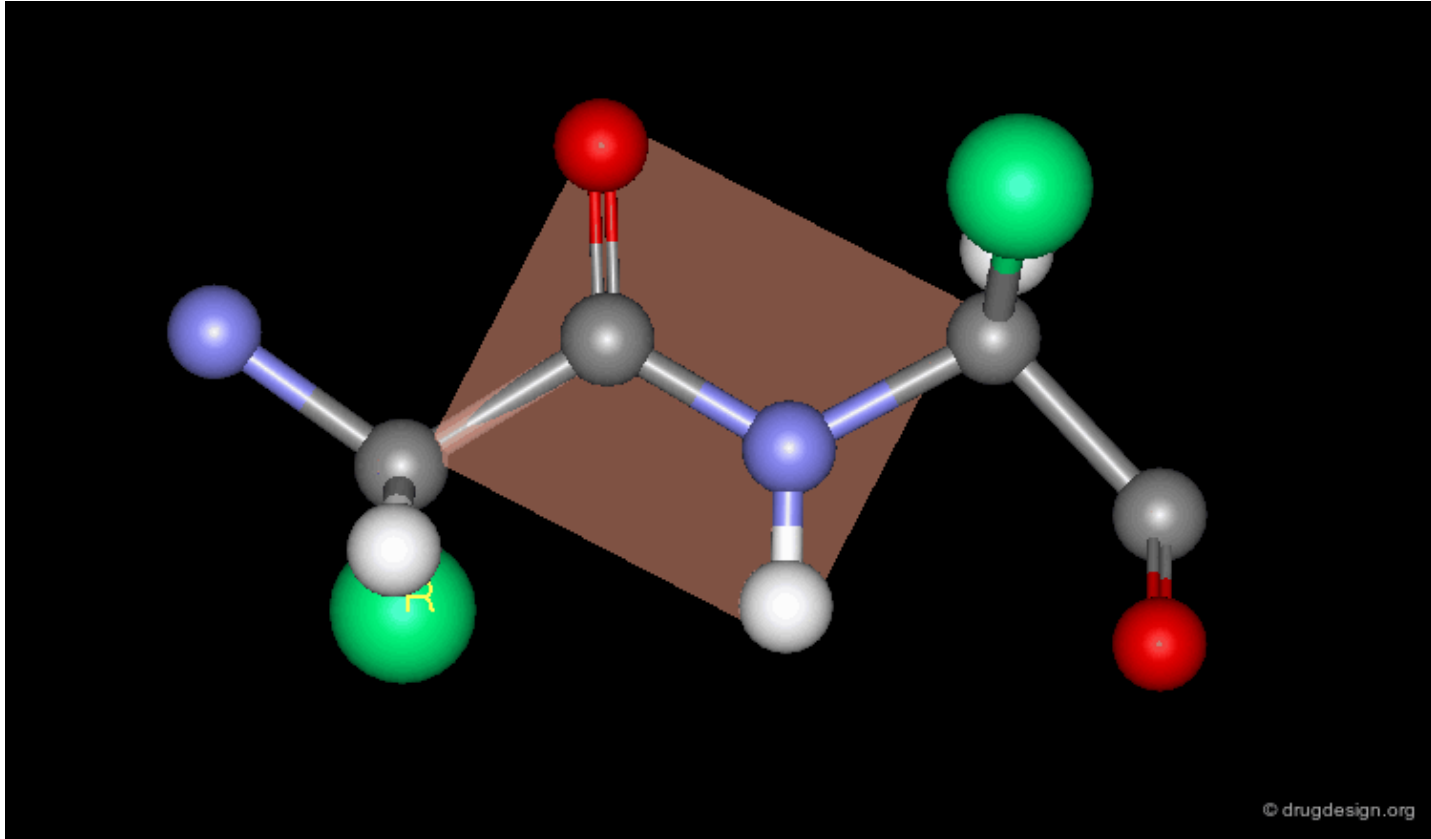
Características del enlace peptídico:

- Tipo amida
- Estable
- Plano
- Rígido
- Posee resonancia



Enlace peptídico

El oxígeno del C=O y el hidrógeno del N-H se encuentran en orientación antiperiplanar.



“Peptide Bonds are Planar”

Recuperado de: <https://www.drugdesign.org/chapters/protein-structure/#peptide-bonds-are-planar>

Acceso: 6 de abril de 2025

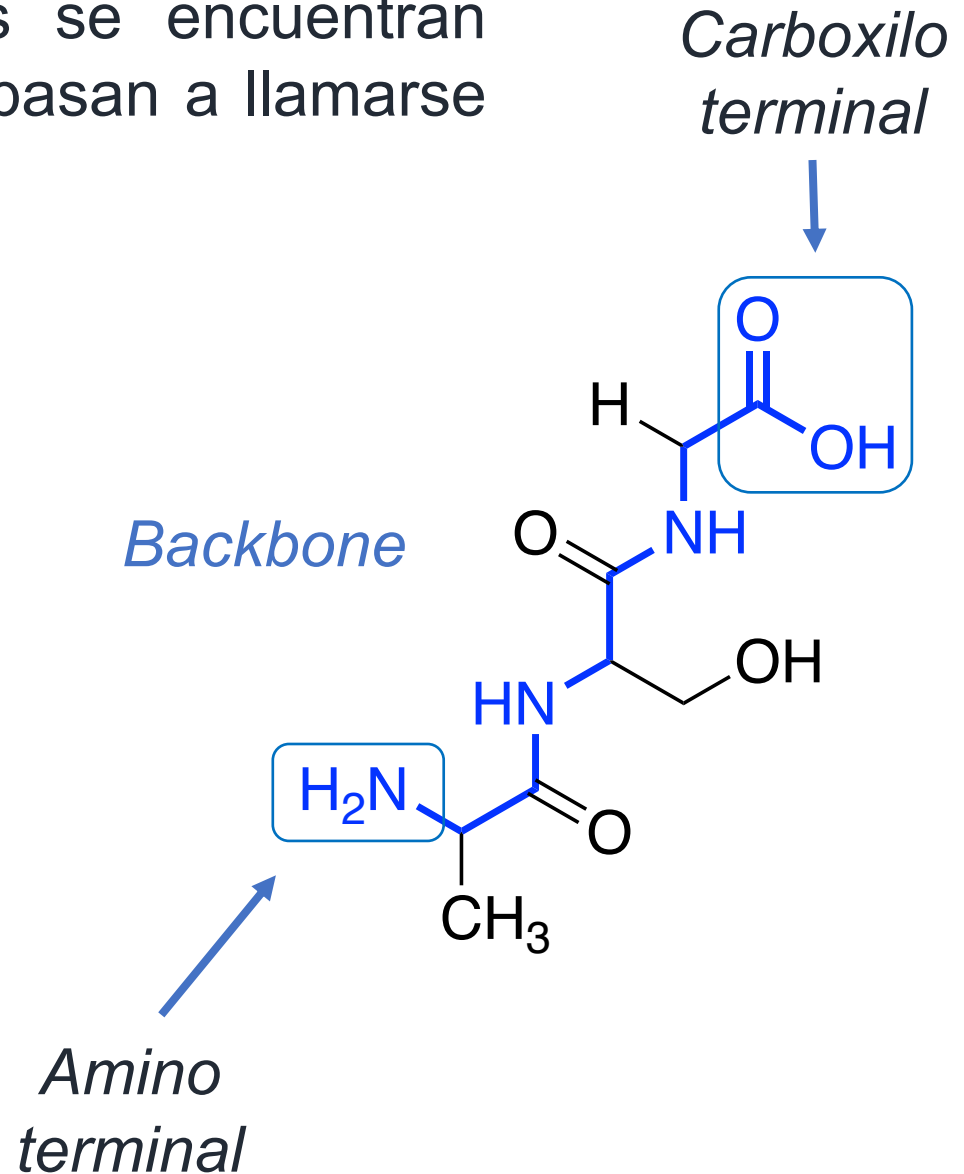
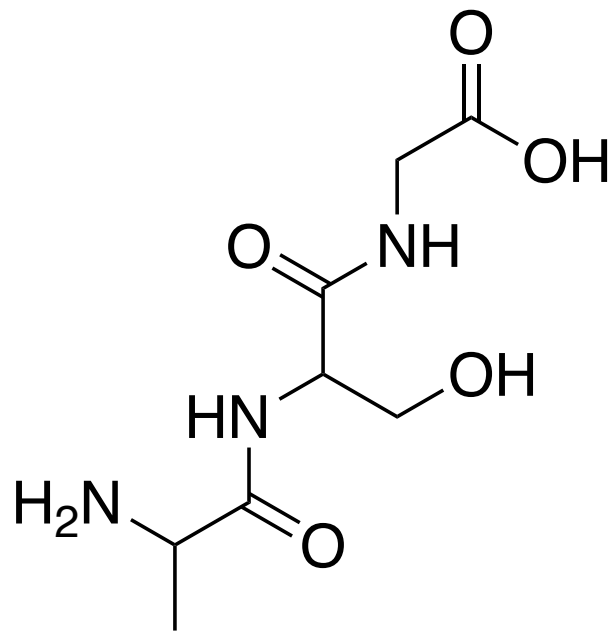
Polipéptido



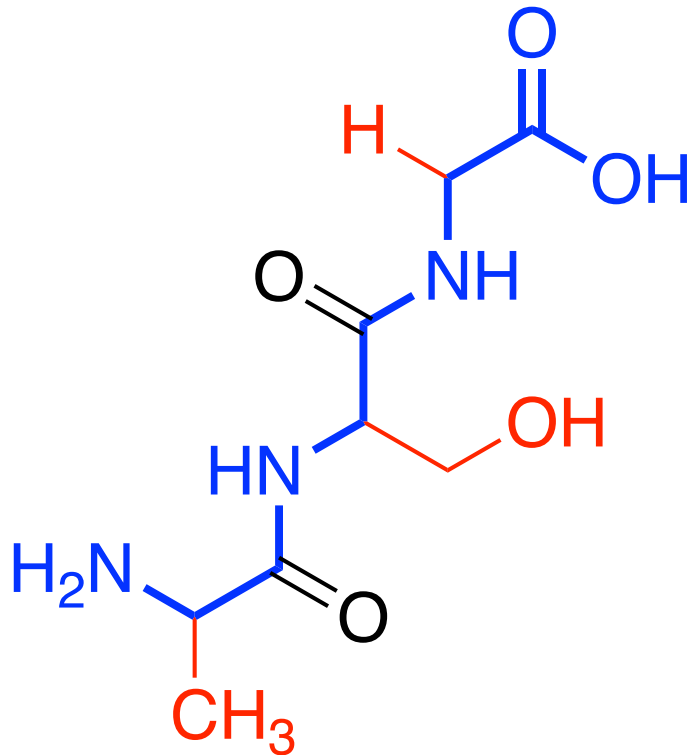
Conformación de una hebra beta en una lámina beta retorcida de la proteína LysC, ID PDB: 6SSC.

Adaptado de: https://proteopedia.org/wiki/index.php/Sheets_in_Proteins ocultando todas las hebras excepto una.

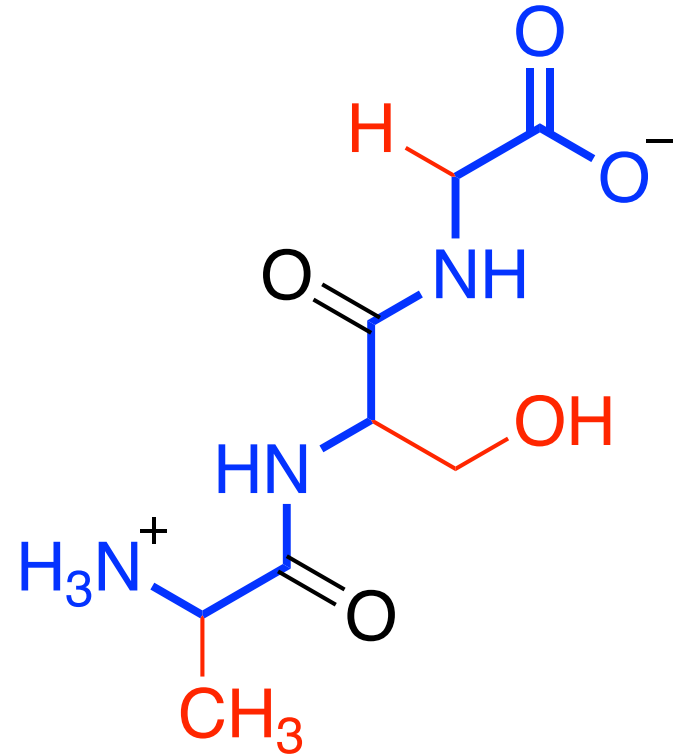
Cuando los aminoácidos se encuentran conformando un péptido pasan a llamarse *residuos*

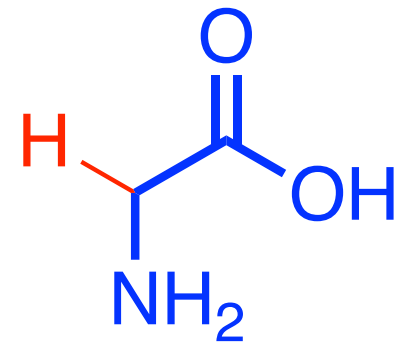


Sustituyentes de cada aminoácido

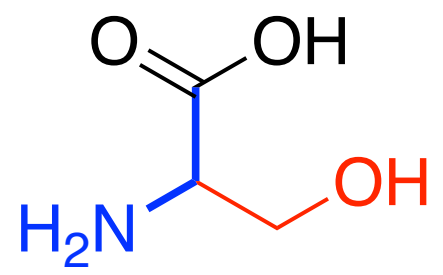


A pH fisiológico

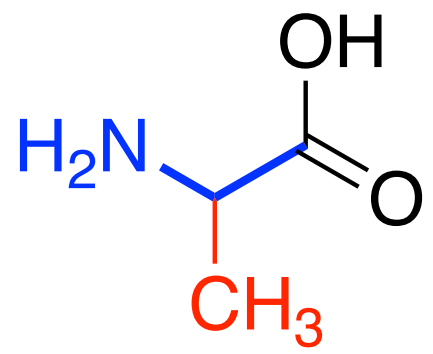




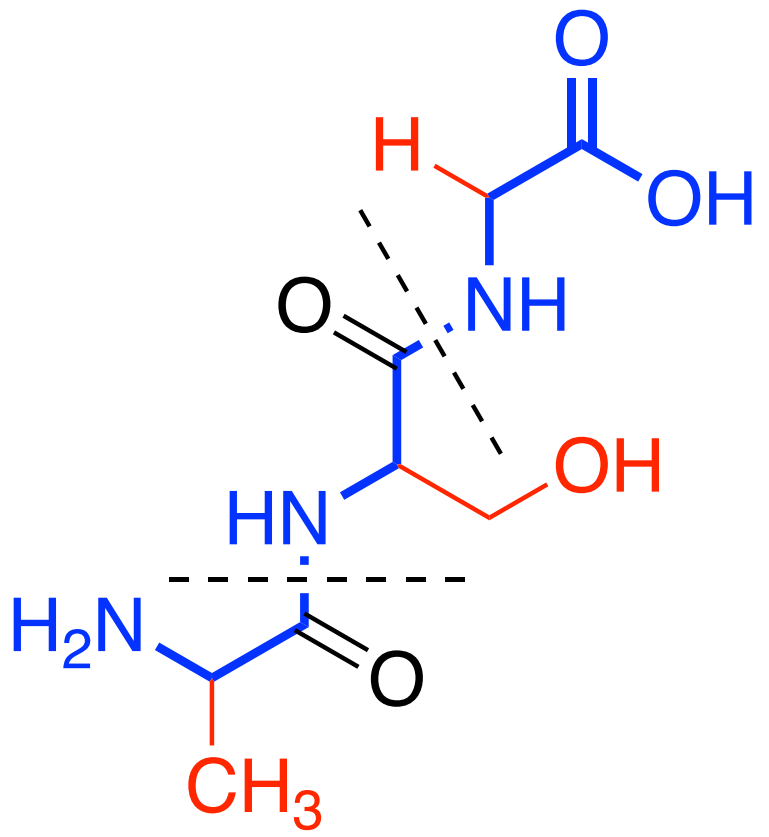
glicina



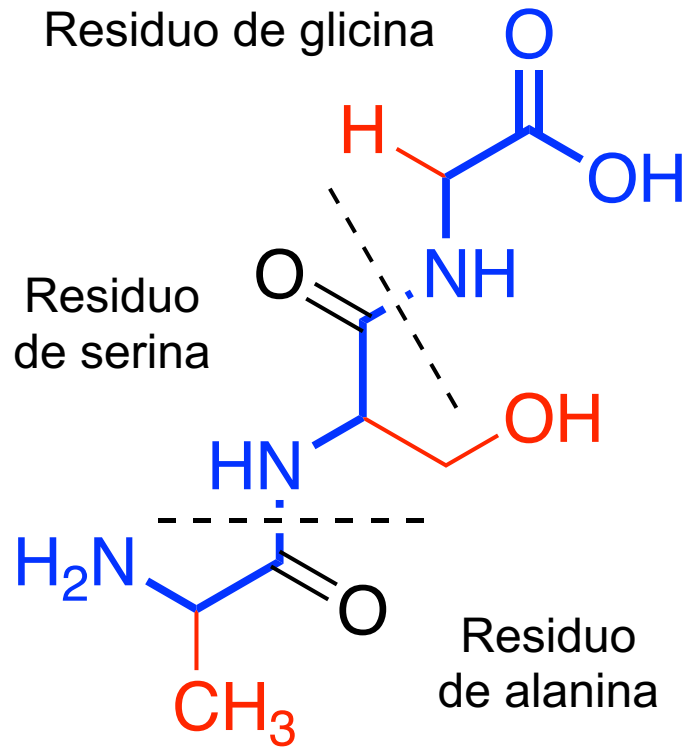
serina



alanina

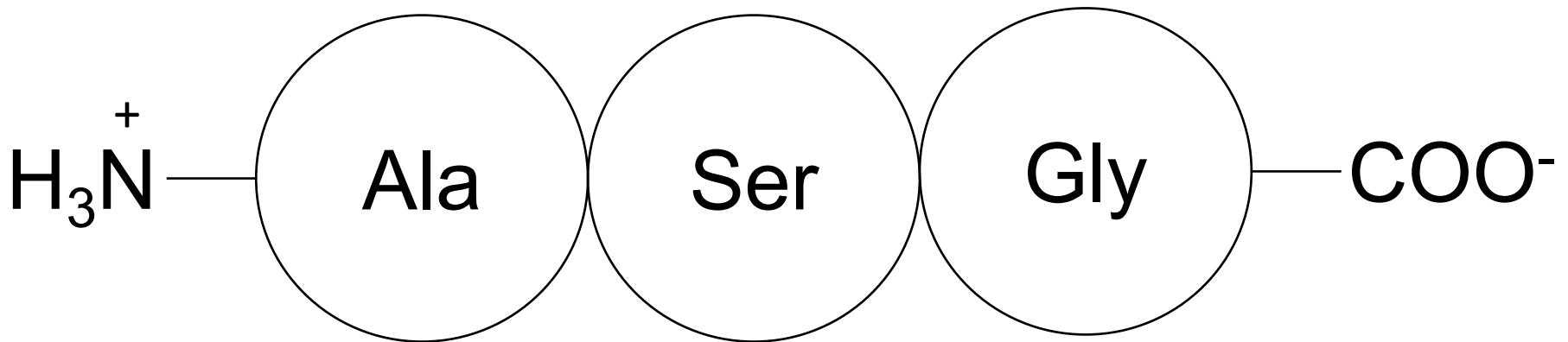


Representaciones de secuencias proteicas (estructura primaria de proteínas)



Ala-Ser-Gly

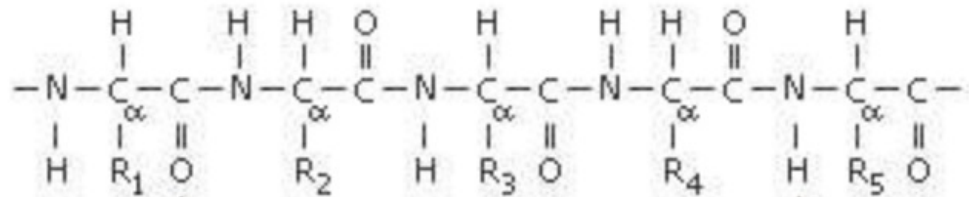
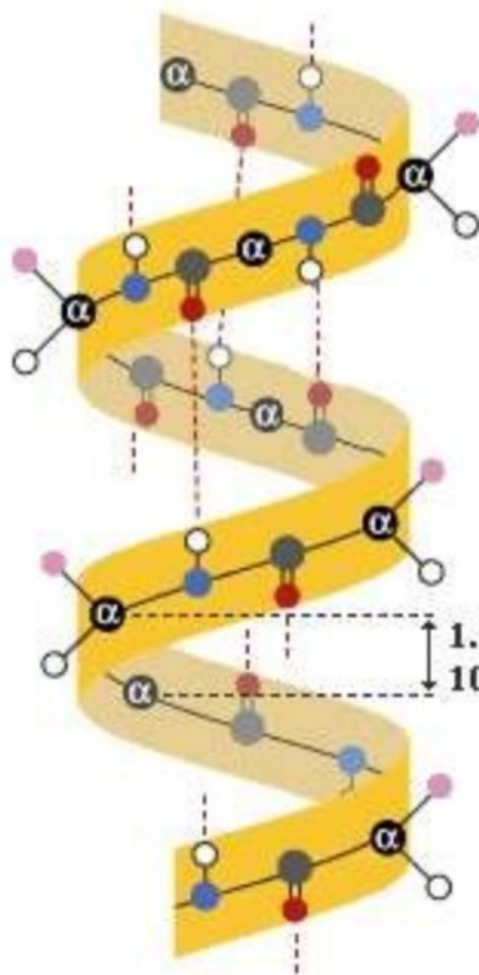
ASG



Plegamiento de proteínas: Estructura secundaria

- Hélices α

Interacciones de enlaces de hidrógeno entre el grupo amino y el carboxilo del enlace peptídico



Necesario mínimo 5 aminoácidos

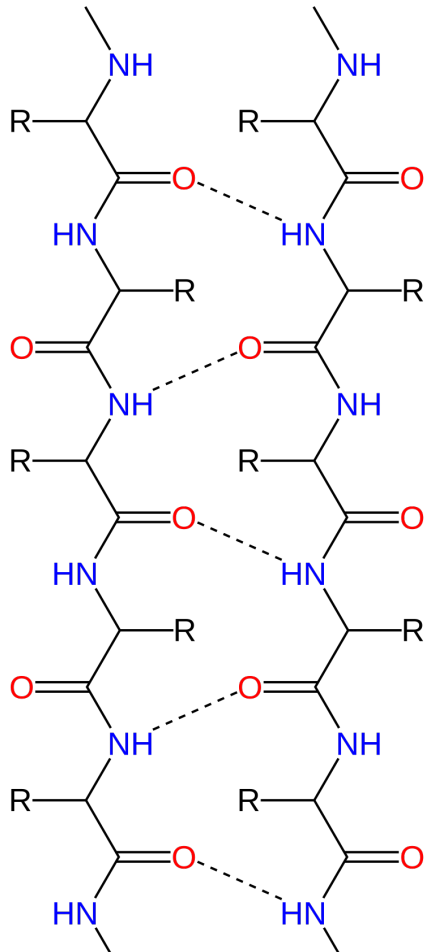
- ⊙ Alpha-carbon atom
- Carbon atom
- Nitrogen atom
- Oxygen atom
- Hydrogen atom
- Amino acid side chain
- ⋮ Hydrogen bond

Shukla, P. Machine Learning Methods for Prediction of Disulphide Bonding States of Cysteine Residues in Proteins.

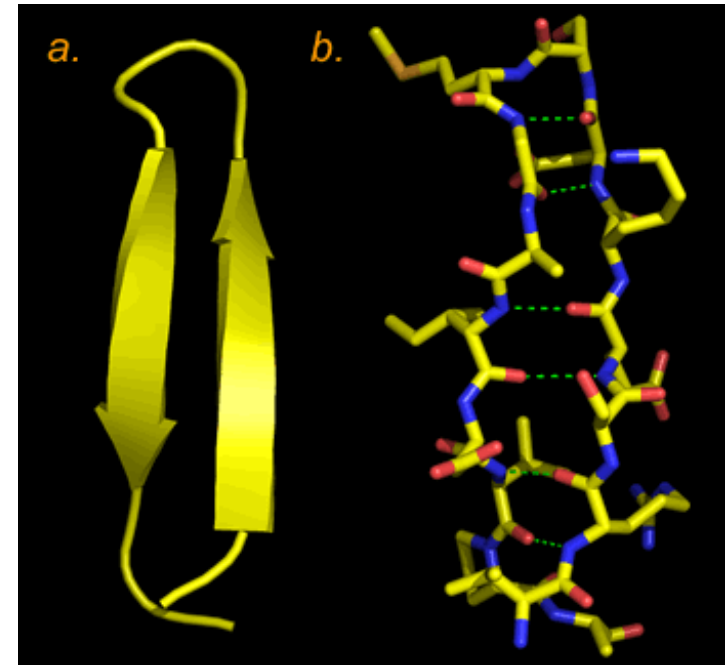
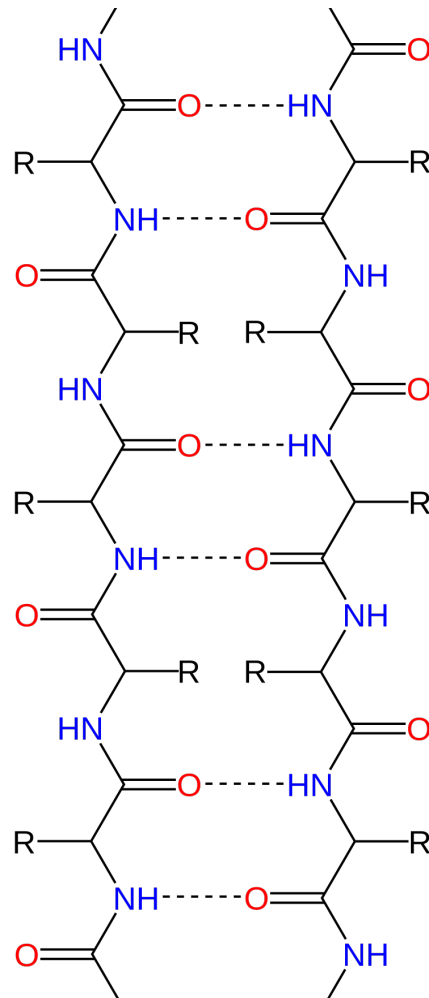
Plegamiento de proteínas: Estructura secundaria

- Láminas β

Paralela



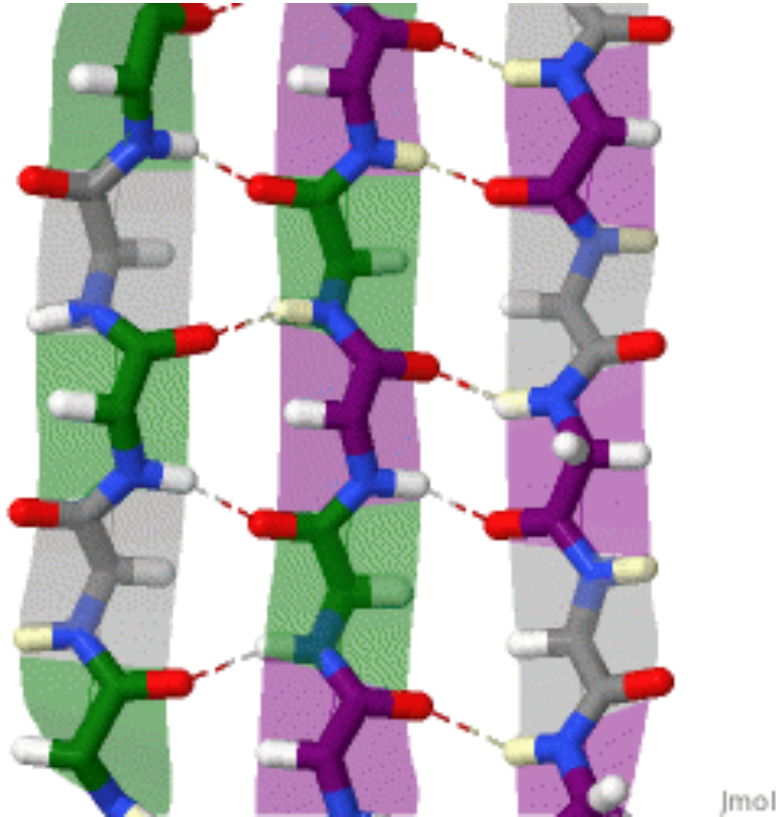
Antiparalela



Fragmento de la enzima fumarasa (PDB: 1FUO)

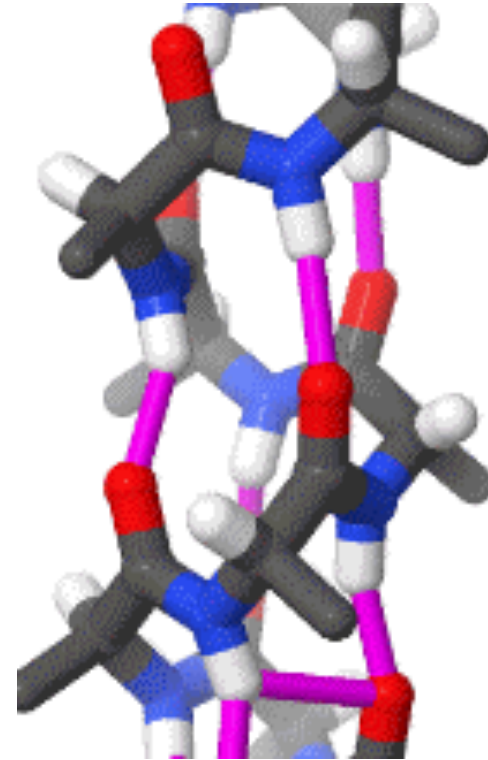
Plegamiento de proteínas

Láminas β
(paralela)



Animación de una lámina beta:
https://proteopedia.org/wiki/index.php/Beta_sheet

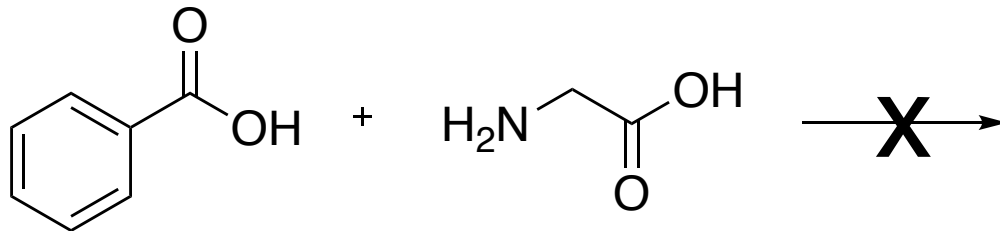
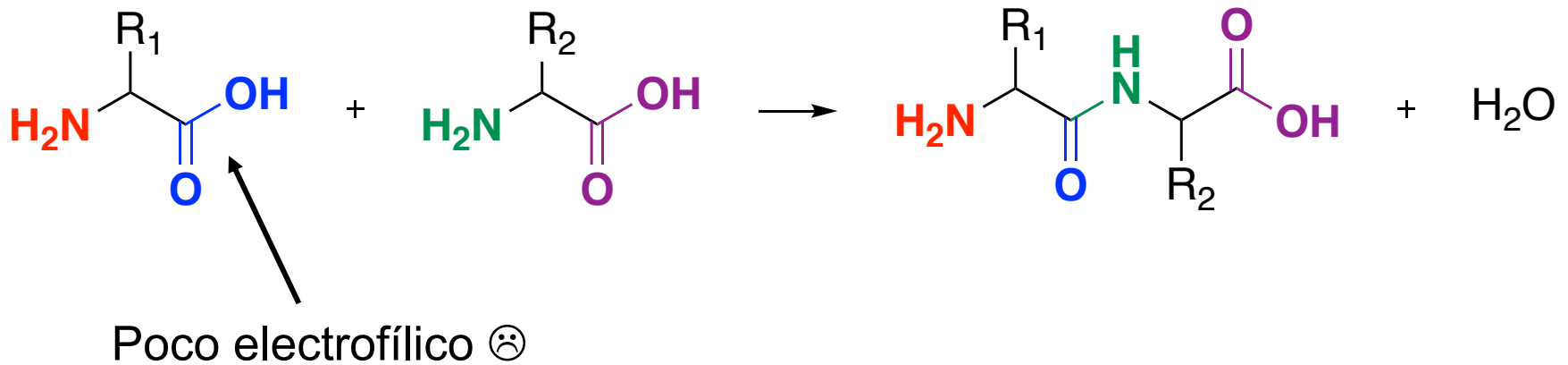
Hélices α



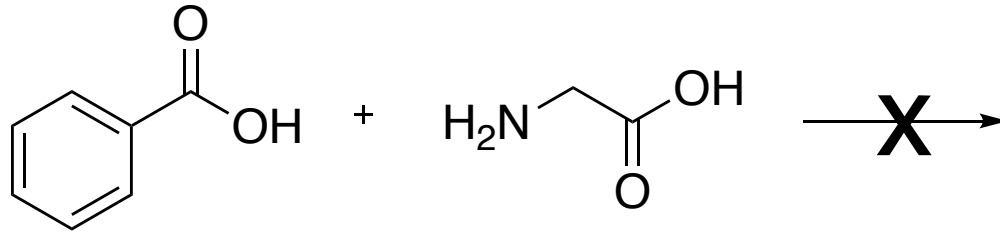
Polipéptido formando una hélice alfa:
http://proteopedia.org/wiki/index.php/Alpha_helix

Enlace peptídico

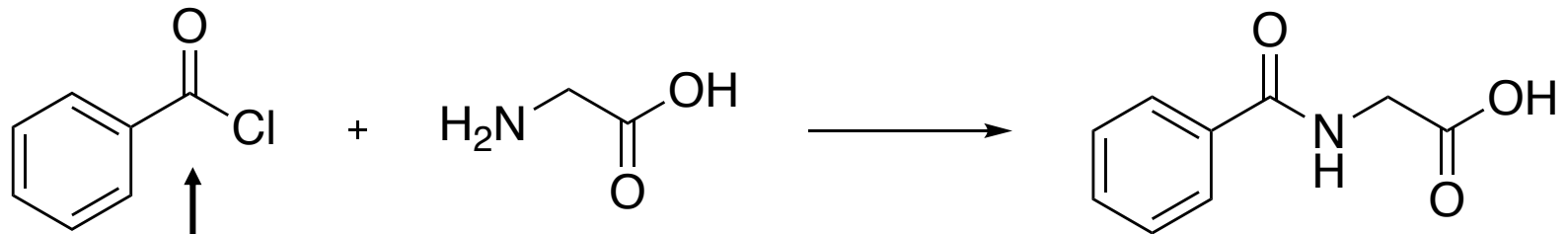
Formación (en el lab):



Enlace “peptídico”



-Reacción de Schotten-Baumann

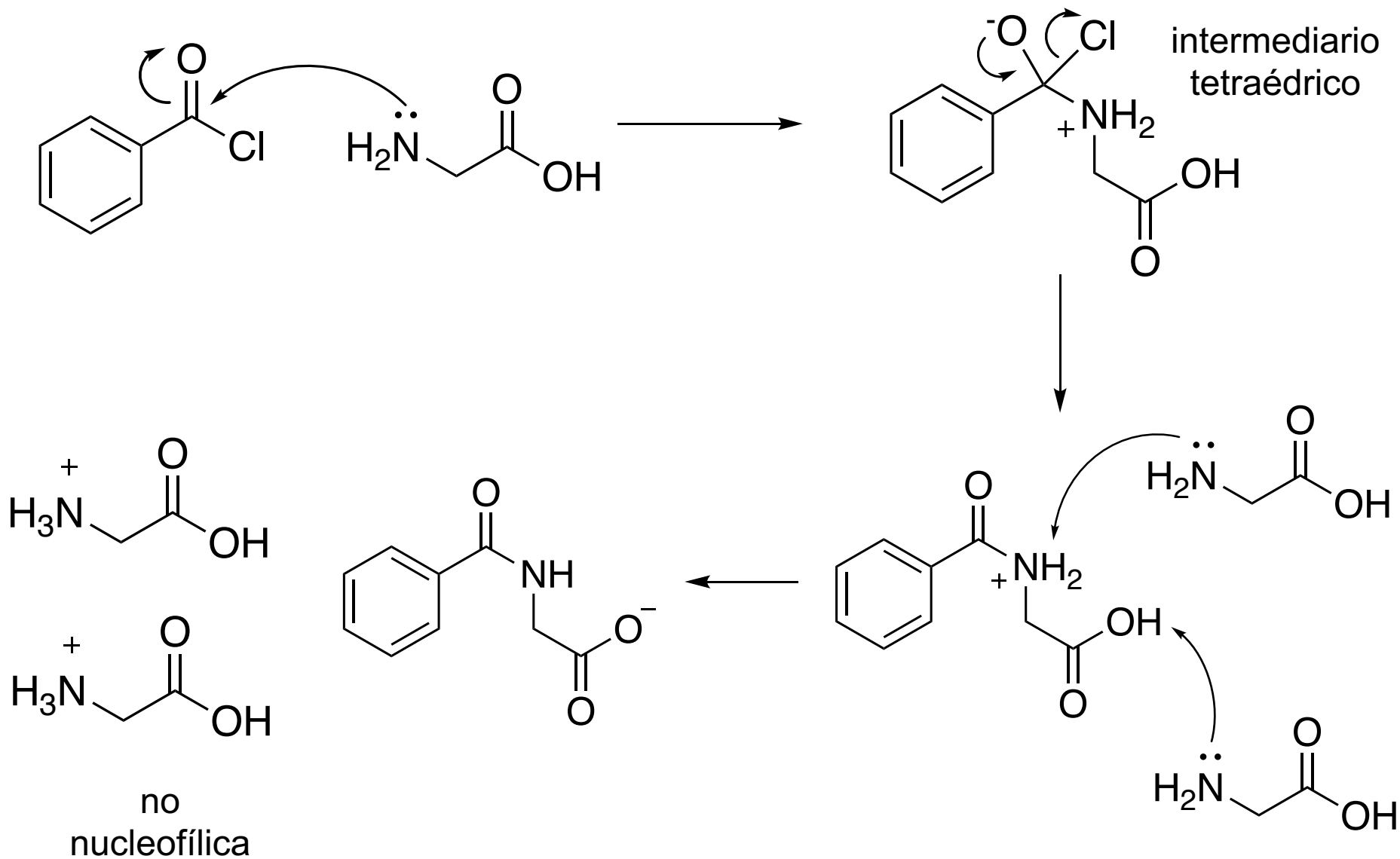


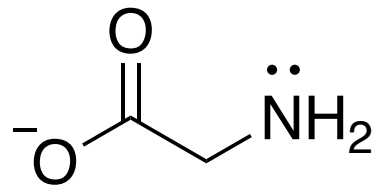
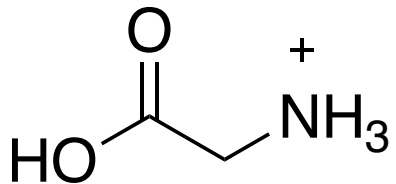
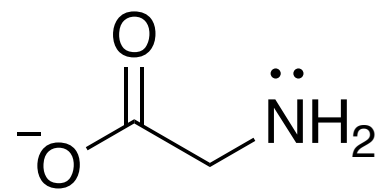
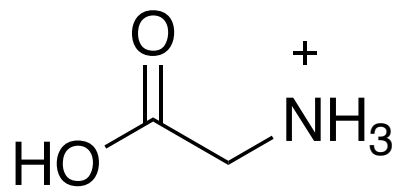
Más electrofílico 😊



Ácido hipúrico

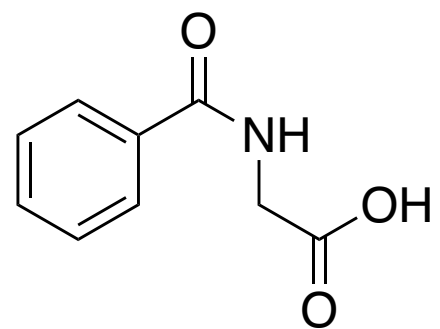
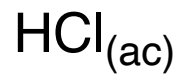
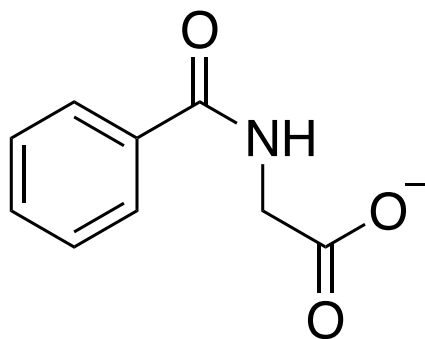
Mecanismo





No nucleofílica

nucleofílica



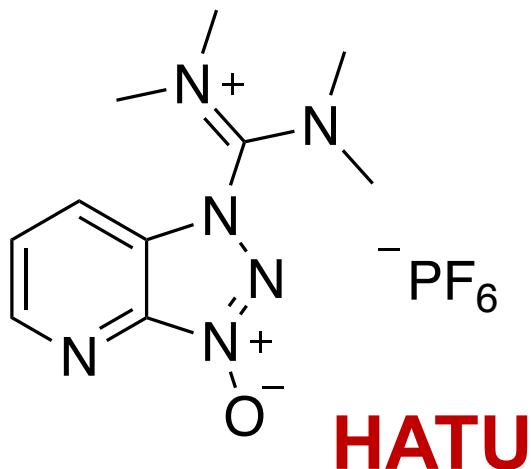
Hipurato

Ácido hipúrico

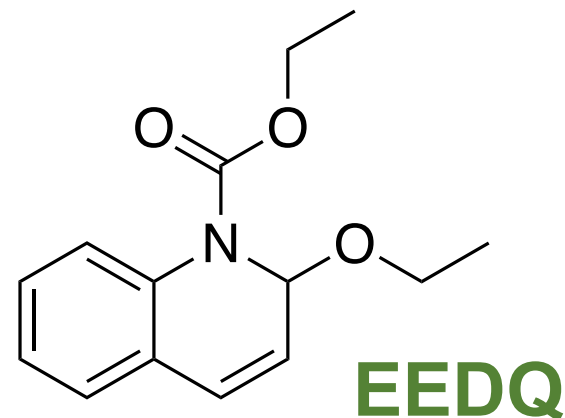
Agentes acoplantes

Generan intermediarios más electrofílicos (activación del COOH)

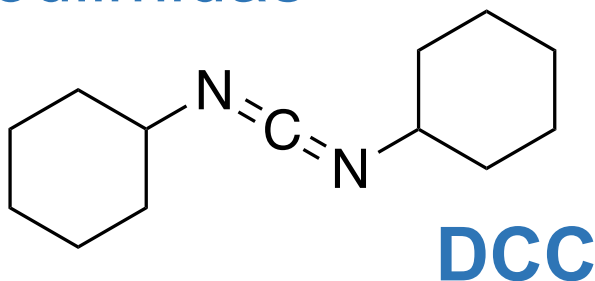
Sales de aminio



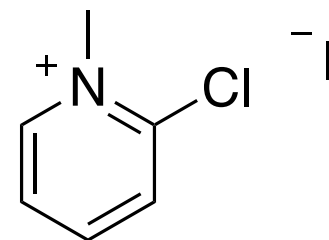
Carbamatos



Carbodiimidas



Sales de piridinas



Reactivo de Mukaiyama

Peptide Coupling Reagents, More than a Letter Soup

Ayman El-Faham^{*,†,‡} and Fernando Albericio^{*,†,§,||}

[†]Institute for Research in Biomedicine, Barcelona Science Park, Baldiri Reixac 10, 08028-Barcelona, Spain

[‡]Alexandria University, Faculty of Science, Department of Chemistry, P.O. Box 426, Ibrahimia, 21321 Alexandria, Egypt

[§]CIBER-BBN, Networking Centre on Bioengineering, Biomaterials and Nanomedicine, Barcelona Science Park, Baldiri Reixac 10, 08028-Barcelona, Spain.

^{||}Department of Organic Chemistry, University of Barcelona, Martí i Franqués 1-11, 08028-Barcelona, Spain

CONTENTS

1. Introduction	6558	7.1.2. Triazine Chlorinating Reagents	6568
2. Carbodiimide-Mediated Reactions	6559	7.1.3. Triphenylphosphine-CCl ₄	6568
2.1. Carbodiimides	6559	7.1.4. Tetramethyl- α -chloroamine Chlorinat-	6568
2.2. Carbodiimides and Additives	6559	ing Reagents	
3. Anhydrides	6562	7.1.5. Bis(trichloromethyl)carbonate Chlorinat-	6568
3.1. Symmetric Anhydrides	6562	ing Reagents	
3.2. Mixed Anhydrides	6562	7.1.6. Coupling Reactions with Acyl Chlorides	6568
3.2.1. Mixed Carbonic Anhydrides	6562	7.2. Acid Fluorides	6568
3.2.1.1. Chloroformate-Mediated Reaction	6562	7.2.1. Fluorinating Reagents	6569
3.2.1.2. 2-Ethoxy-1-ethoxycarbonyl-		8. Phosphonium Salts	6570
1,2-dihydroquinoline (EDDQ)-Mediated		8.1. HOBT Phosphonium Salt Derivatives	6571
Reaction	6562	8.1.1. PyBOP Coupling Reagent	6571
3.2.2. Cyclic Anhydrides	6562	8.2. HOAt Phosphonium Salt Derivatives	6571
4. Active Esters	6563	8.3. Oxyma-Based Phosphonium Salts	6571
4.1. Procedure for the Preparation of Active Ester	6564	8.4. Other Phosphonium Salts	6571
4.1.1. Phenyl Active Ester Derivatives	6564	8.5. Preparation of Phosphonium Salts	6571
4.1.2. <i>p</i> -Hydroxamic Active Ester	6564	9. Aminium/Uronium salts	6573
4.2. Hexafluoroacetone (HFA) as Activating and		9.1. Tetramethyl Aminium Salts	6573
Protecting Strategy	6565	9.2. Bispyrrolidino Aminium Salts	6578
5. Acylazoles as Coupling Reagents	6565	9.2.1. HBPyU	6578
5.1. Acylimidazoles Using CDI	6565	9.2.2. HXPYU	6578
5.2. Acylbenzotriazoles	6565	9.2.3. HPyOPfp	6578
5.2.1. Preparation of <i>N</i> -(Protected- α -amino-		9.2.4. Phenol Derivatives	6578
acyl)benzotriazoles (61)	6565	9.3. Bispiperidino Aminium Salts	6578
5.2.2. Peptide Coupling with Chiral <i>N</i> -(Protected-		9.4. Imidazolium Uronium Salts	6579
α -aminoacyl)benzotriazoles	6566		