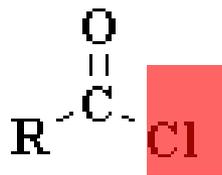


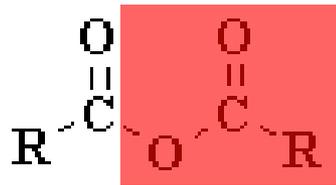
DERIVADOS DE ÁCIDOS CARBOXÍLICOS

Organic Chemistry, 8th Edition
Leroy G. Wade, Whitman College

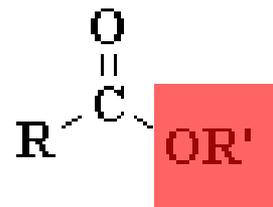




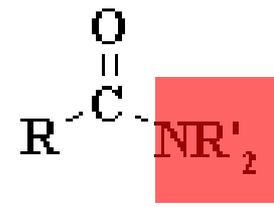
Haluro de
acilo



Anhídrido de
ácido



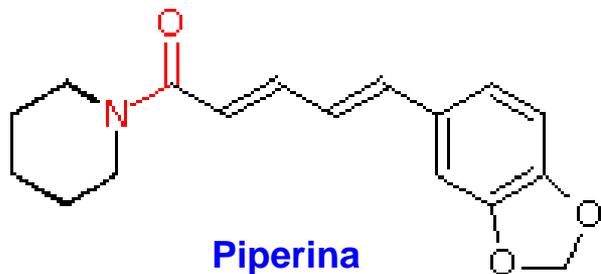
Éster



Amida

Derivados de ácido



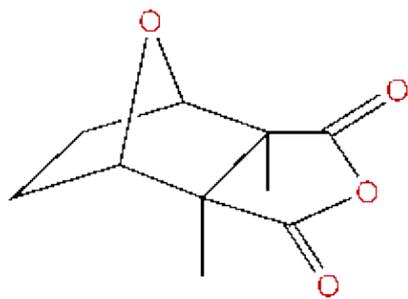


Piperina
(pimienta negra)



https://es.wikipedia.org/wiki/Piper_nigrum#/media/File:Piper_nigrum_-_K%C3%B6hler%E2%80%93Medizinale-Pflanzen-107.jpg

https://es.wikipedia.org/wiki/Piper_nigrum#/media/File:BlackPeppercorns.JPG

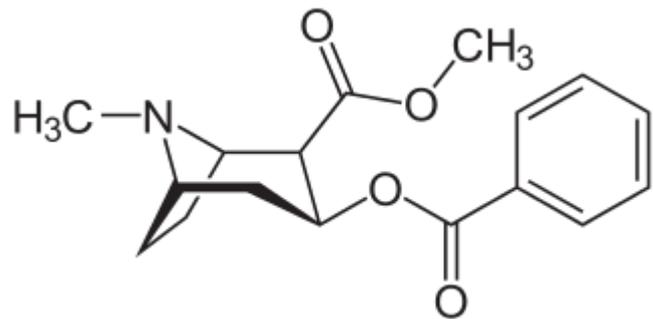


Cantaridín
(escarabajo blister)



<http://previews.123rf.com/images/mite/mite0902/mite090200011/4305266-Blister-escarabajo-negro-de-rastreo-en-la-arena-Foto-de-archivo.jpg>





Cocaina
(arbusto de Coca)

Planta de la coca



<http://fotos.subefotos.com/863d846c47896d55b3ac194fa04f9a56o.jpg>

Indios quechuas

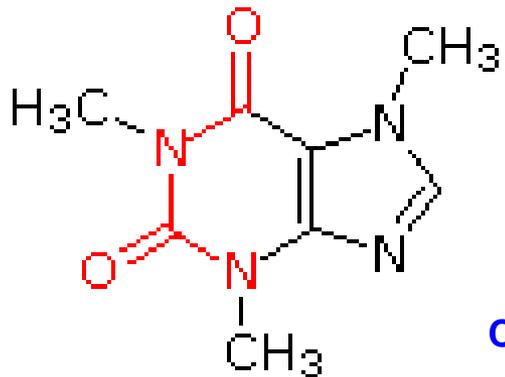


<http://bucultureshock.com/wp-content/uploads/2012/03/cusco-coca-kintu.jpg>



http://media.economist.com/sites/default/files/cf_images/20040424/1704AM1.jpg





Cafeína
(café y té)



Ilustración de la planta y semillas de *Coffea arabica*

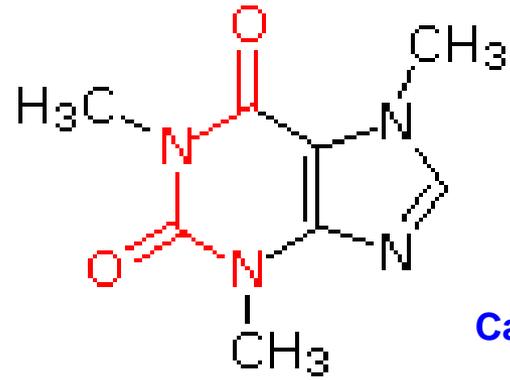
https://en.wikipedia.org/wiki/Coffee#/media/File:Coffea_arabica_-_K%C3%B6hler%E2%80%93Medizinal-Pflanzen-189.jpg



Flores y planta de *Coffea robusta*

https://en.wikipedia.org/wiki/Coffee#/media/File:Coffee_flowers.jpg





Cafeína
(café y té)

Un arbol de café *Coffea arabica* floreando en una
plantación brasileña

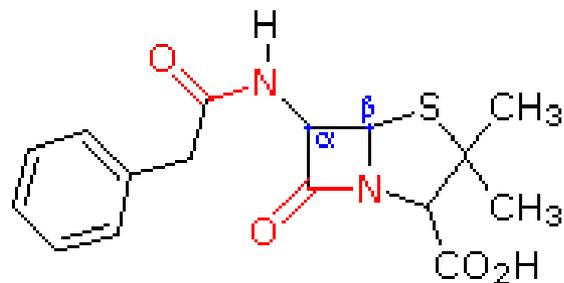


Plantación de te en Malasia



https://en.wikipedia.org/wiki/Coffee#/media/File:Coffee_Flowers_Show.jpg





Penicilina G
(un antibiótico)



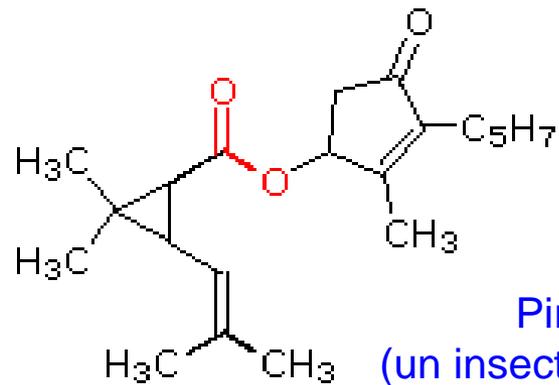
Alexander Fleming
(1881-1955)

<https://s-media-cache-ak0.pinimg.com/originals/6e/36/d1/6e36d1c9e97b4f7848b587c825451be9.jpg>



Hongo (*Penicillium notatum*)
Penicilina: sustancia natural que segrega el hongo y favorece la lisis bacteriana

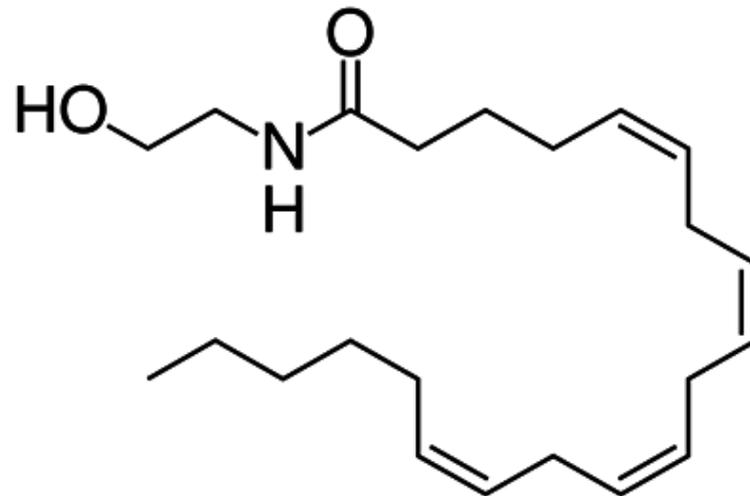




Piretrina
(un insecticida natural)



Crisantemo



Anandamida



Habañero



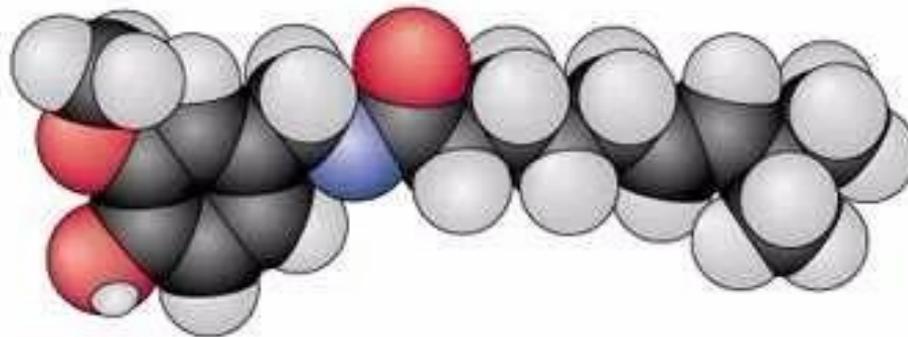
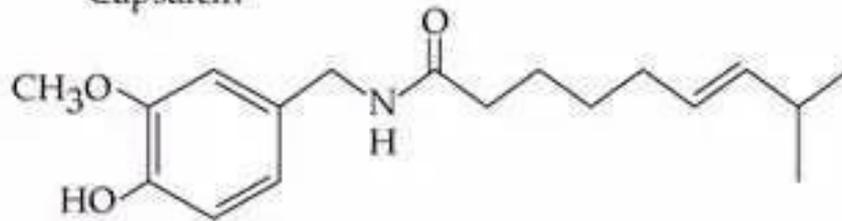
Jalapeño



Red chile



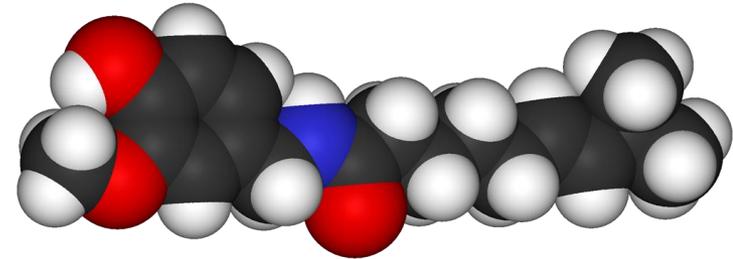
Capsaicin



La **capsaicina** o **capsicina** (8-metil-N-vanillil-6-nonenamida) es una oleorresina, componente activo de los pimientos picantes (*Capsicum*).



Es irritante para los mamíferos; produce una fuerte sensación de ardor (pungencia) en la boca. La capsaicina y otras sustancias relacionadas se denominan **capsaicinoides** y se producen como un metabolito secundario en diversas especies de plantas del género *Capsicum*, lo que probablemente les impide ser consumidas por animales herbívoros. Las aves en general no son sensibles a los capsaicinoides. La capsaicina pura es un compuesto lipofílico, inodoro, incoloro, parecido a la cera



<https://es.wikipedia.org/wiki/Capsaicina#/media/Archivo:Capsaicin-3D-vdW.png>



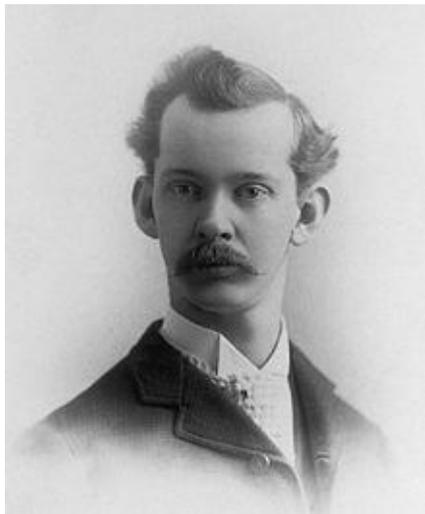
https://es.wikipedia.org/wiki/Capsicum#/media/Archivo:Illustration_Capsicum_annuum0.jpg





La capsaicina, que es el principio responsable de perspiración y de sensación picante en algunos alimentos, es empleada en algunas neuralgias, neuropatía diabética, algunos cuadros dolorosos referidos a zonas específicas de la piel y en los picores de los dializados por insuficiencia renal u otras afecciones difusas de la piel similares. Es de suponer que tiene cierta acción anticancerosa

https://es.wikipedia.org/wiki/Capsicum#/media/Archivo:C_anuum_big_jim_fruits.jpg



Wilbur Lincoln Scoville
(1865-1942)
Químico y farmacólogo estadounidense

Es conocido por la escala Scoville de reconocimiento organoléptico



Carolina Reaper

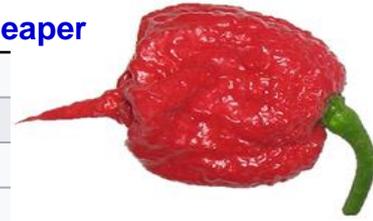
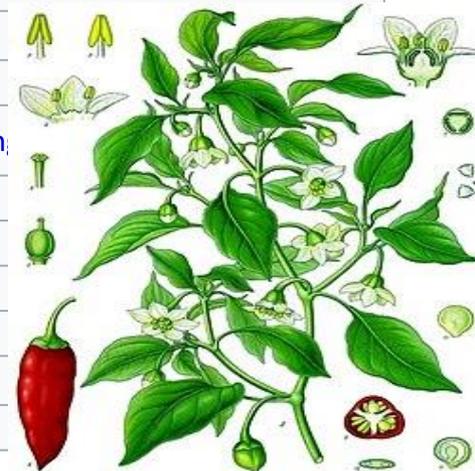


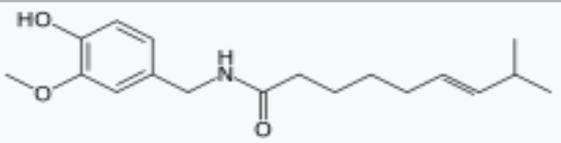
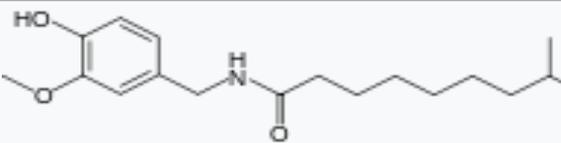
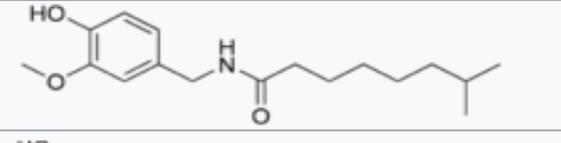
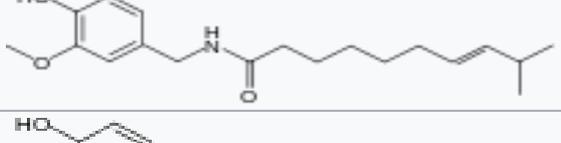
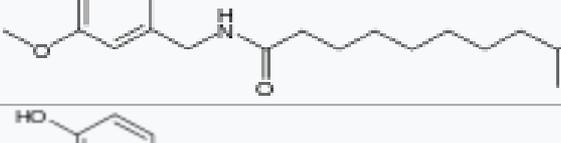
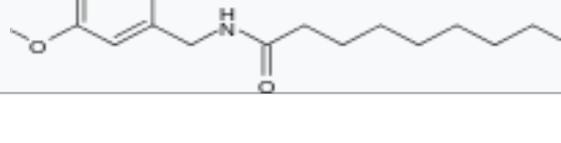
Tabla de Scoville	
Unidades Scoville	Tipo de chile
16 000 000	Capsaicina
2 800 000 – 3 180 000	Pepper X³
2 900 000 – 3 000 000	Death Strain
1 900 500 – 2 480 000	Dragon's Breath
1 569 300 – 2 220 000	Carolina Reaper
1 300 000 – 2 000 000	Naga Viper , Trinidad Scorpion Butch T
855 000 – 1 041 427	Naga Jolokia , 7 Pod Chaguanas⁴⁵
350 000 – 580 000	Habanero Savinas Roja⁶⁷
100 000 – 350 000	Ají habanero , ⁸ Scotch Bonnet , Merkén , ⁸ Chile dátil , Capsicum chinense
100 000 – 200 000	Rocoto o manzano, ⁹ chile jamaicano picante , piri piri
50 000 – 100 000	Chile thai , chile malagueta , chile chiltepín , chile piquín
30 000 – 50 000	Pimienta roja o de cayena , ají amarillo , ⁸ chile tabasco , calabrese , algunos tipos de chile chipotle⁹
10 000 – 23 000	Chile serrano , chile de árbol , chile chipotle
5 000 – 15 000	Chile Campana
5 000 – 8 000	Nuevo Mexico del chile anaheim , ¹⁰ guindilla de Ibarra , chile hún ,
2 500 – 5 000	Chile jalapeño , Pimiento de Padrón ,
1 500 – 2 500	Chile rocotillo , Salsa Sriracha
1 000 – 1 500	Chile poblano
500 – 1 000	Chile anaheim¹²
100 – 500	Pimiento , pepperoncini , pimiento banana
0	No picante, pimiento verde Pimiento morrón



Capsicum chinense



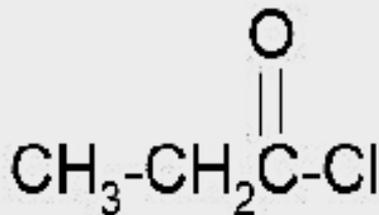
Hay seis capsaicinoides naturales (tabla a continuación). Aunque la vanililamida del ácido n-nonanoico (Nonivamide, VNA, también PAVA) se produce sintéticamente, para la mayoría de las aplicaciones, se encuentra en forma natural en las especies de *Capsicum*.

Nombre capsinoide	Abrev.	Cantidad relativa típica	Unidades de calor de Scoville	Estructura química
Capsaicina	C	69%	16,000,000	
<u>Dihydrocapsaicina</u>	DHC	22%	16,000,000	
<u>Nordihydrocapsaicina</u>	NDHC	7%	9,100,000	
<u>Homocapsaicina</u>	HC	1%	8,600,000	
<u>Homodihydrocapsaicina</u>	HDHC	1%	8,600,000	
<u>Nonivamida</u>	PAVA		9,200,000	

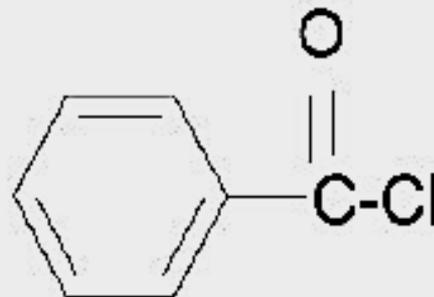


NOMENCLATURA HALURO DE ÁCIDO:

Se cambia el prefijo ácido por el haluro correspondiente (**CLORURO DE**) y se cambia la terminación **-oico** por **-oilo**

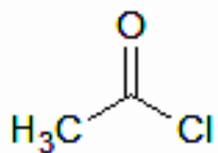


Cloruro de propanoilo

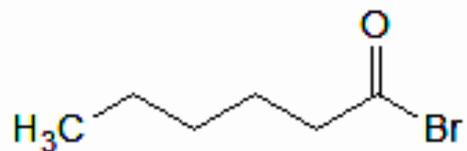


Cloruro de benzoilo

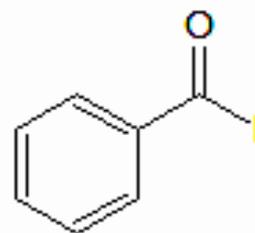




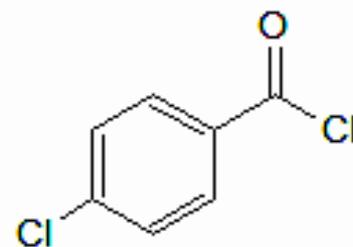
Cloruro de acetilo



Bromuro de hexanoilo



Yoduro de benzoilo

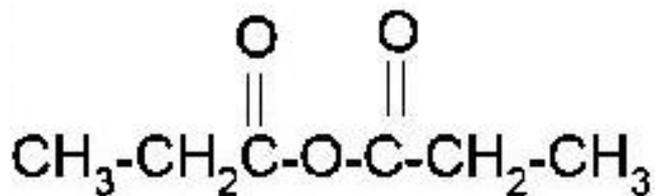


Cloruro de *p*-clorobenzoilo

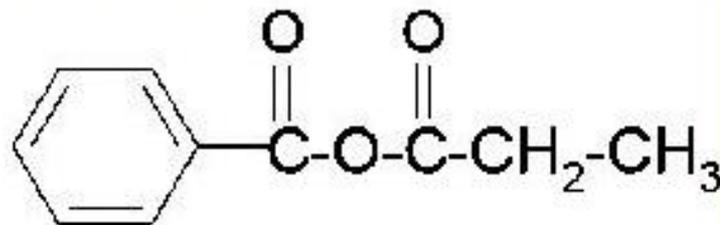


NOMENCLATURA ANHIDRIDOS:

Se cambia la palabra ÁCIDO por ANHIDRIDO

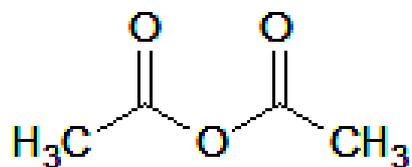


Anhídrido propiónico

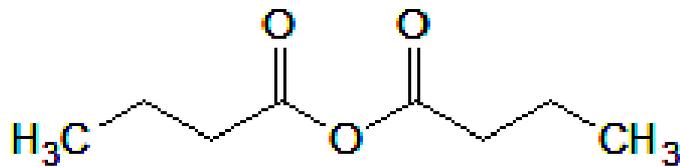


**Anhídrido mixto
benzoícopropanoíco**

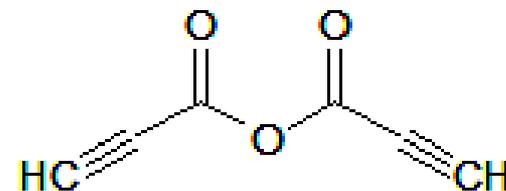




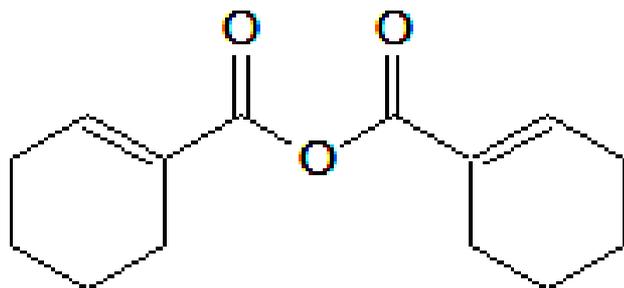
Anhídrido acético



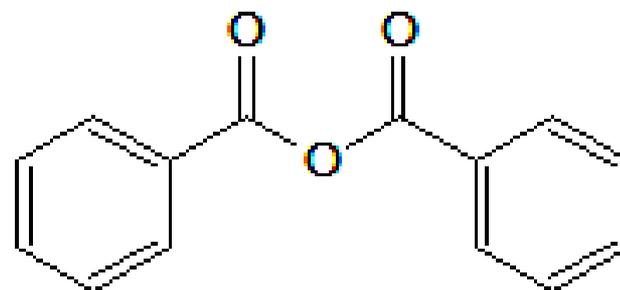
Ánhídrido butírico



Anhídrido 2-propinoico



Anhídrido ciclohex-1-eno-1-carboxílico

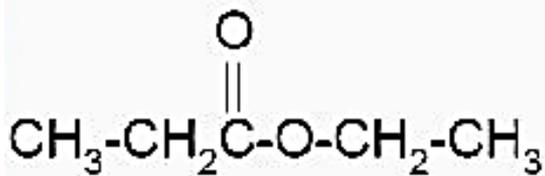


Anhídrido benzoico

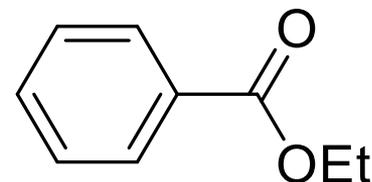


NOMENCLATURA ESTERES:

Se elimina el prefijo ácido y se cambia la terminación **-ico** por **-ato** de, agregando el nombre del grupo alquilo unido al **-O-** del éster

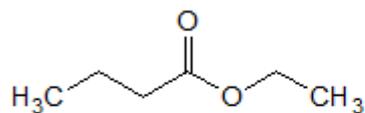


Acido propano**íco**
Propano**ato** de etilo

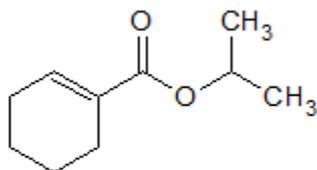


Acido benzo**íco**
Benzo**ato** de etilo

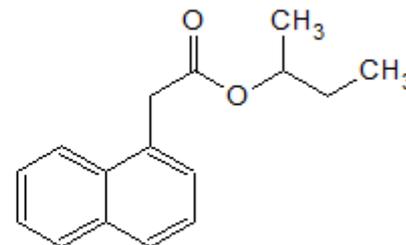




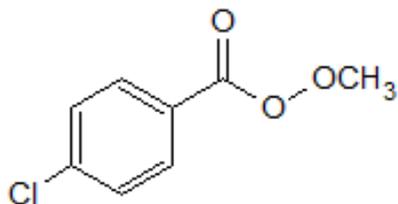
Butanoato de etilo
ó butirato de etilo
ó butirato etílico
ó éster etílico del ácido butírico



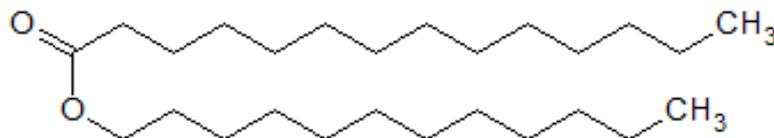
Ciclohex-1-eno carboxilato de propan-2-ilo
Ciclohex-1-eno carboxilato propan-2-ílico



Naftalen-1-ilacetato de butan-2-ilo



m-Clorobencenocarboperoxoato de metilo

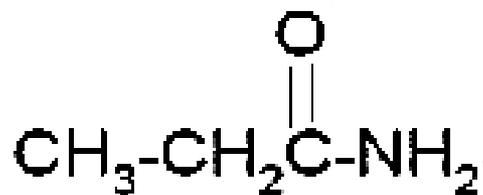


Tetradecanoato de dodecilo
ó miristoato de dodecilo

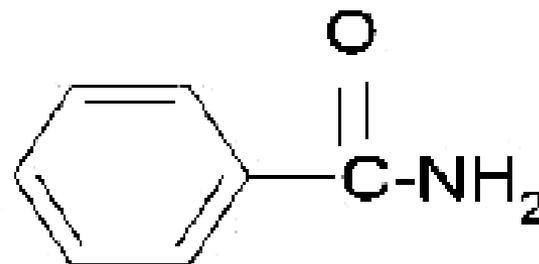


NOMENCLATURA AMIDAS:

Se elimina el prefijo ácido y se cambia la terminación **-ico** por **-amida**

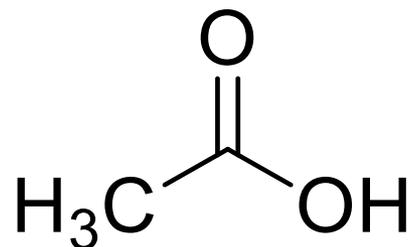


Acido propanoico
Propan**amida**



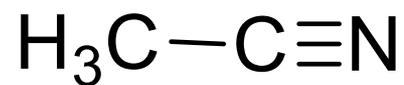
Acido benzoico
Benzo**amida**





Ácido acético

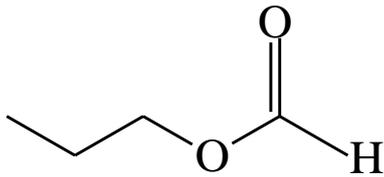
Ácido etanóico



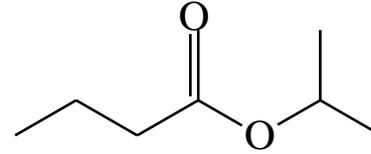
Acetonitrilo

Etanonitrilo

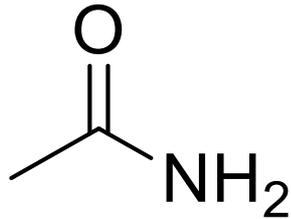




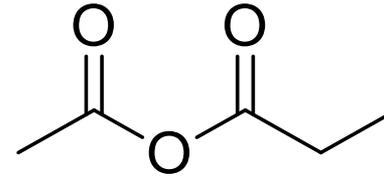
Formiato de *n*-propilo
Metanoato de *n*-propilo



Butirato de *iso*-propilo
Butanoato de 2-propilo

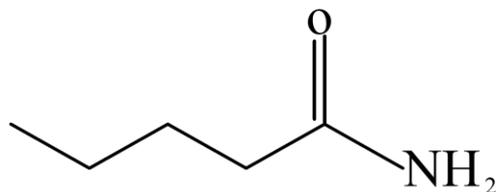


Acetamida
Etanamida

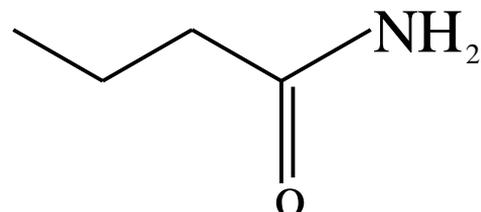


Anhídrido acético-propionico
Anhídrido etanoíco-propanoíco

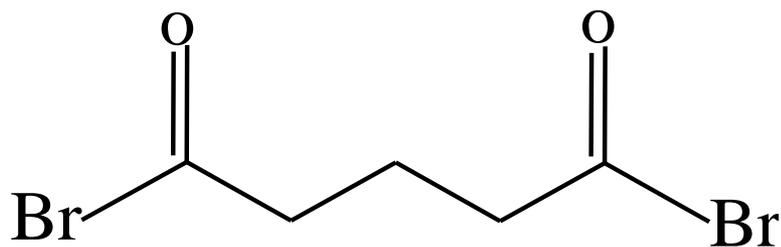




Valeramida
Pentanoamida



Butiramida
Butanamida



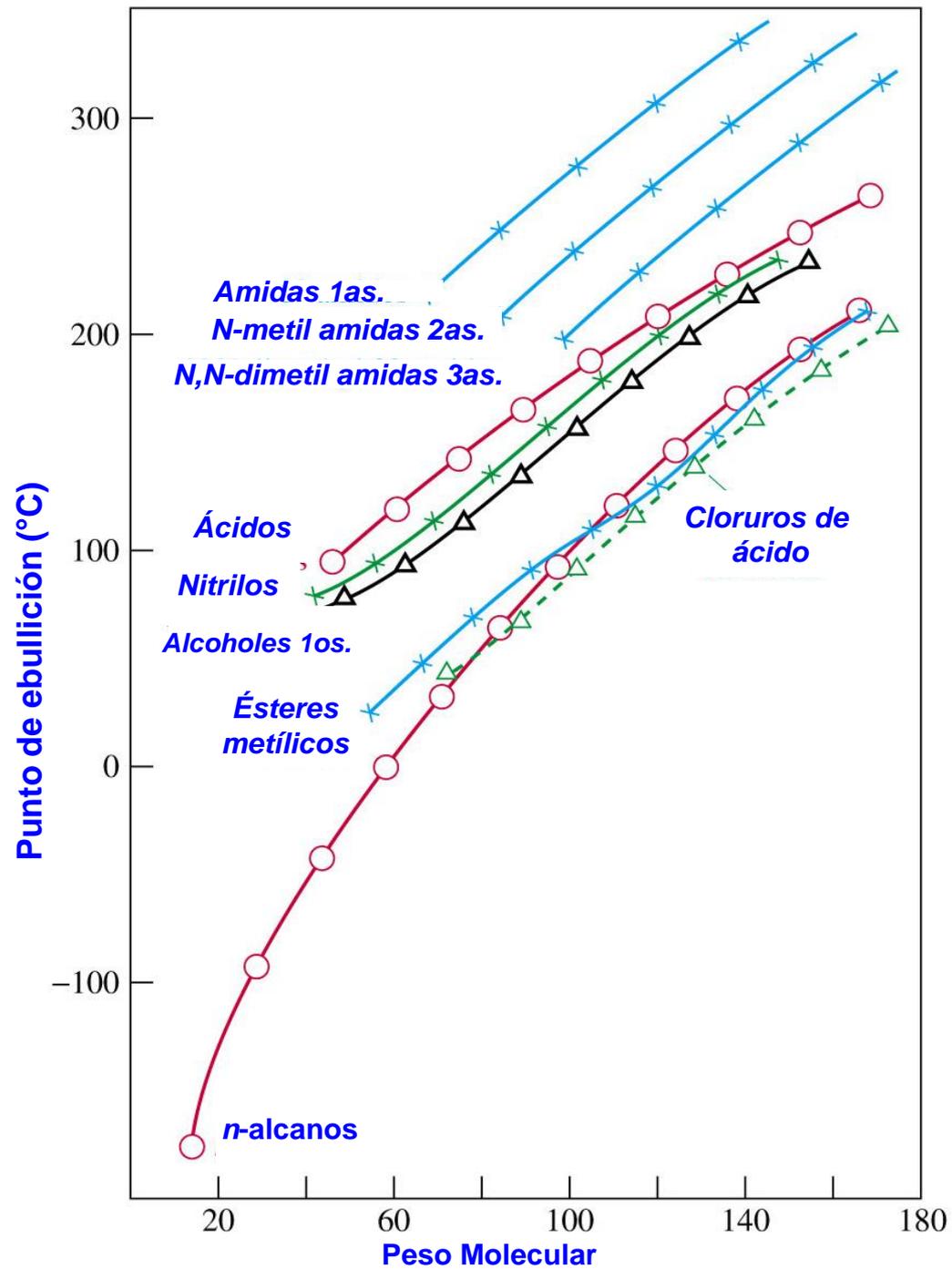
Dibromuro de glutaróilo
Dibromuro de pentanodioílo

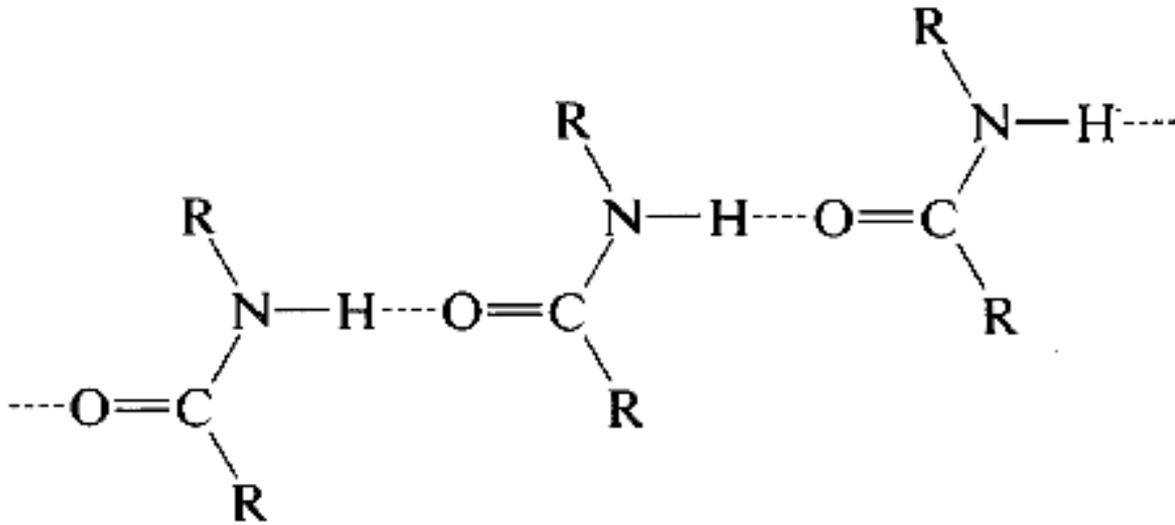


Puntos de ebullición de derivados de ácidos carboxílicos

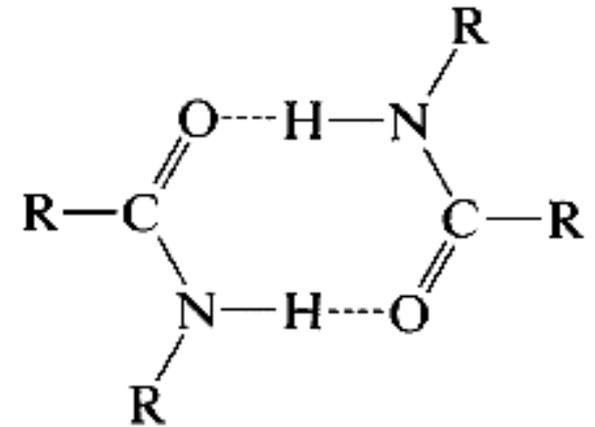
Ejemplos (Peso Molecular 55 a 60)	P. eb. (°C)
$\text{CH}_3-\overset{\text{O}}{\parallel}{\text{C}}-\text{NH}_2$	222
$\text{CH}_3-\overset{\text{O}}{\parallel}{\text{C}}-\text{OH}$	118
$\text{CH}_3\text{CH}_2\text{CH}_2\text{OH}$	97
$\text{CH}_3\text{CH}_2-\text{C}\equiv\text{N}$	97
$\text{H}-\overset{\text{O}}{\parallel}{\text{C}}-\text{OCH}_3$	32
$\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_3$	0







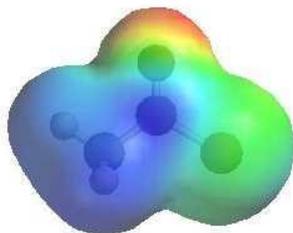
Asociación polimérica por puentes de hidrógeno



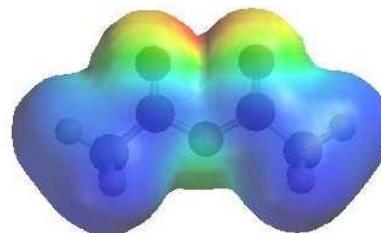
Formación de dímero por puentes de hidrógeno



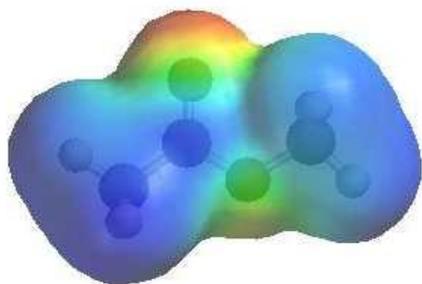
Mapas de potencial electrostático



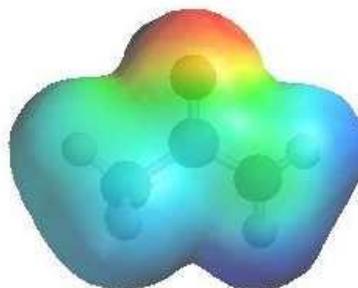
CLORURO DE ACETILO



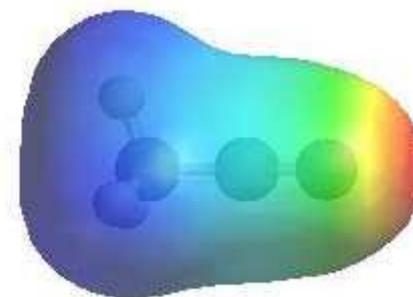
ANHÍDRIDO ACETICO



ACETATO DE METILO



ACETAMIDA



ACETONITRILO

Color rojo: mayor densidad electrónica



Absorción en el IR

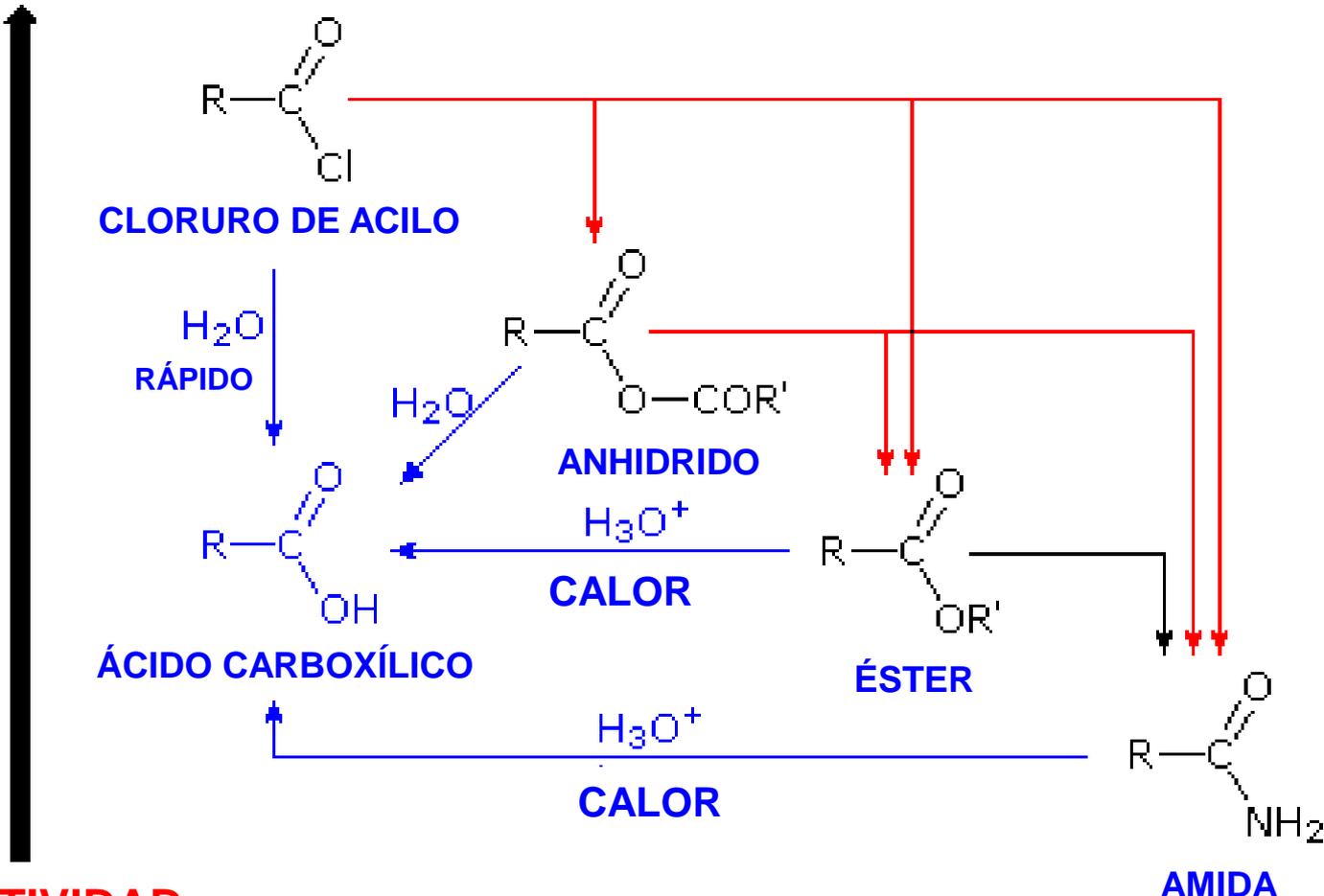
Cloruro de ácido: el C=O mostrará señal arriba de 1700 cm^{-1} , bastante cercana a 1800 cm^{-1}

Anhídrido: el doble enlace C=O no muestra solo una señal, sino que se observan dos señales entre 1700 y 1800 cm^{-1}

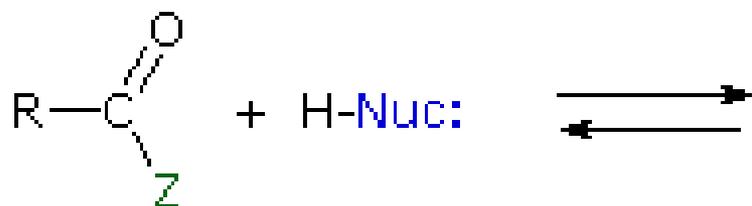
Amida: el enlace N-H muestra una señal alrededor de 3000 cm^{-1} , y el enlace C=O muestra señal arriba de 1700 cm^{-1}

Éster: el grupo C=O muestra señal arriba de 1700 cm^{-1} . El enlace C-O del éter muestra una señal alrededor de 1200 cm^{-1}



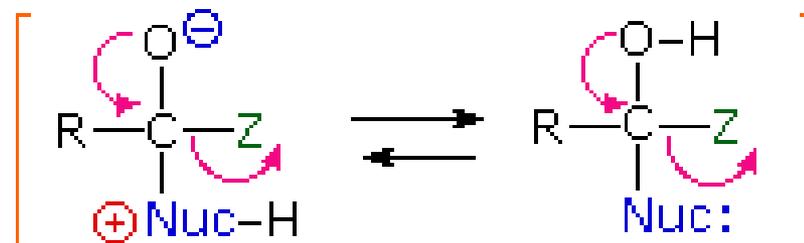


MECANISMO S_NAc

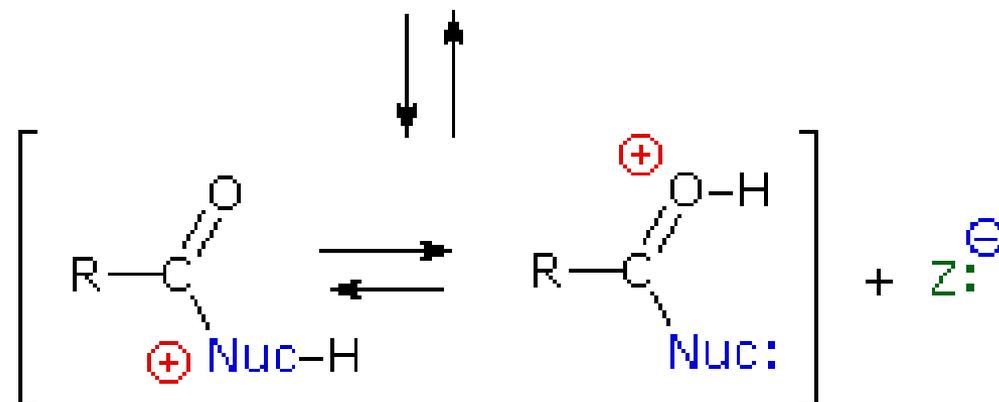
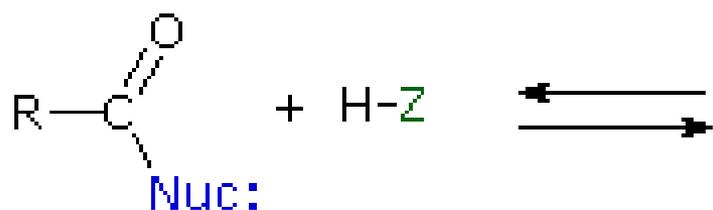


Z = Cl, Br, OCOR', OR', NHR'

Nuc = OH, OR', OCOR', NH₂, NHR'



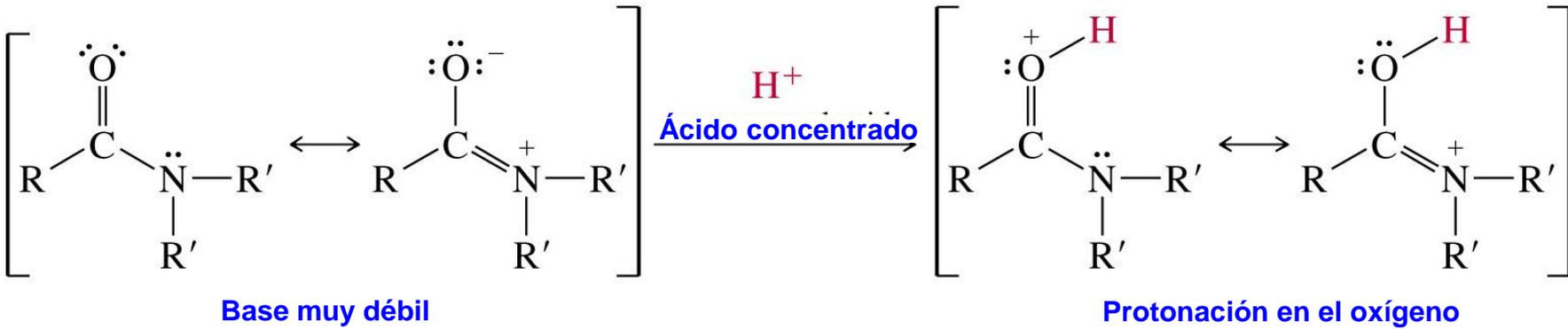
INTERMEDIARIO TETRAÉDRICO



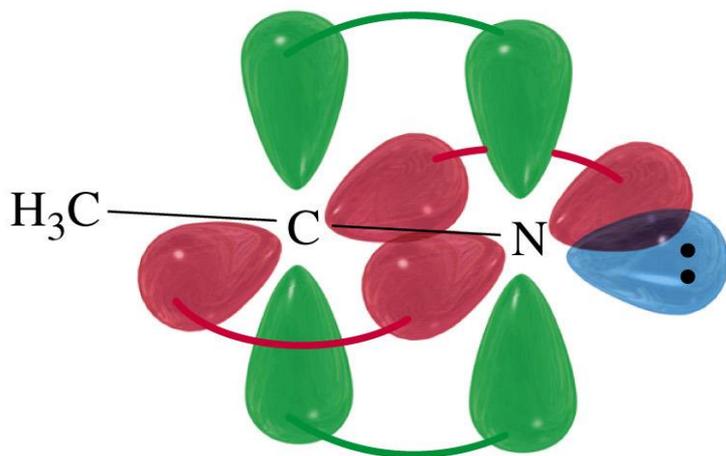
ÁCIDO CONJUGADO DEL PRODUCTO



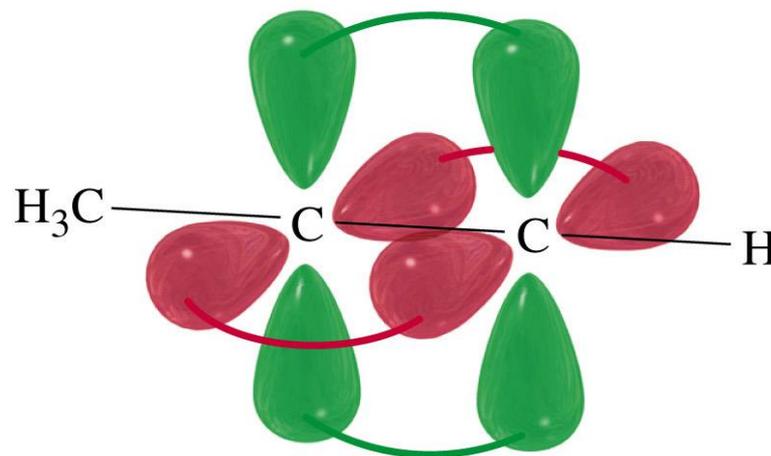
Protonación de una Amida



Estructuras electrónicas del Acetonitrilo y del Propino



Acetonitrilo

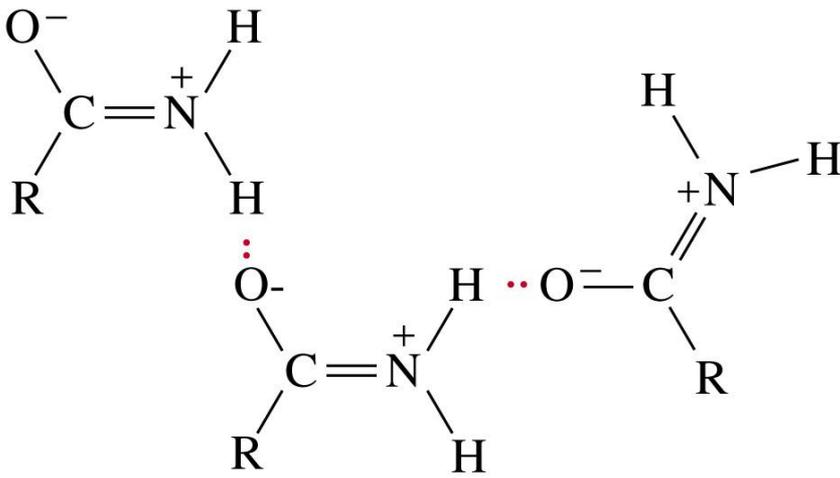
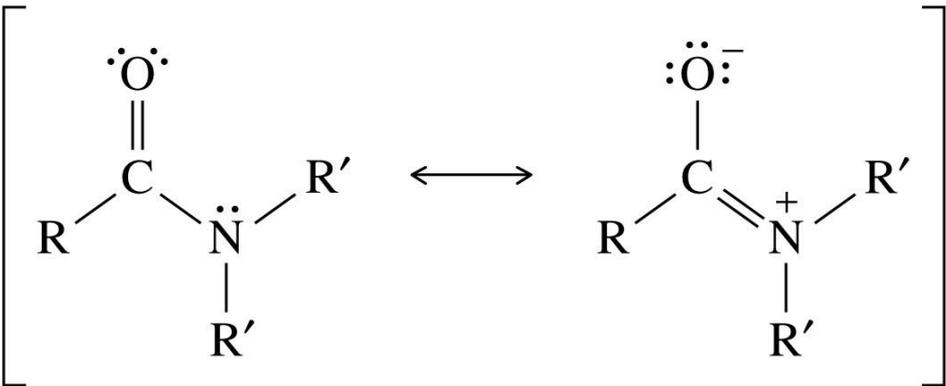


Propino

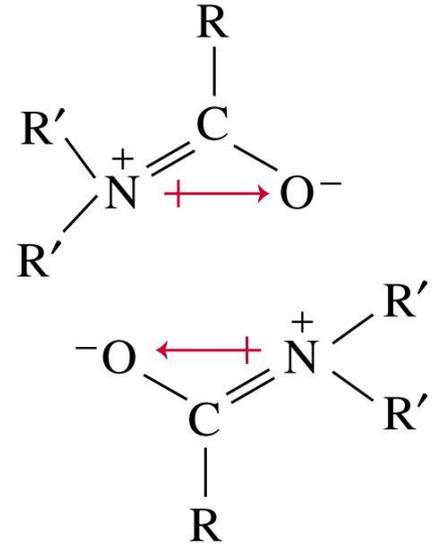
Átomos con hibridación sp



Fuerzas Intermoleculares en las Amidas



Puente de hidrógeno



Atracción intermolecular



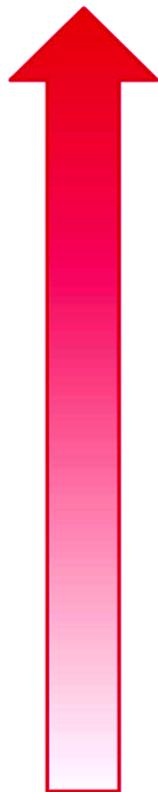
Reactividad de los Derivados de ácidos

Reactividad

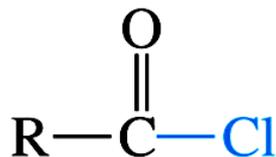
Derivado

Grupo saliente Basicidad

Más reactivo



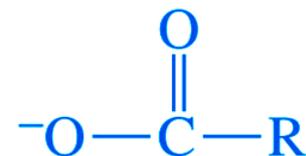
**Cloruro
de ácido**



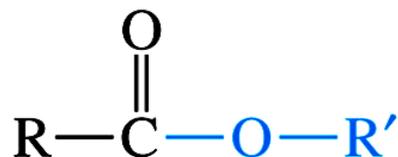
Menos básico



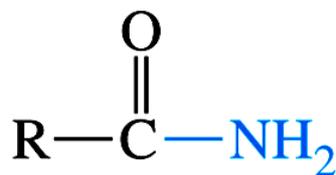
Anhídrido



Éster

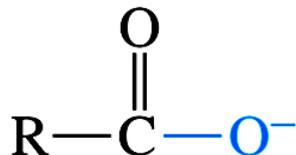


Amida

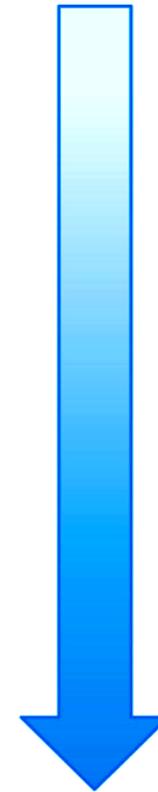


Menos reactivo

Carboxilato



Más básico



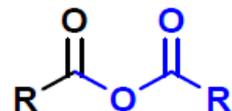


Estabilidad

**Rapidez
de hidrólisis**

Muy pequeña

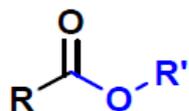
10^{11}



Anhídrido de ácido

Pequeña

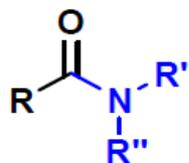
10^7



Éster

Moderada

1.0

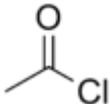
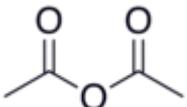
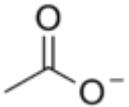
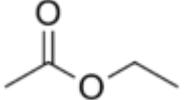
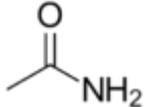
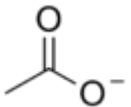


Amida

Muy grande

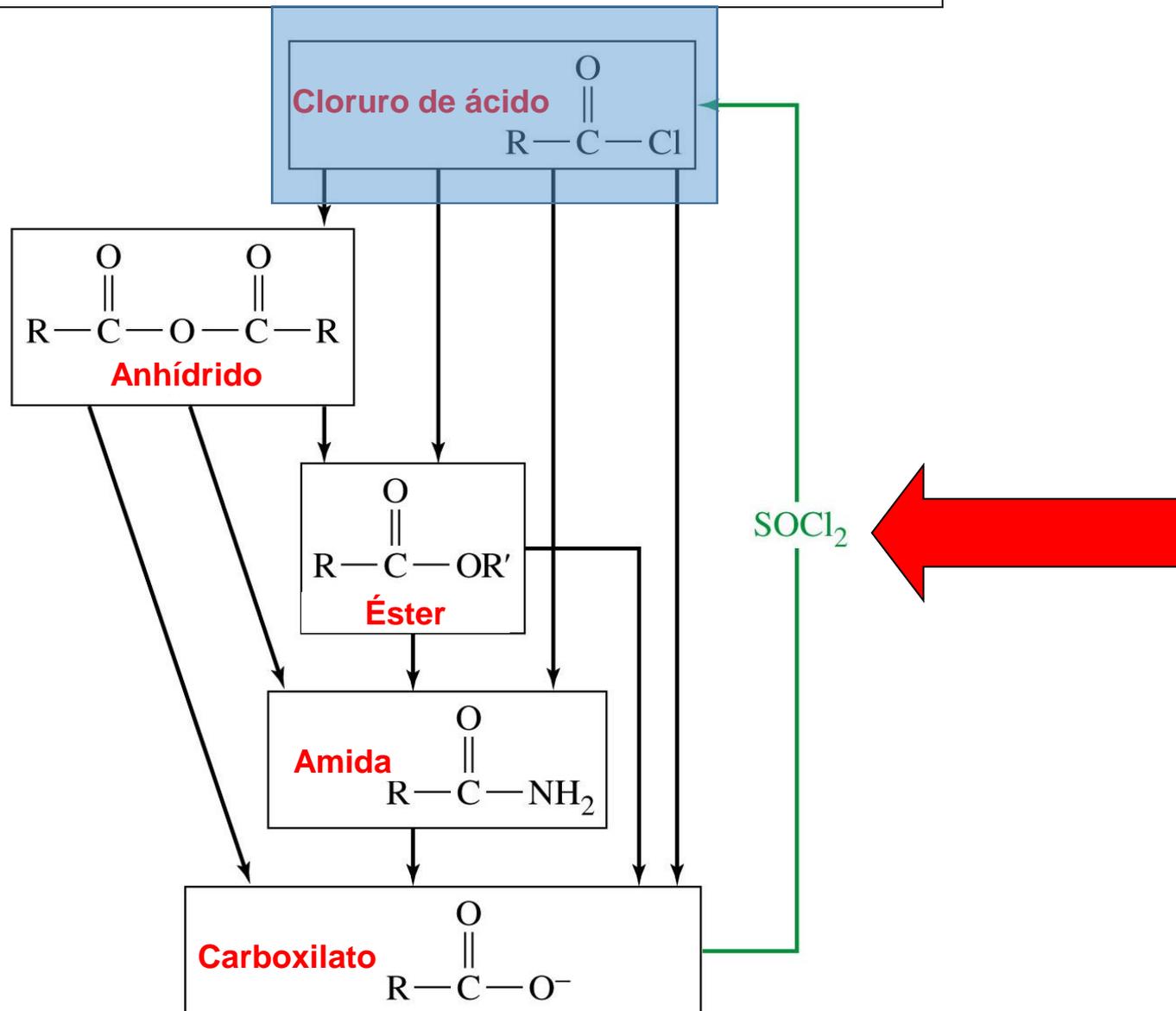
$< 10^{-2}$



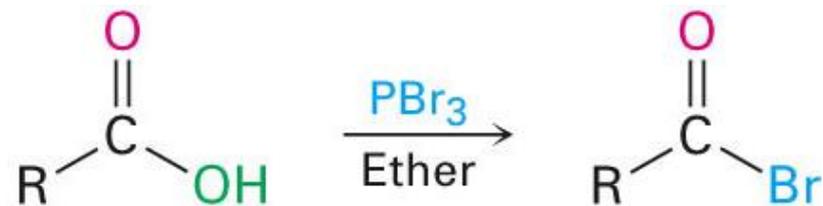
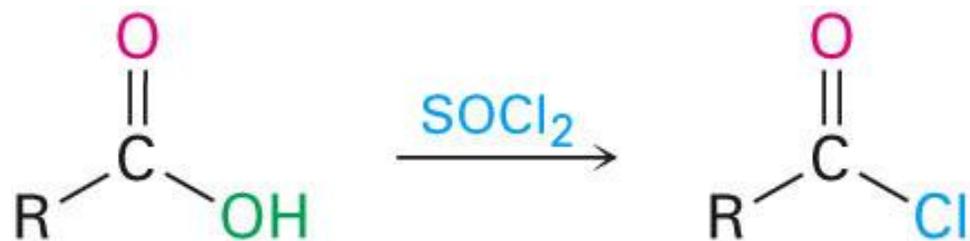
Nombre del Compuesto	Estructura	Grupo saliente	pKa del ácido conjugado
Cloruro de acetilo		Cl ⁻	-7
Anhídrido acético			4.76
Acetato de etilo			15.9
Acetamida		⁻ NH ₂	38
Anión acetato		N / ¿O ₂ ²⁻ ?	¿?

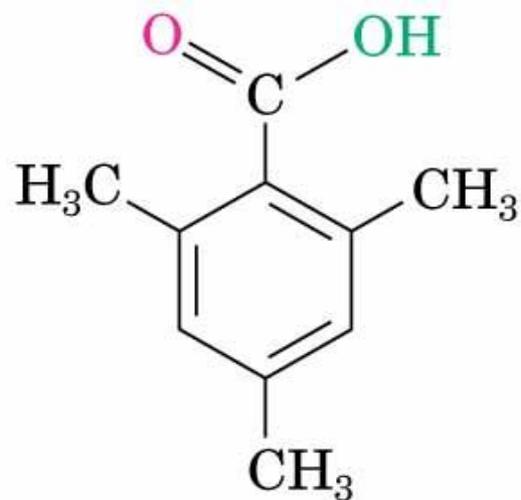


Interconversión de los derivados de ácido

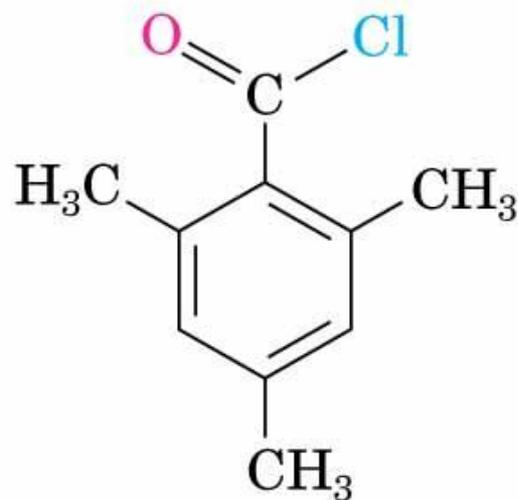


Formación de Cloruros de ácido



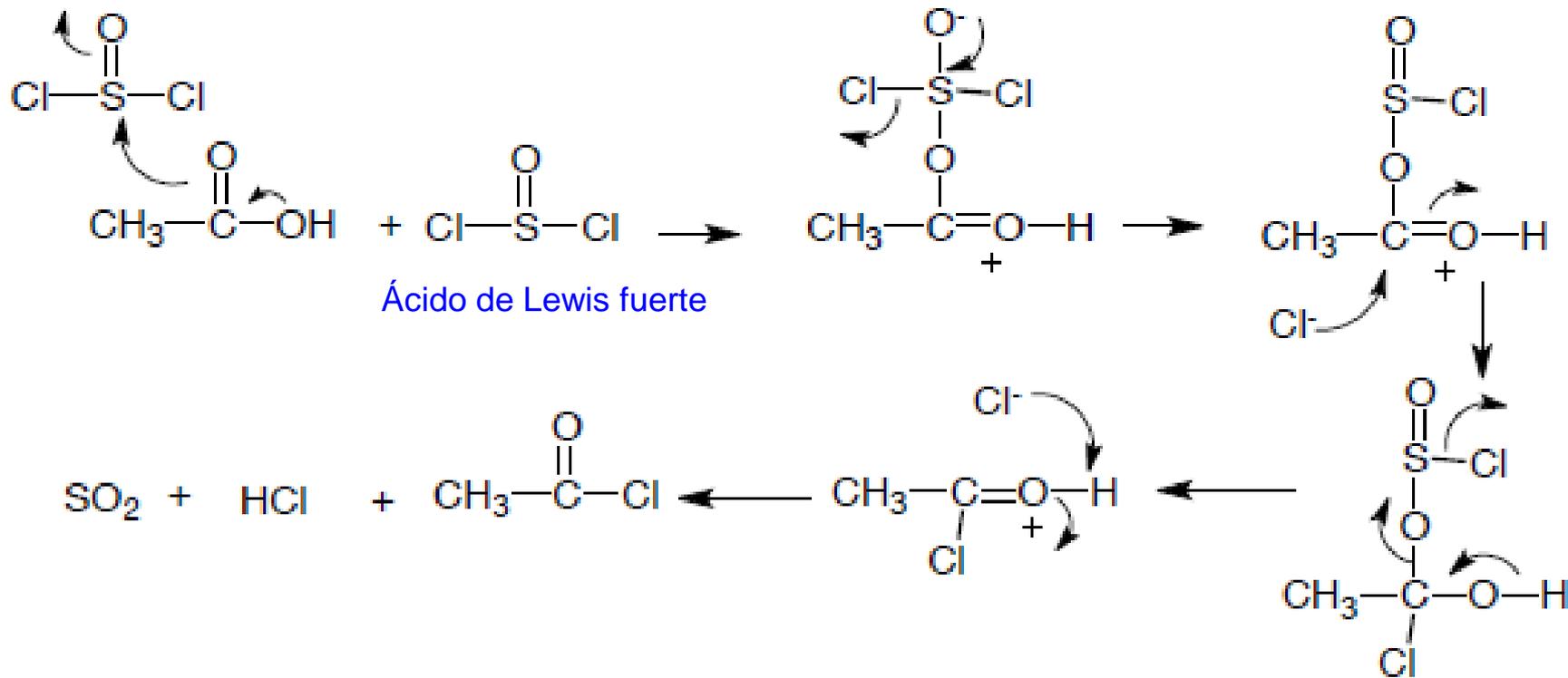


Ácido
2,4,6-trimetilbenzoico



Cloruro de
2,4,6-trimetilbenzoilo
(90 %)

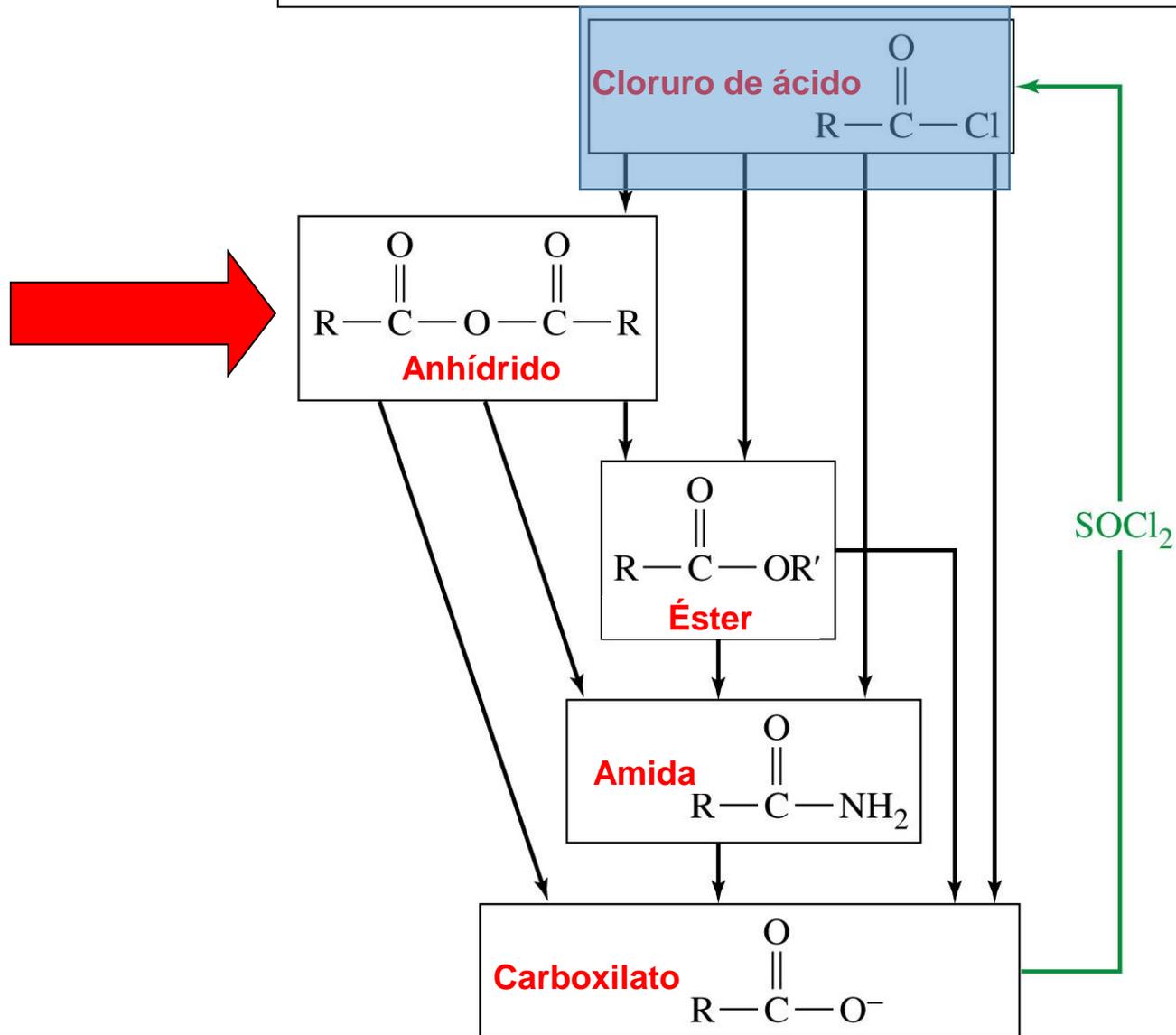




Ácido de Lewis fuerte

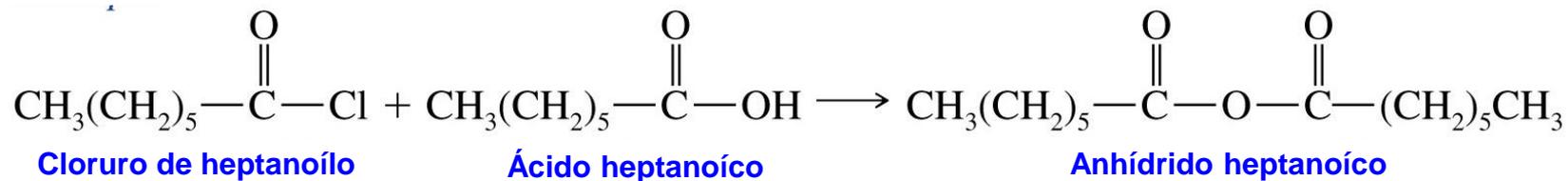


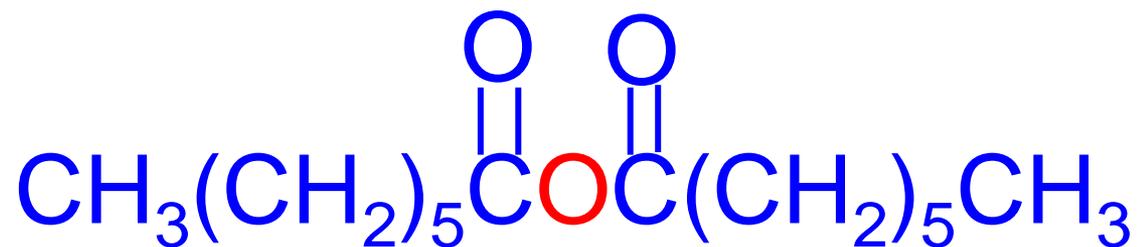
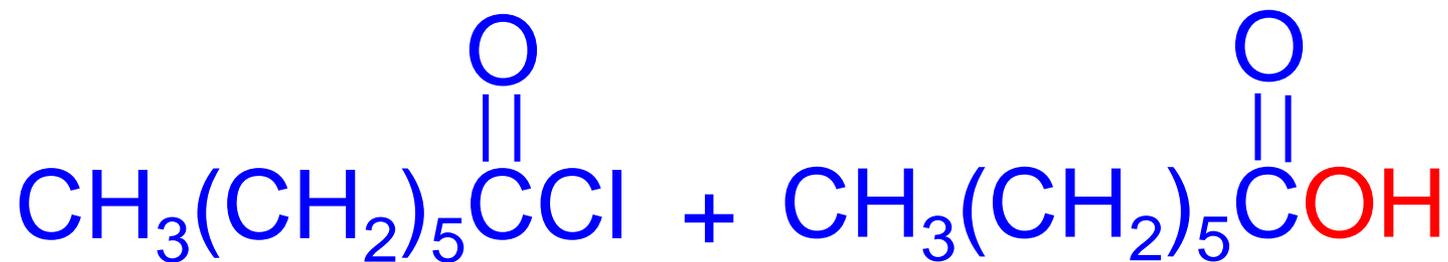
Interconversión de los derivados de ácido



Síntesis de Anhídridos

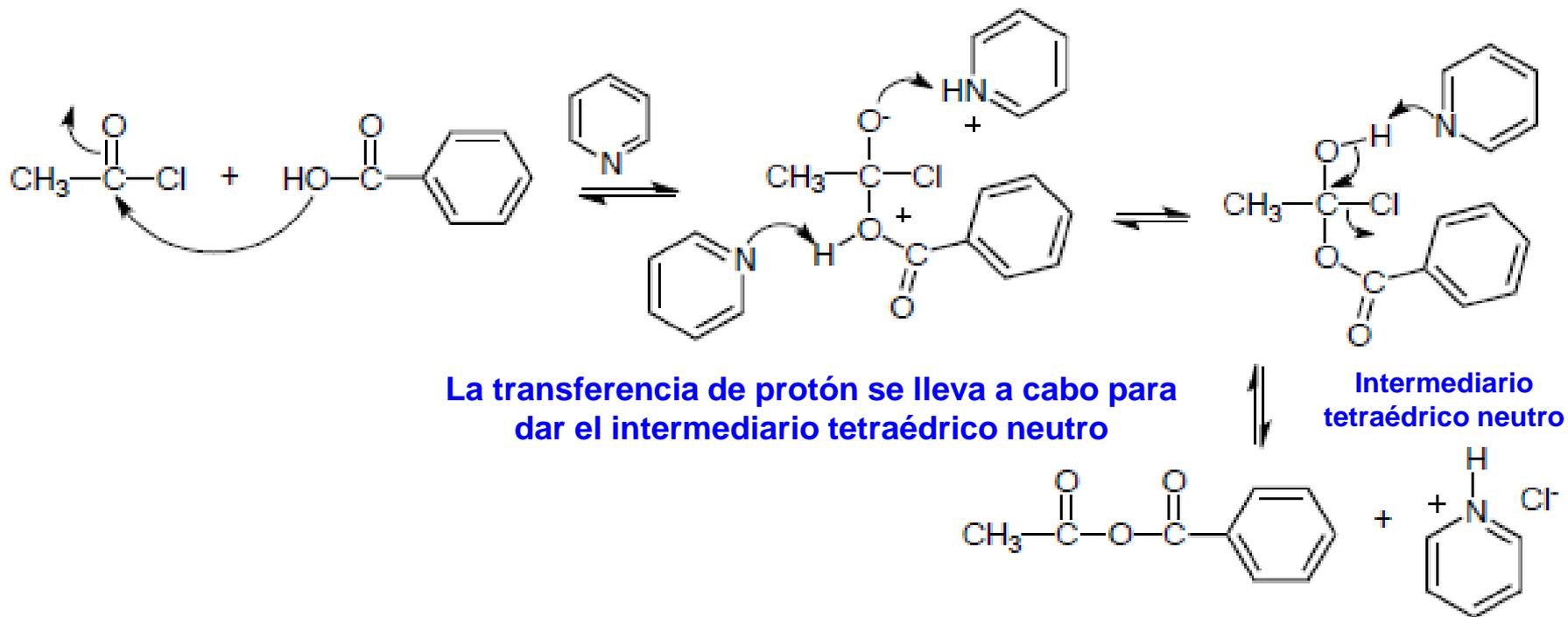
Ejemplo



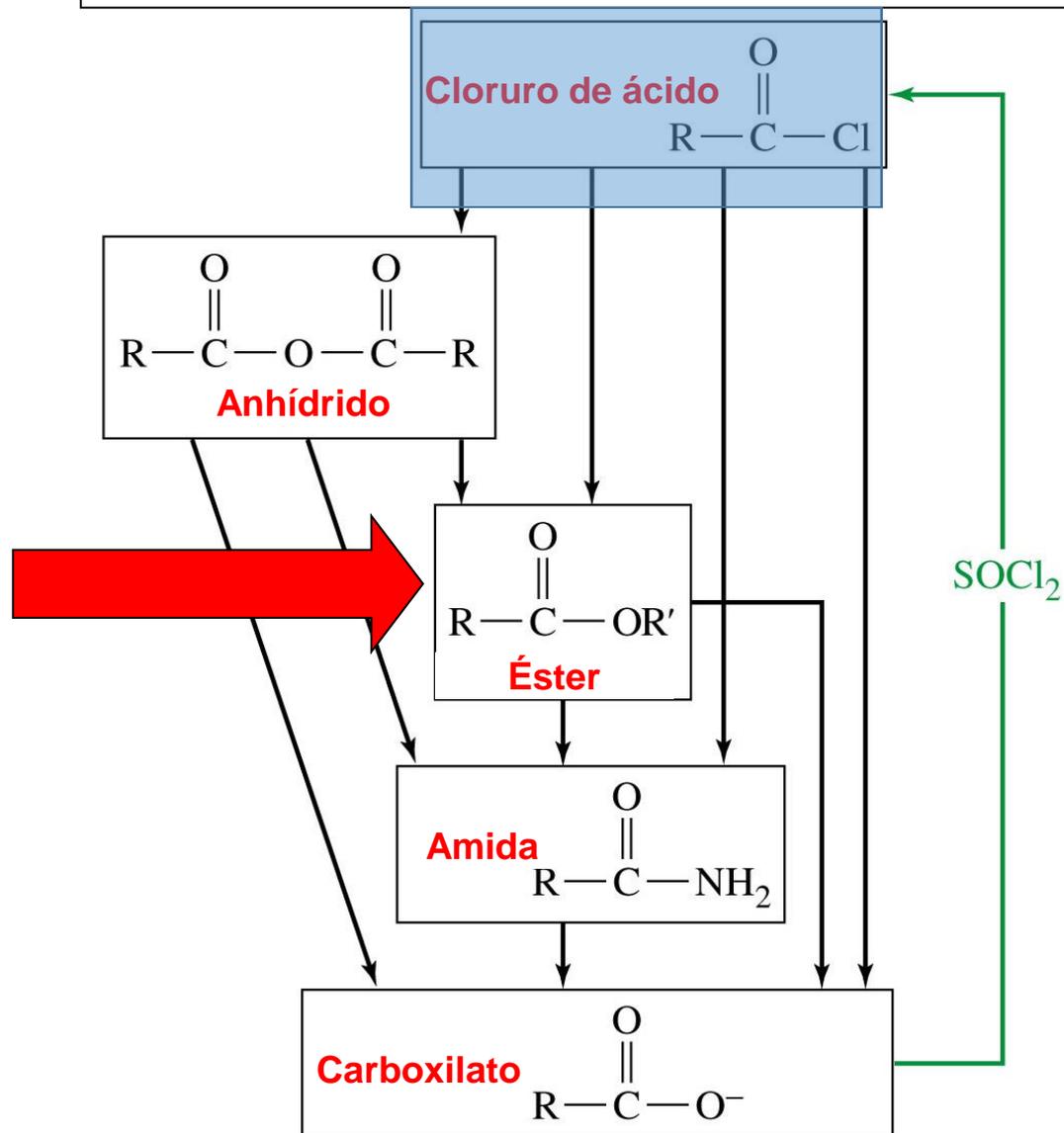


(78-83%)



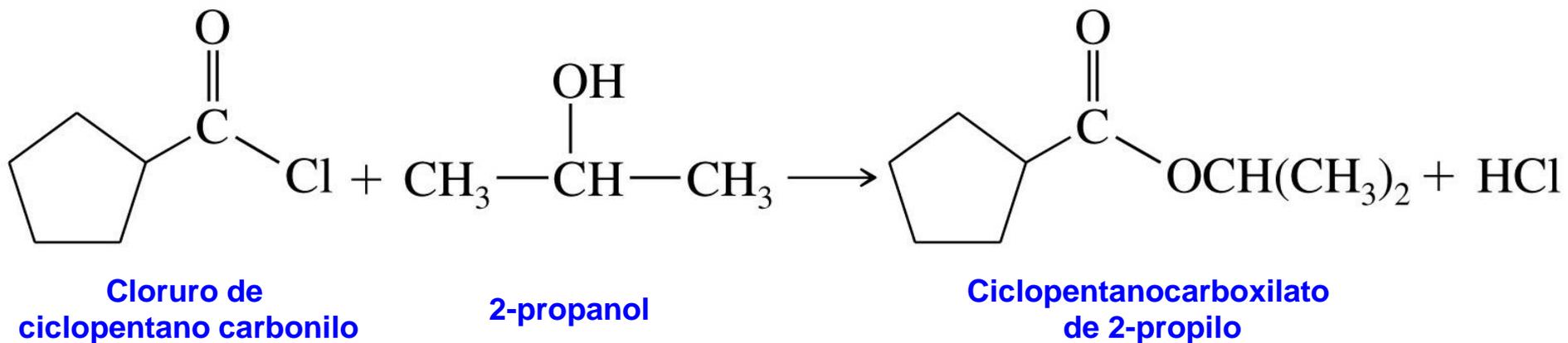


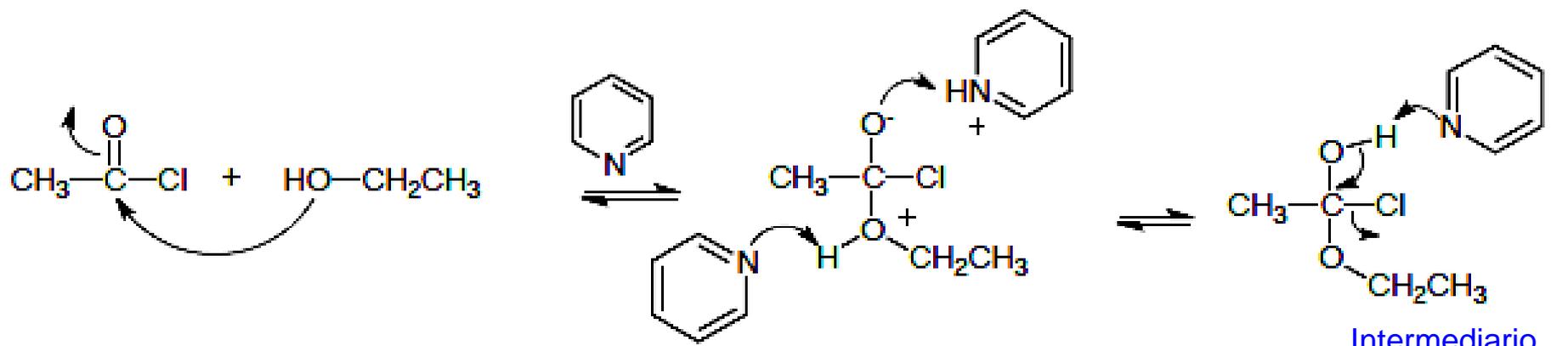
Interconversión de los derivados de ácido



Síntesis de Ésteres

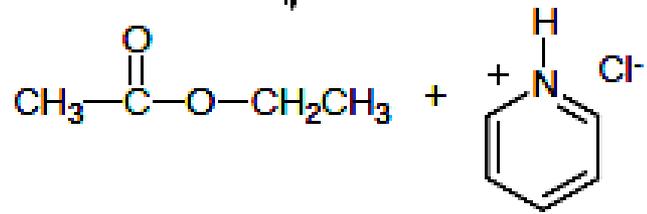
Ejemplo



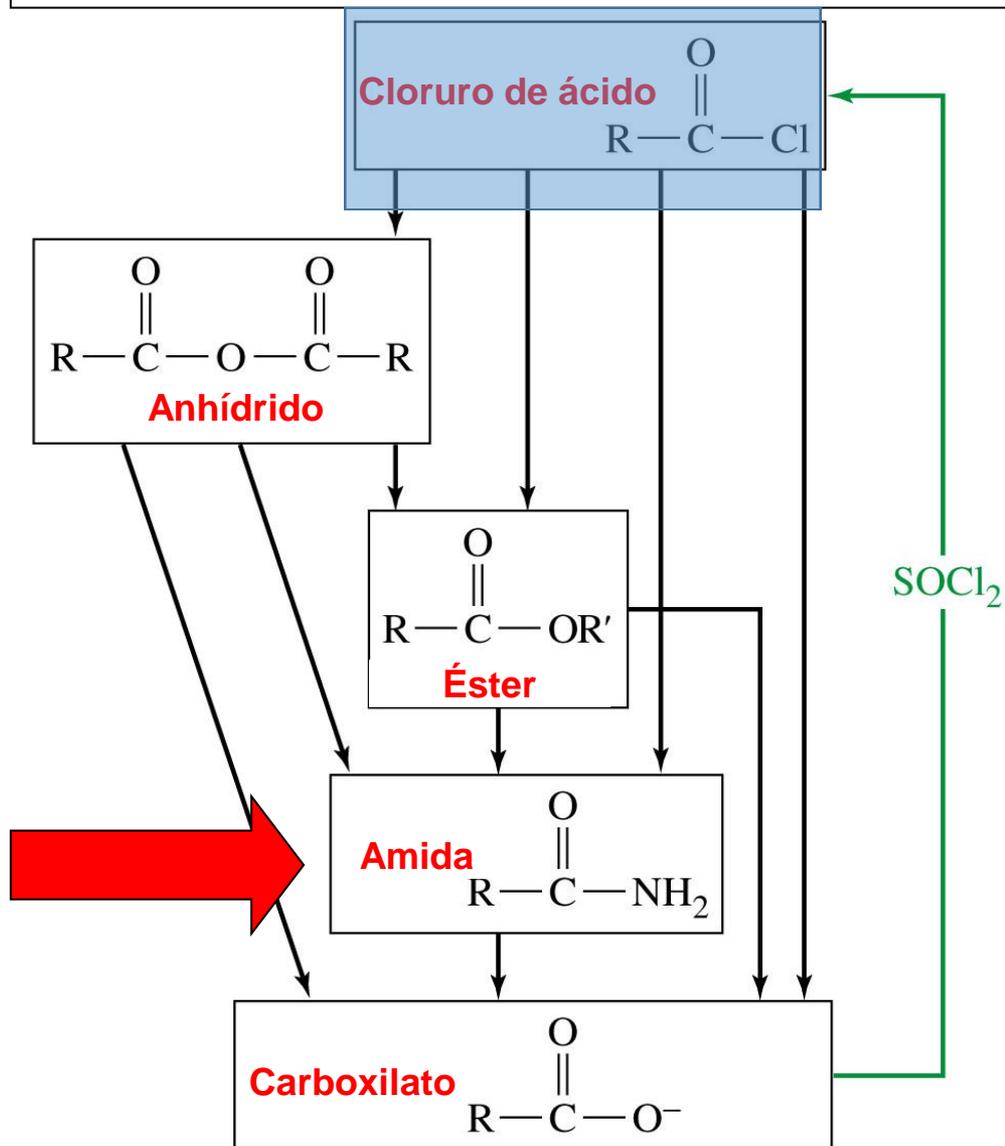


La transferencia de protón se lleva a cabo para dar el intermediario tetraédrico neutro

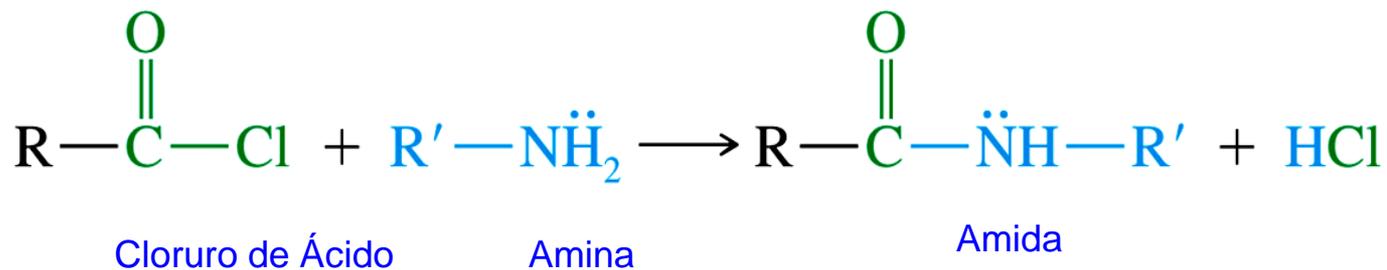
Intermediario tetraédrico neutro



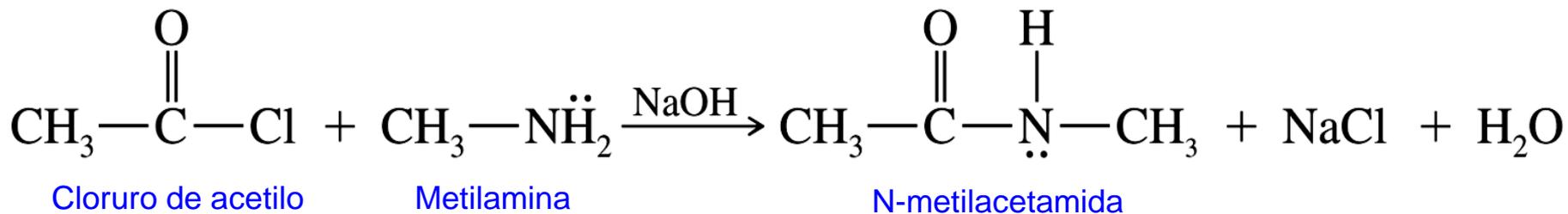
Interconversión de los derivados de ácido



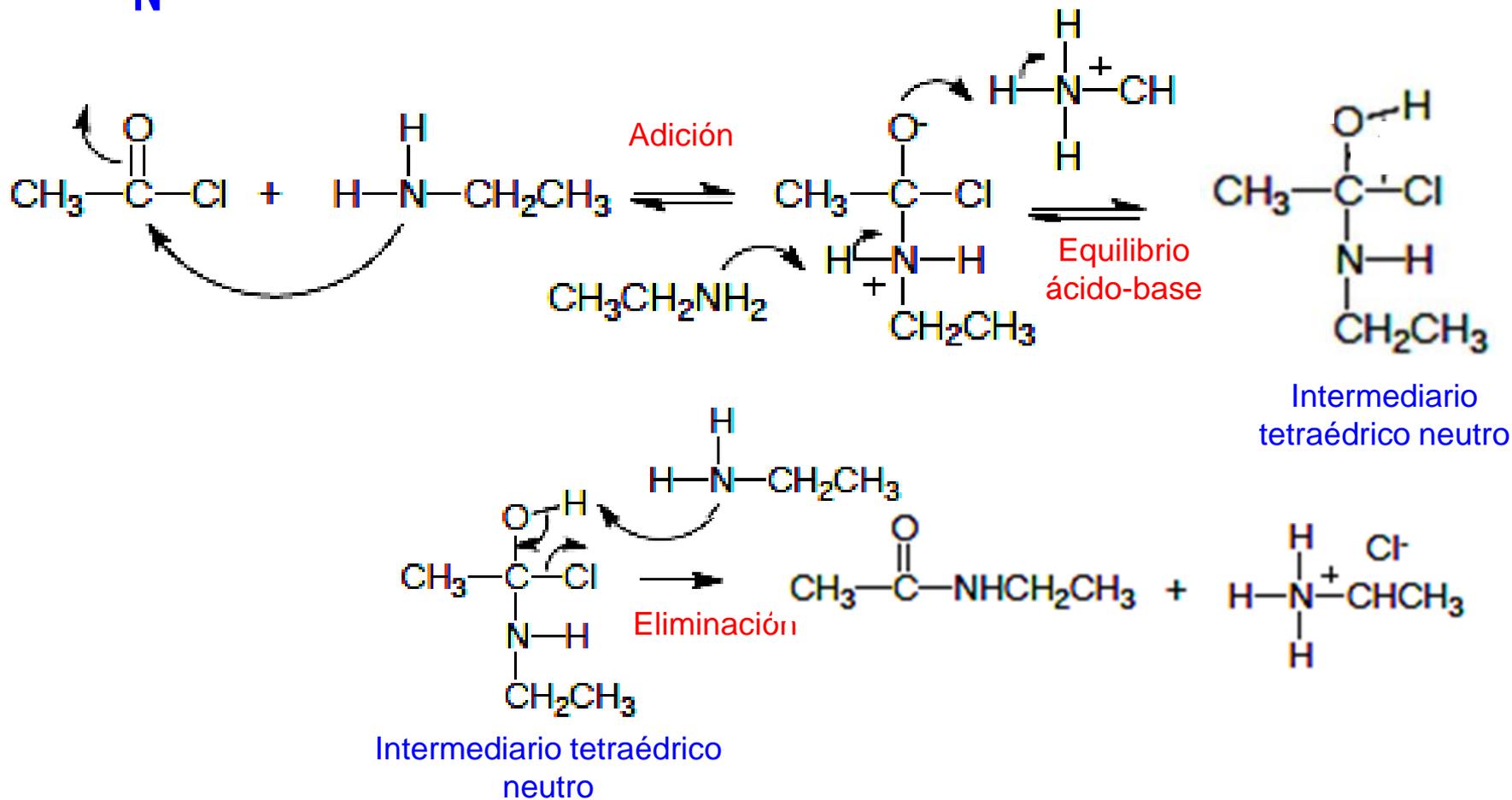
Síntesis de Amidas



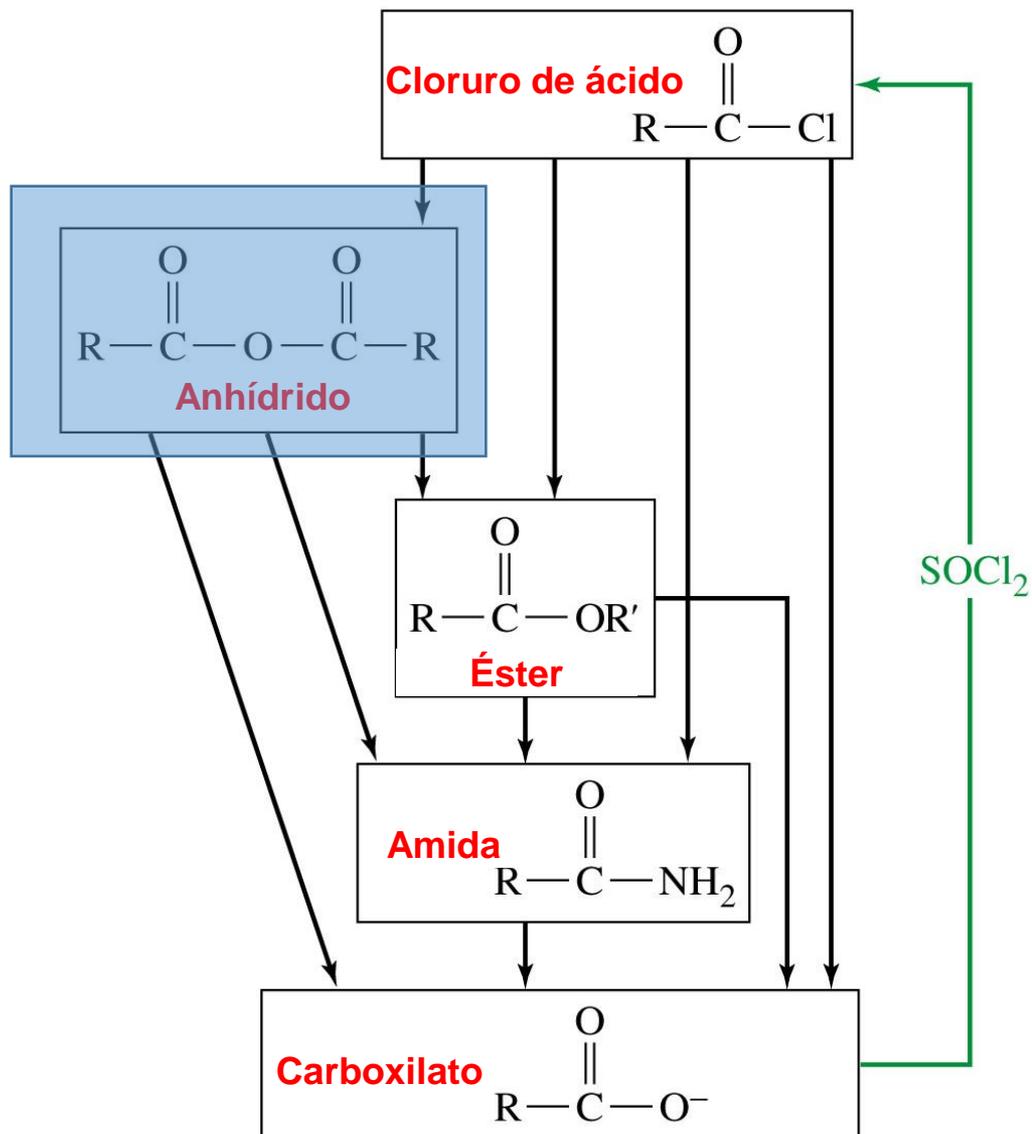
Ejemplo

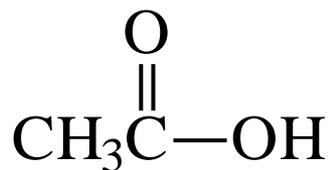


S_NAc

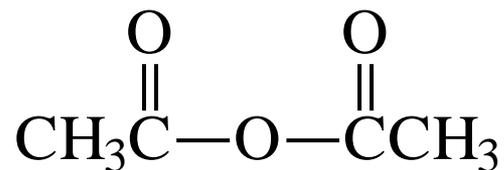
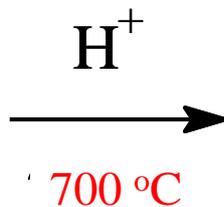


Interconversión de los derivados de ácido

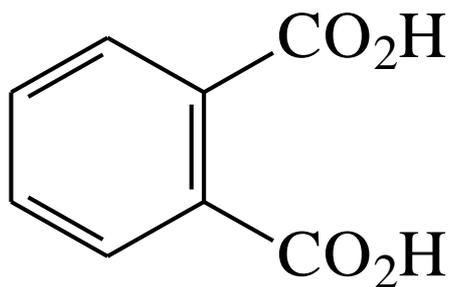




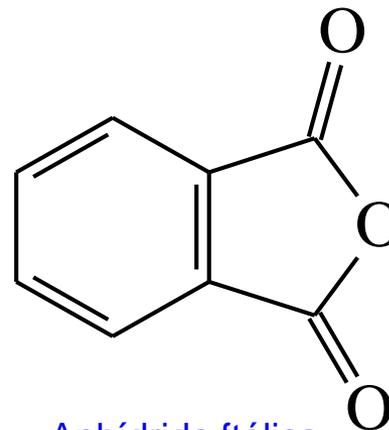
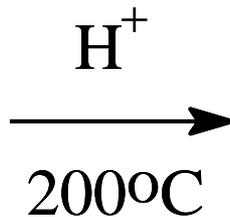
Ácido acético



Anhídrido acético



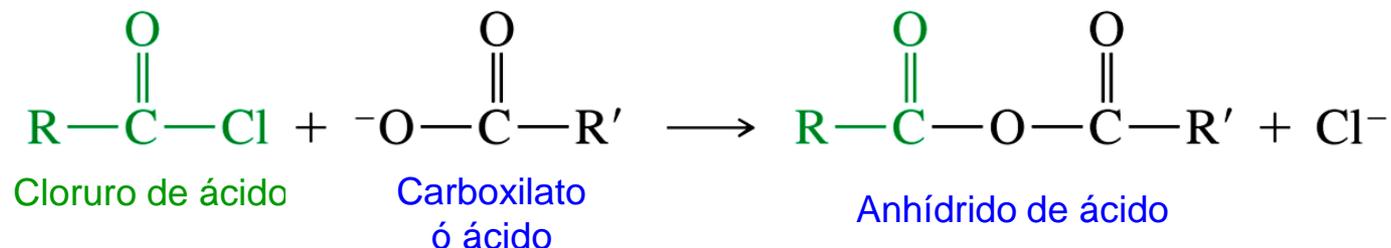
Ácido ftálico



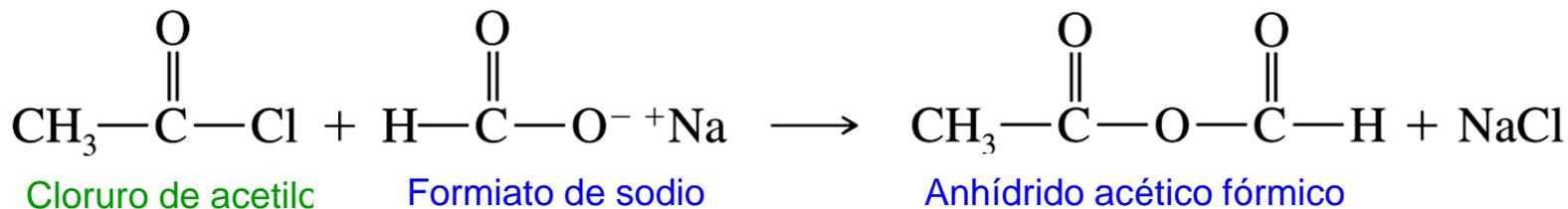
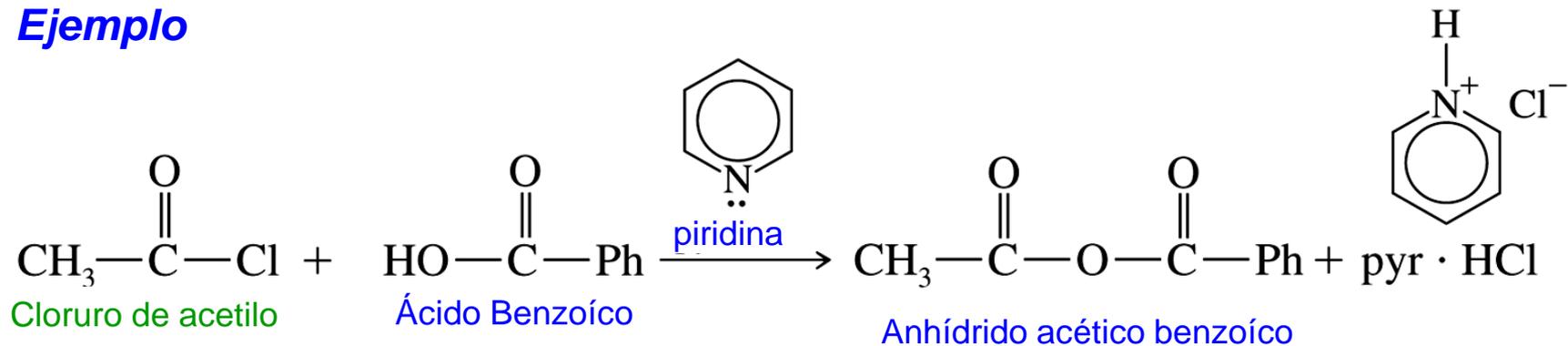
Anhídrido ftálico

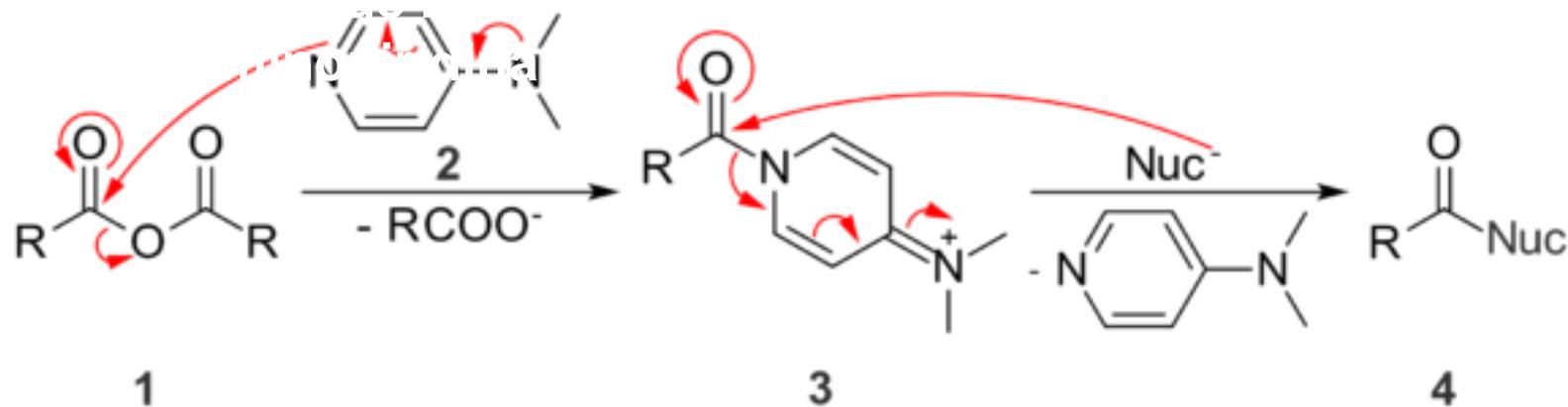
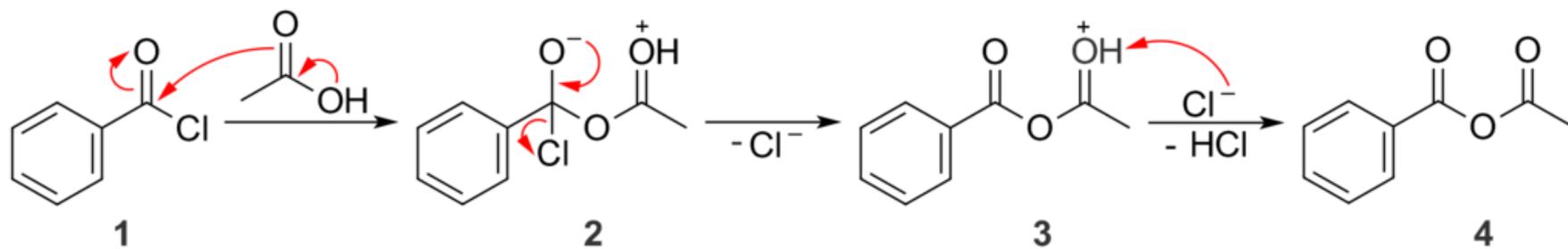


Síntesis General de Anhídridos

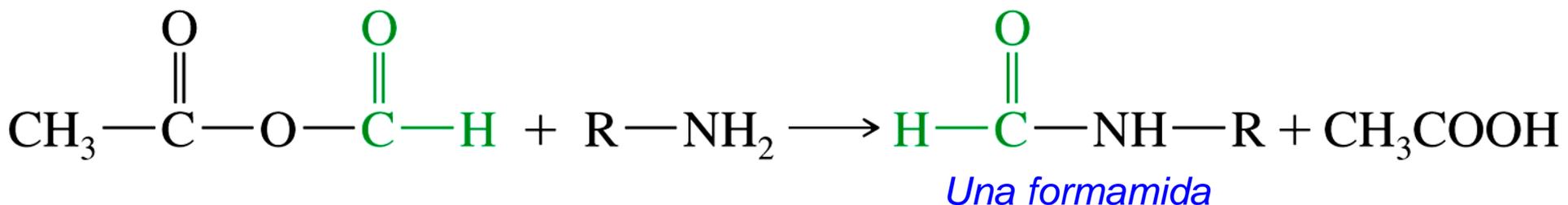
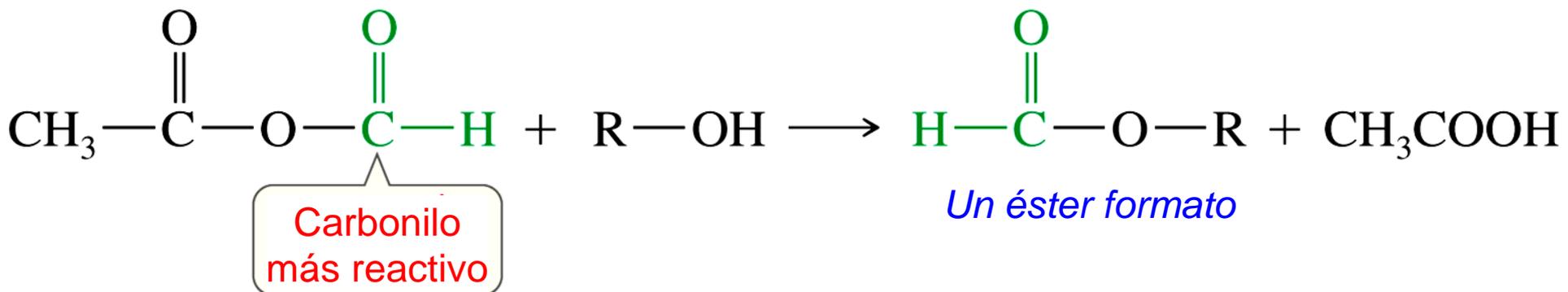


Ejemplo

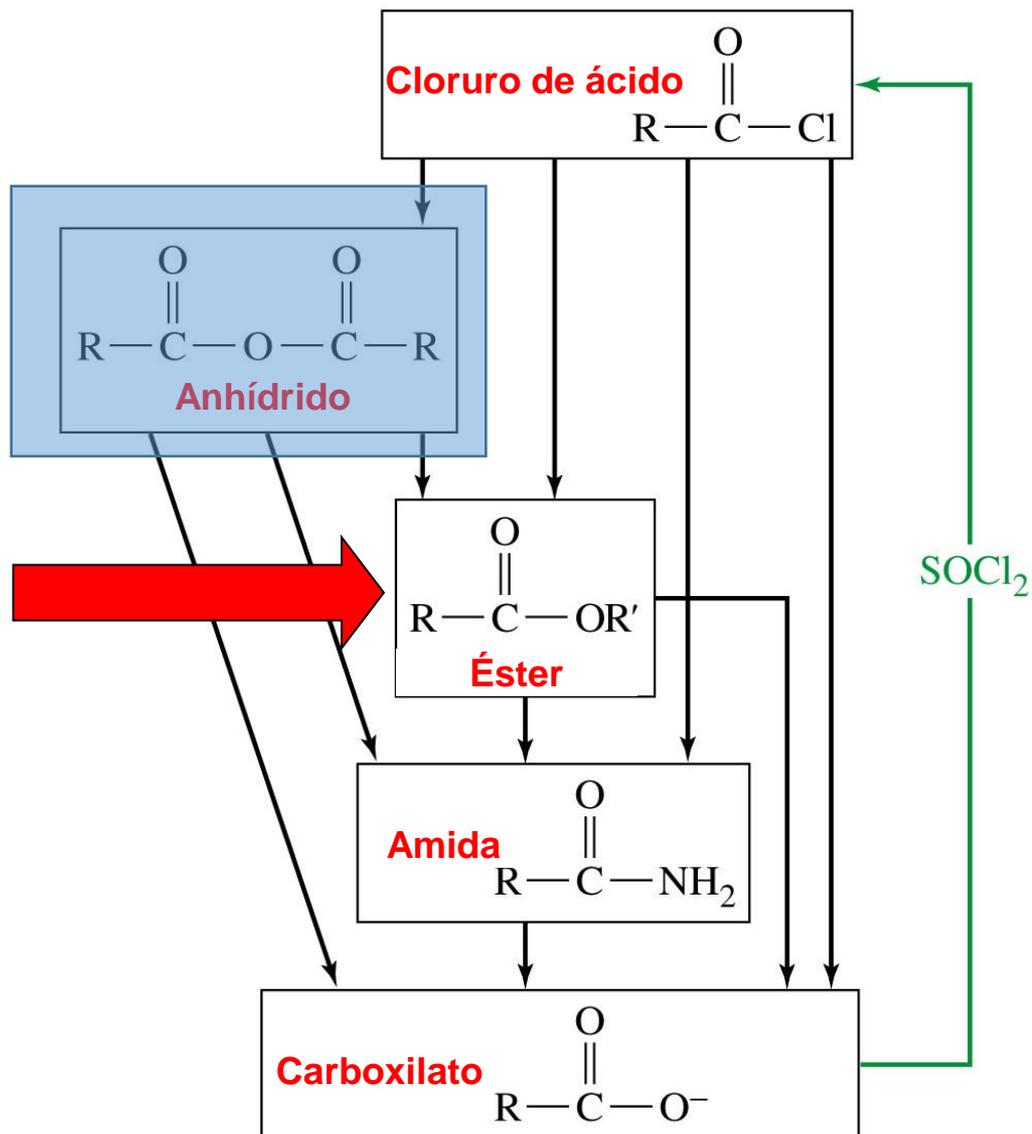




Anhídrido mixto acético fórmico

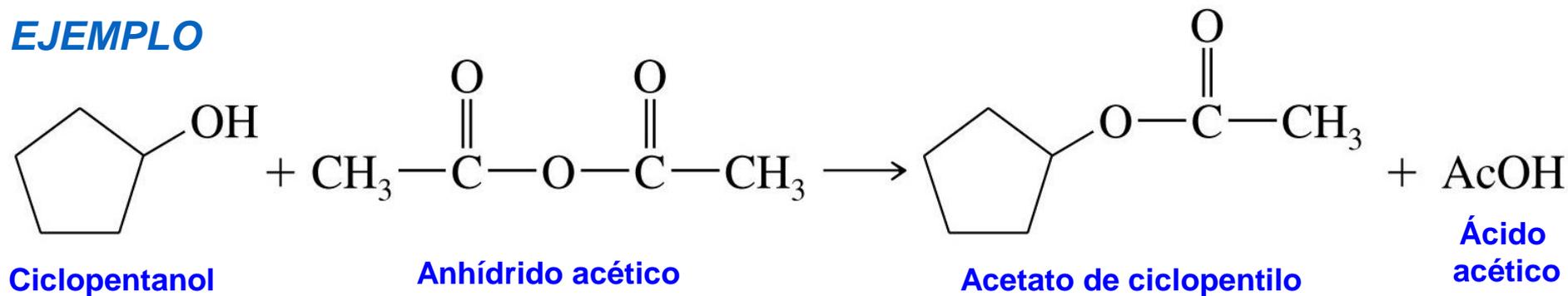


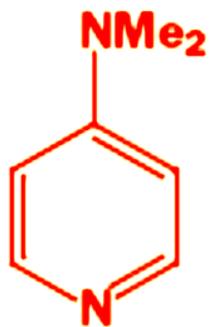
Interconversión de los derivados de ácido



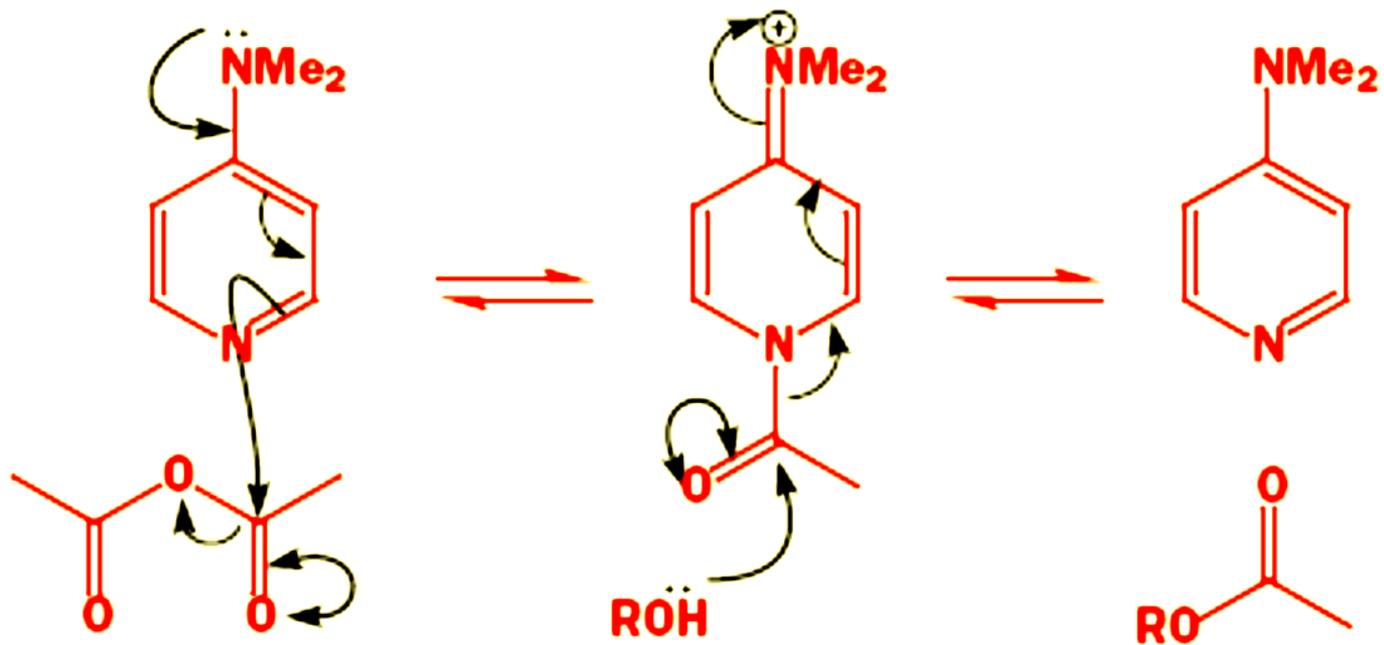
Síntesis de Ésteres

EJEMPLO

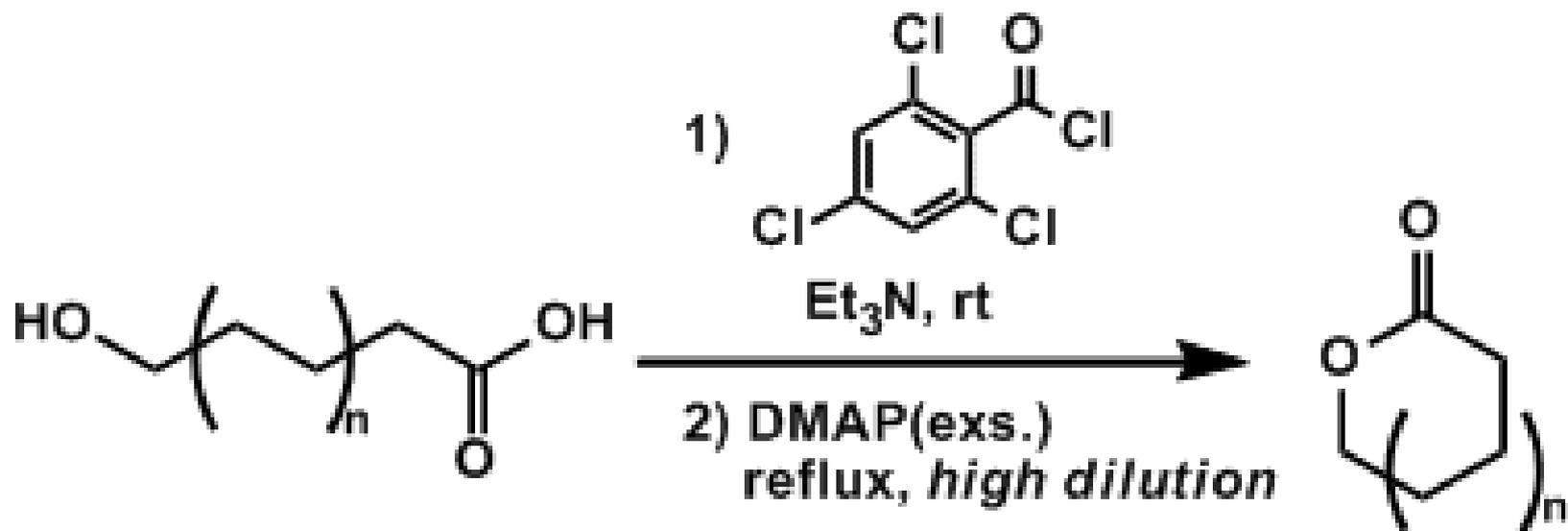




DMPA
4-DIMETILAMINO-
PIRIDINA



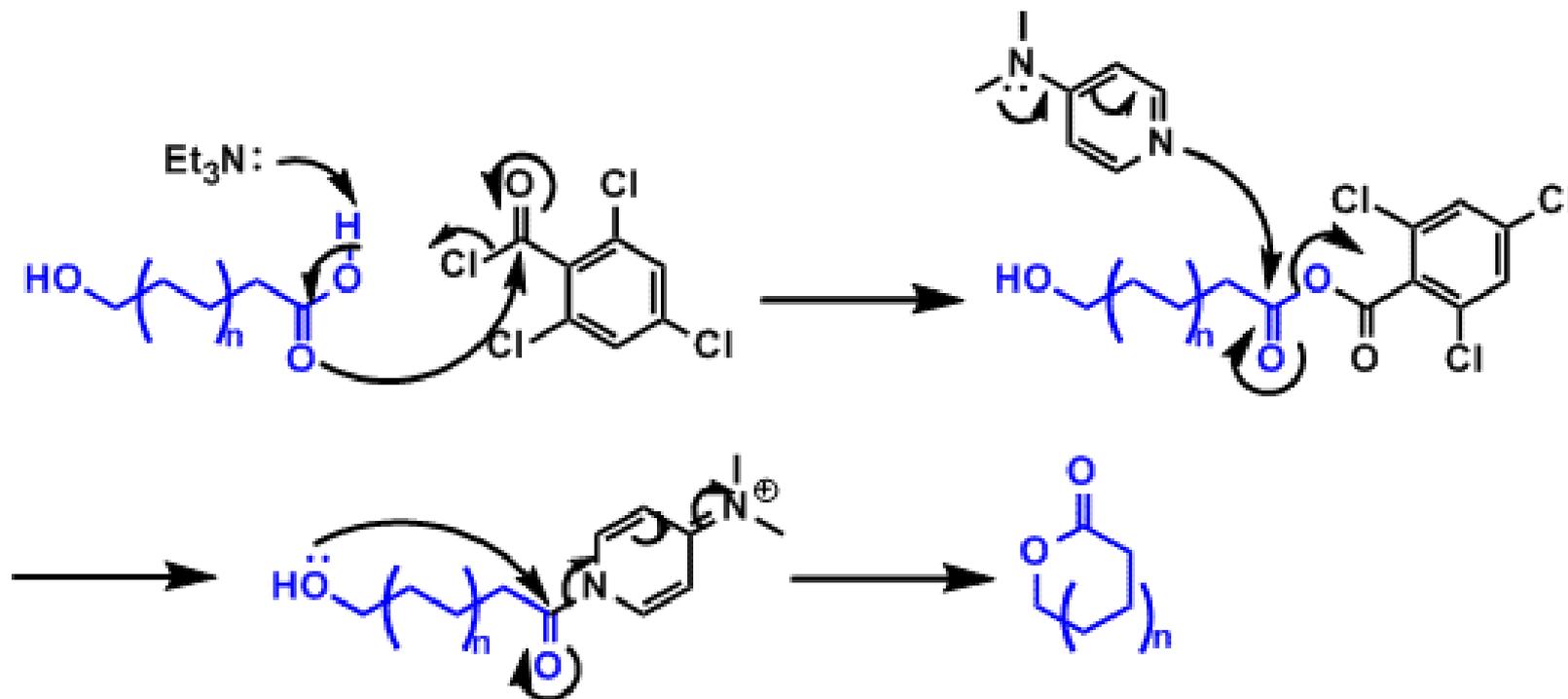
Macrolactonización de Yamaguchi



Inanaga, J.; Hirata, K.; Saeki, H.; Katsuki, T.; Yamaguchi, M. *Bull. Chem. Soc. Jpn.* **1979**, *52*, 1989.
Kawanami, Y.; Dainobu, Y.; Inanaga, J.; Katsuki, T.; Yamaguchi, M. *Bull. Chem. Soc. Jpn.* **1981**, *54*, 943



Investigación del mecanismo de esterificación de Yamaguchi

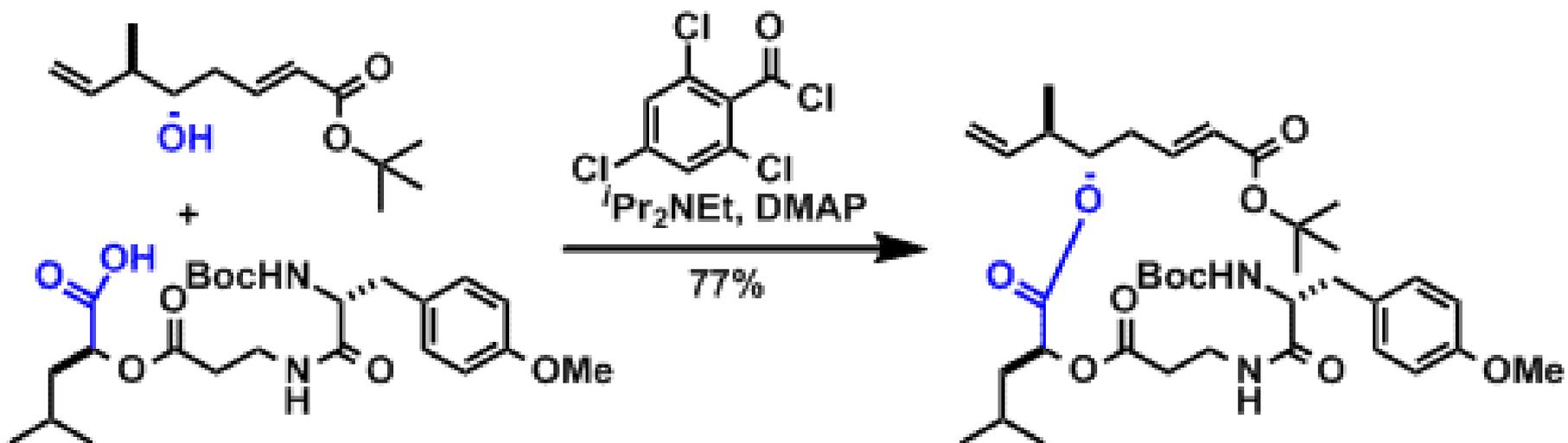


Ilirian Dhimitruka; John SantaLucia, Jr.; *Org. Lett.* **2006**, 8, 47.



Síntesis total de Criptoficina-24

Esterificación entre dos fragmentos (paso convergente)

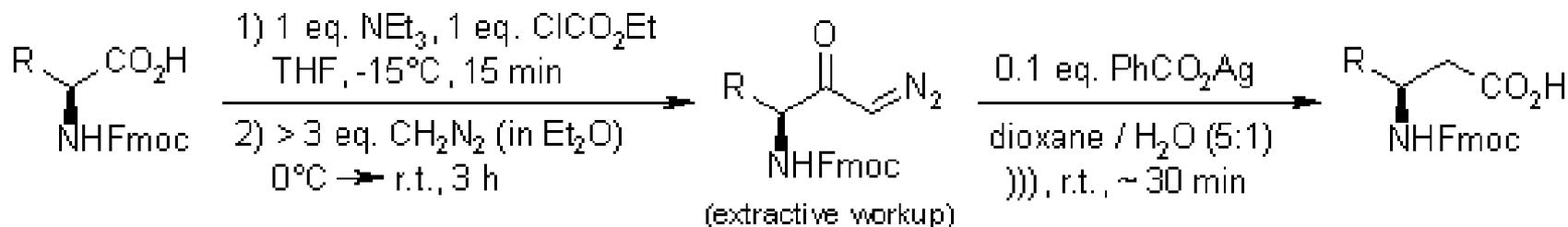


Eggen, M.; Mossman, C. J. *et al. J. Org. Chem.* **2000**, *65*, 7792



Synthesis of Fmoc-β-Homoamino Acids by Ultrasound-Promoted Wolff Rearrangement

A. Müller, C. Vogt, N. Sewald, *Synthesis*, **1998**, 837-841.



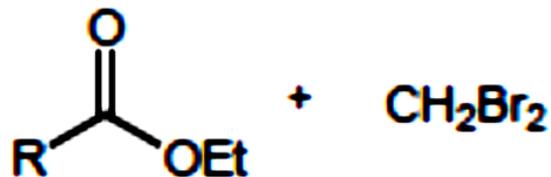
	Product	Yield (% , isol.)	ee (%)	Product	Yield (% , isol.)	ee (%)
1)		70	80.5		77	-
2)		76	99		80	-



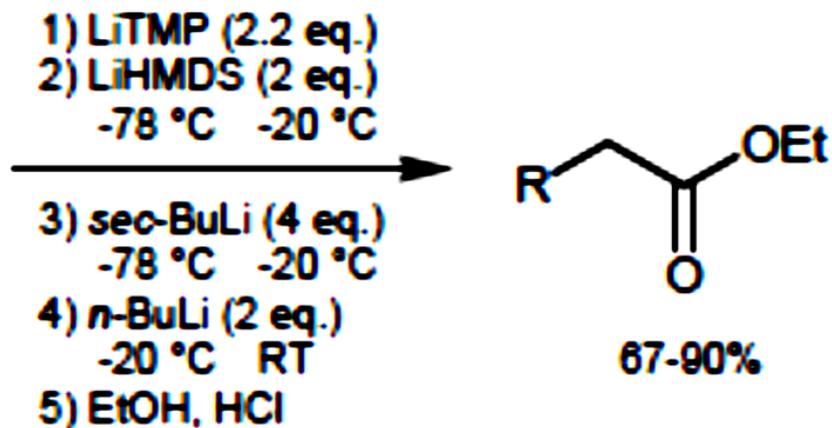
Entrada	Apellidos
1	A a E
2	F a K
3	L a P
4	Q a Z



Homologación de ésteres de Kowalski



R = aryl, 1°, 2°, and 3° alkyl, alkenyl



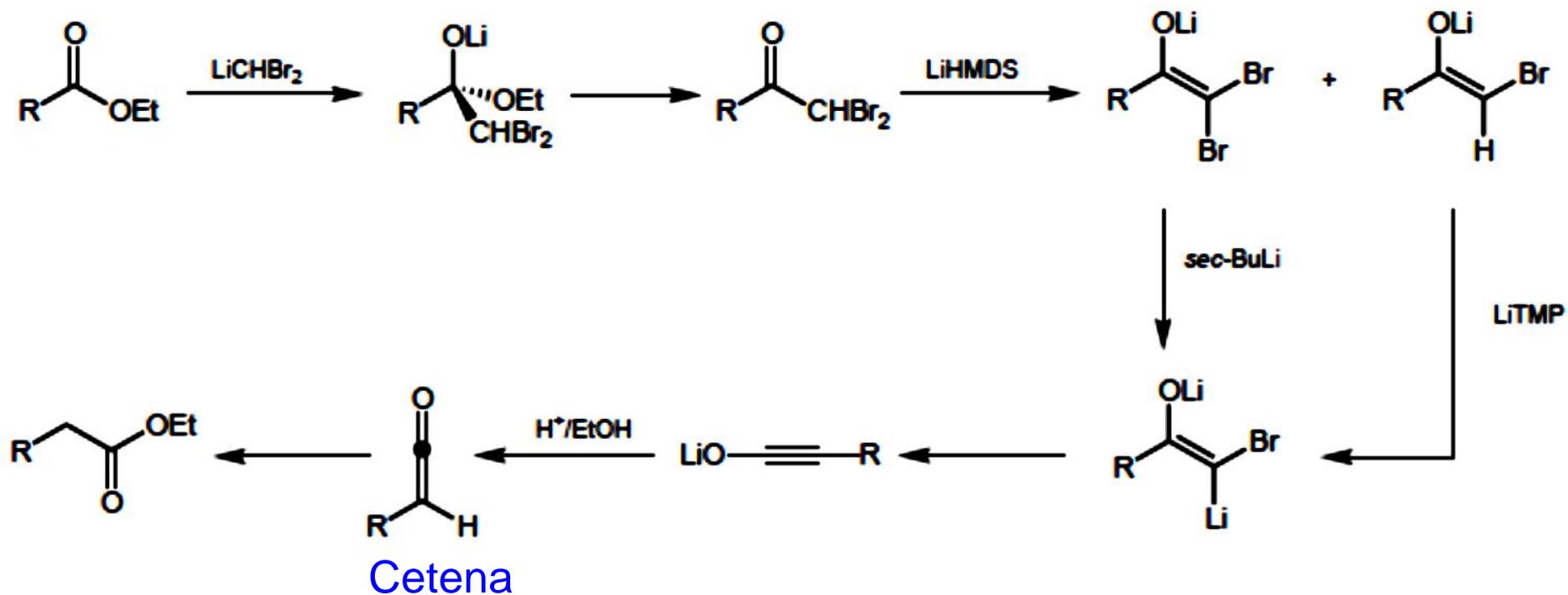
Kowalski, C. J. *J. Org. Chem.* 1992, 57, 7194

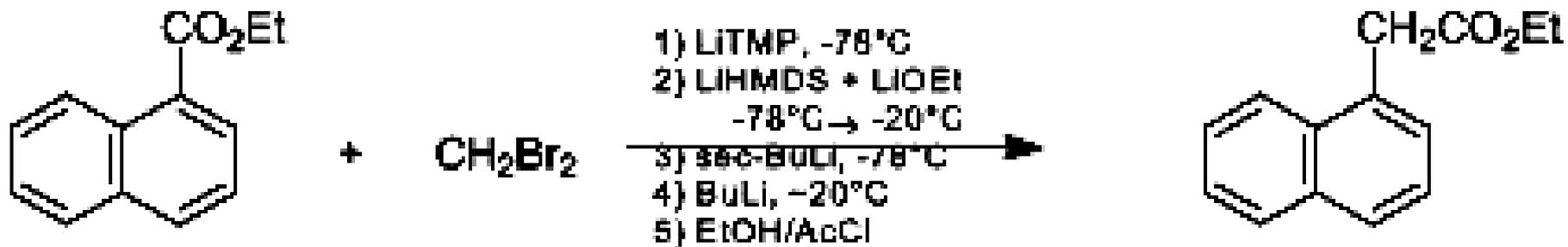
Nota:

Un estereocentro metoxi alílico en posición β al sitio de homologación, no se racemiza bajo las condiciones de reacción



Intermediarios que se forman durante la homologación de ésteres de Kowalski

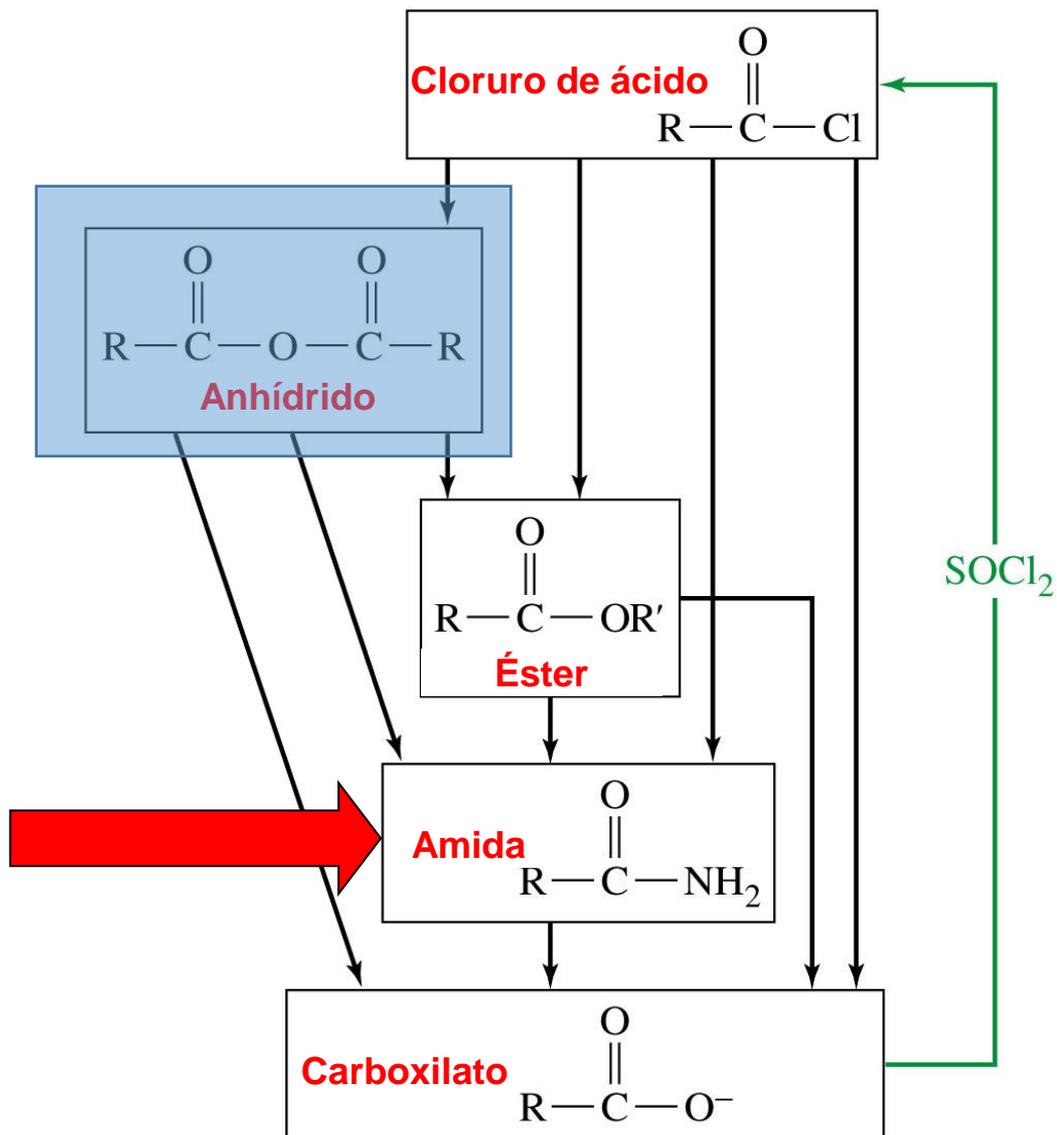




Organic_Syntheses, Coll. Vol. 9, p.426 (1998); Vol. 71, p.146 (1993).

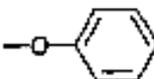
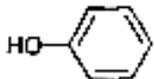
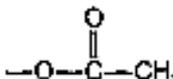
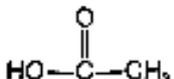
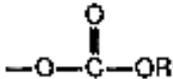


Interconversión de los derivados de ácido



Derivados y reactividad de los ácidos carboxílicos comúnmente utilizados en la formación de amidas



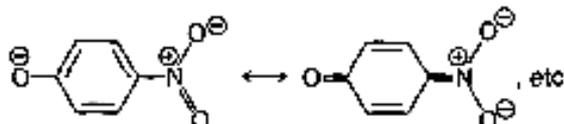
X	HX	pKa de H	rapidez de la formación de la amida
-OH	HOH	16	Lenta ^a
-Cl	HCl	-6	Buena
-N ₃	HN ₃	3	Buena
-OCH ₂ CH ₃	HOCH ₂ CH ₃	16	Lenta
		9.89	Moderada
		7.15	Buena ^b
		4.75	Moderada
	-	-	Buena ^b

[https://chem.libretexts.org/?title=Bookshelves/Organic_Chemistry/Book:_Basic_Principles_of_Organic_Chemistry_\(Roberts_and_Caserio\)/24:_Organonitrogen_Compounds_II-_Amides,_Nitriles,_%26_Nitro_Compounds/24.03:_Synthesis_of_Amides](https://chem.libretexts.org/?title=Bookshelves/Organic_Chemistry/Book:_Basic_Principles_of_Organic_Chemistry_(Roberts_and_Caserio)/24:_Organonitrogen_Compounds_II-_Amides,_Nitriles,_%26_Nitro_Compounds/24.03:_Synthesis_of_Amides)

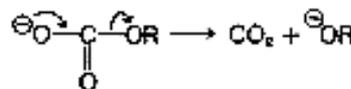
John D. Robert and Marjorie C. Caserio (1977) Basic Principles of Organic Chemistry, second edition. W. A. Benjamin, Inc. , Menlo Park, CA. ISBN 0-8053-8329-8. This content is copyrighted under the following conditions, "You are granted permission for individual, educational, research and non-commercial reproduction, distribution, display and performance of this work in any format."

^A A temperaturas ordinarias, se requiere la activación a través de un agente acoplante, pero con un calentamiento fuerte se puede obtener la amida en forma directa

^B Un buen grupo saliente debido a la siguiente estabilización

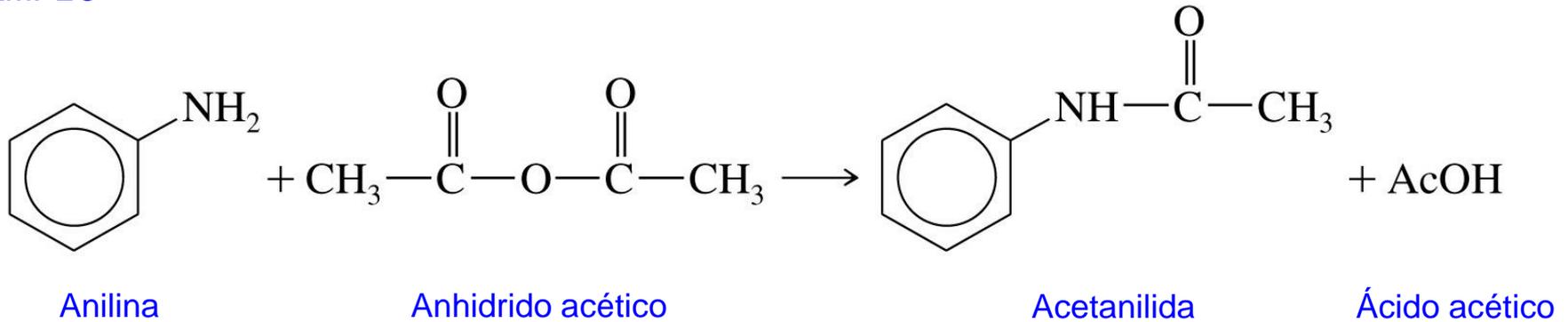


^C Es un buen grupo saliente, posiblemente debido a la descomposición asociada para formar productos más estables



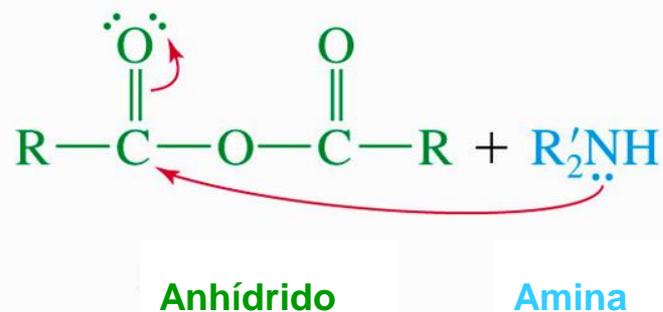
Síntesis de Amidas. Amonólisis de un anhídrido

EJEMPLO

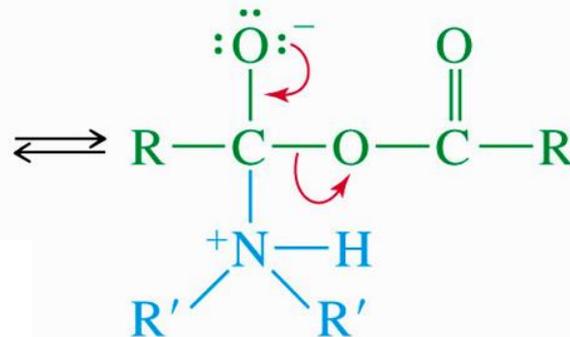


Síntesis de Amidas. Mecanismo

Paso.1 Adición del nucleófilo

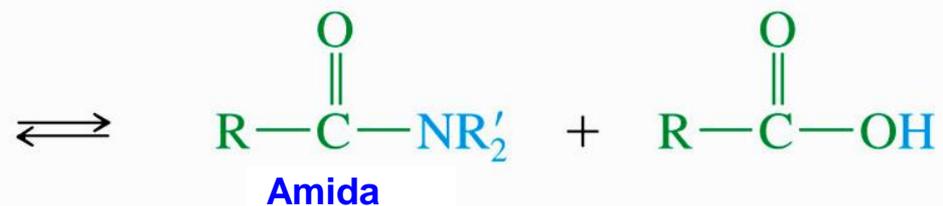
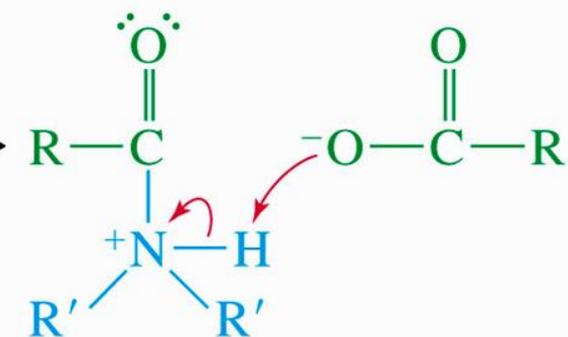


Paso.2 Eliminación del grupo saliente



[Intermediario tetraédrico]

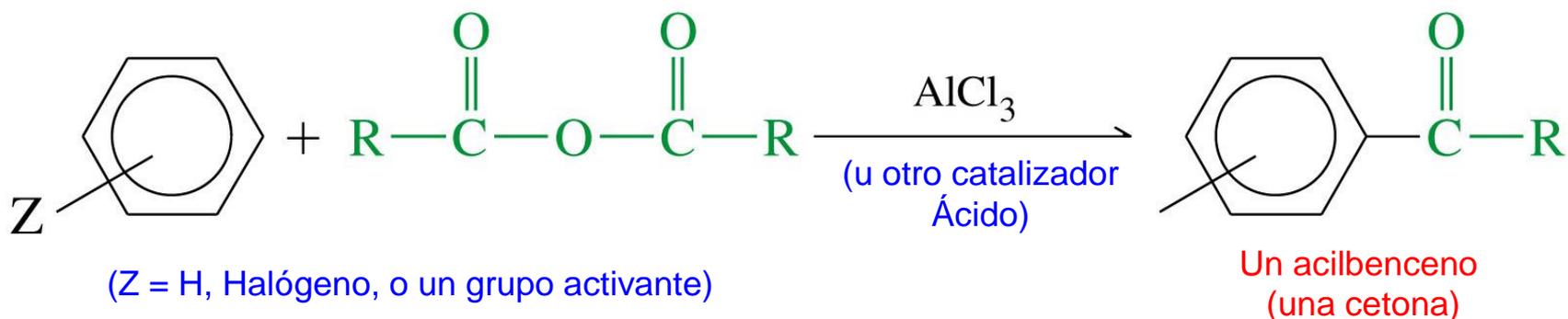
Paso.3 Pérdida de un protón



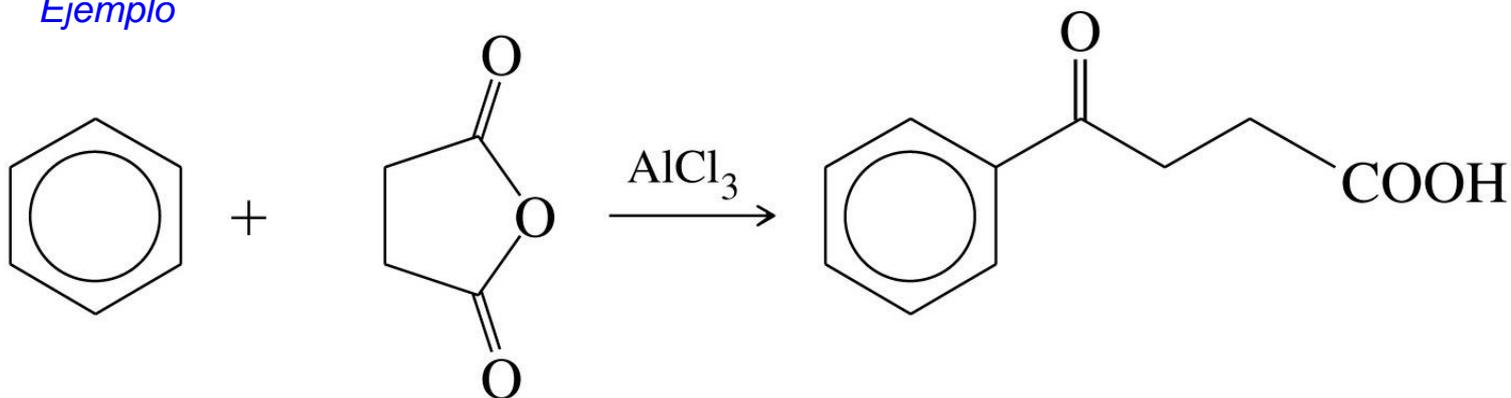
Acilación de Friedel Crafts



Acilación de Friedel-Crafts usando anhídridos



Ejemplo



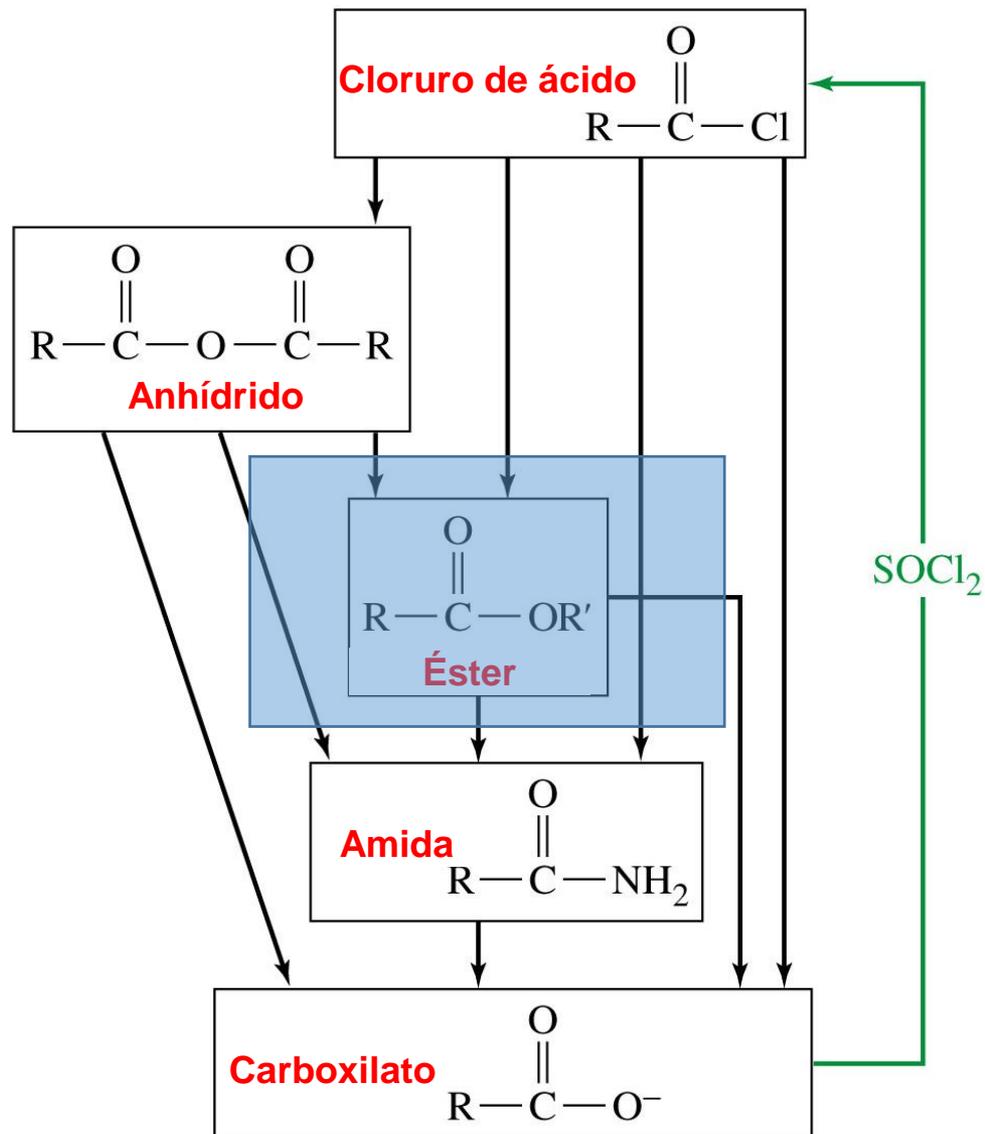
Benceno

Anhídrido succínico

Ácido 4-oxo-4-fenilbutanoico



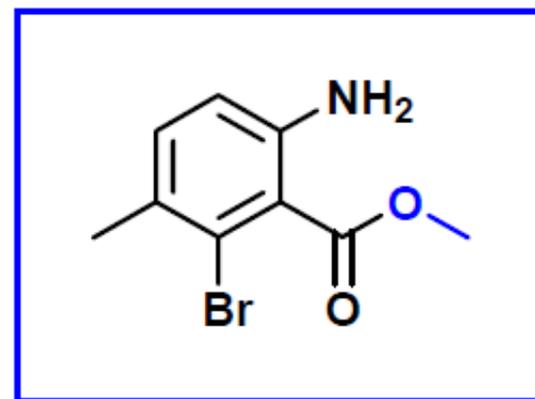
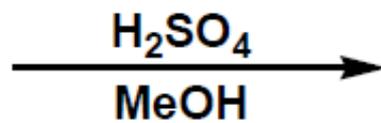
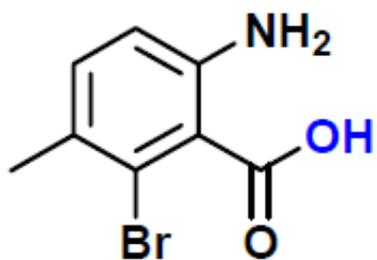
Interconversión de los derivados de ácido

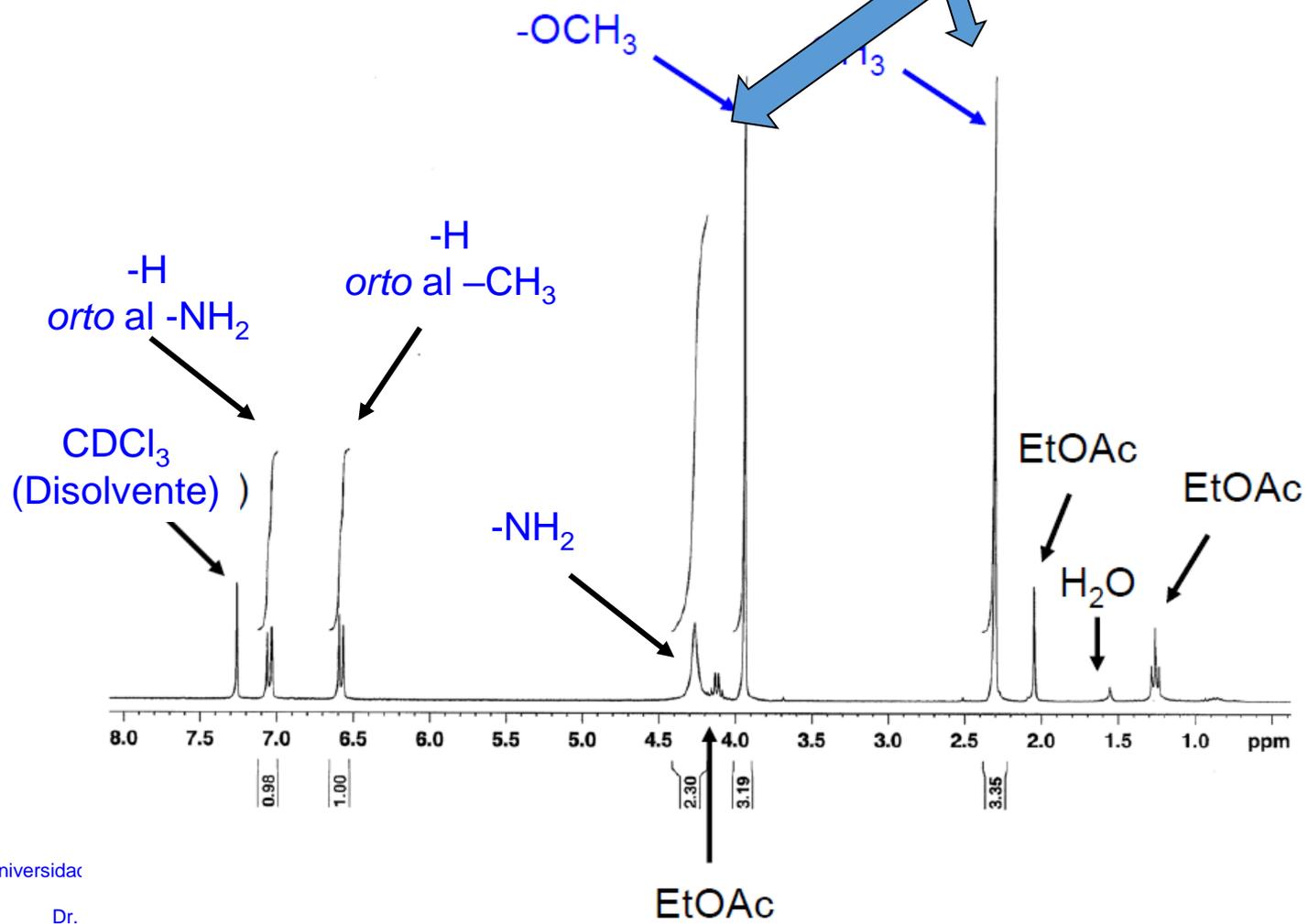
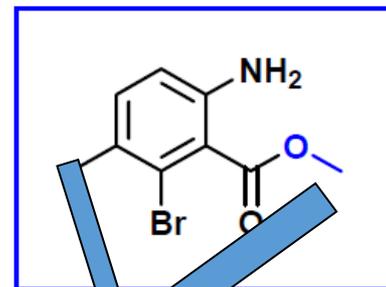
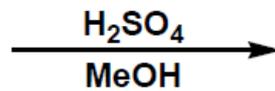
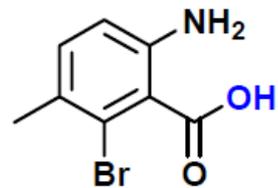


ÉSTERES



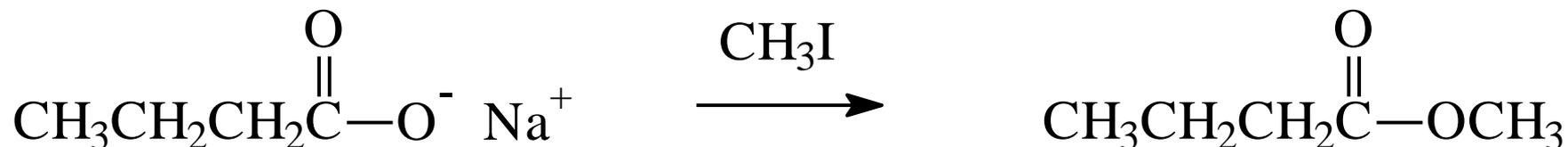
Reacción de esterificación de Fisher



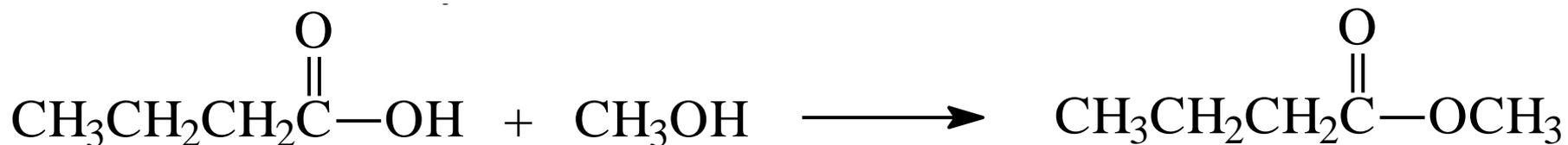


Síntesis de Ésteres

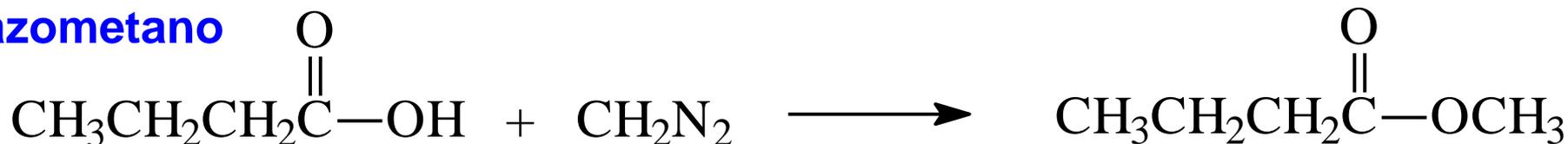
A través de reacciones tipo S_N2:

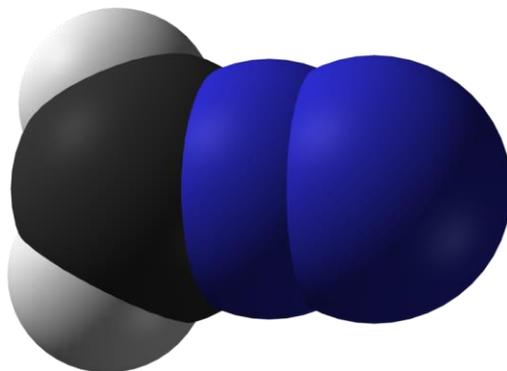
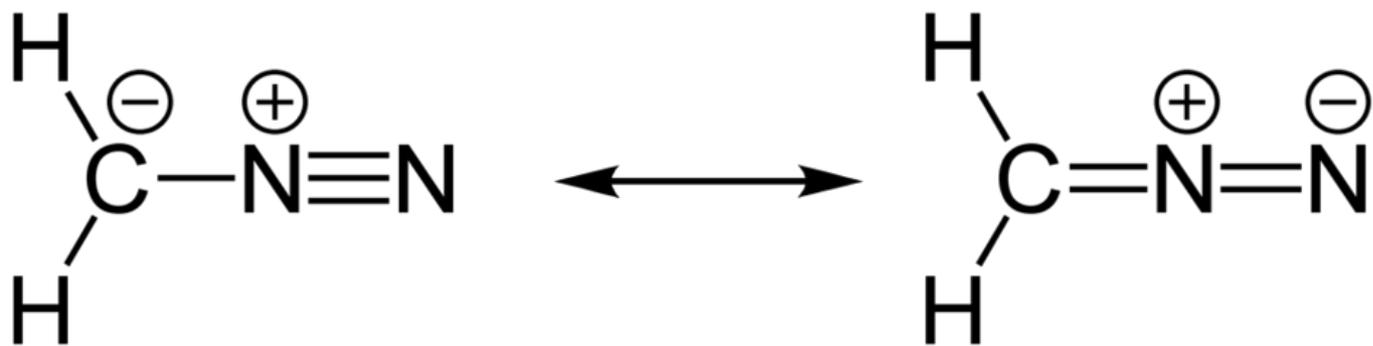


Reacción de esterificación directa catalizada por ácido (Fischer)

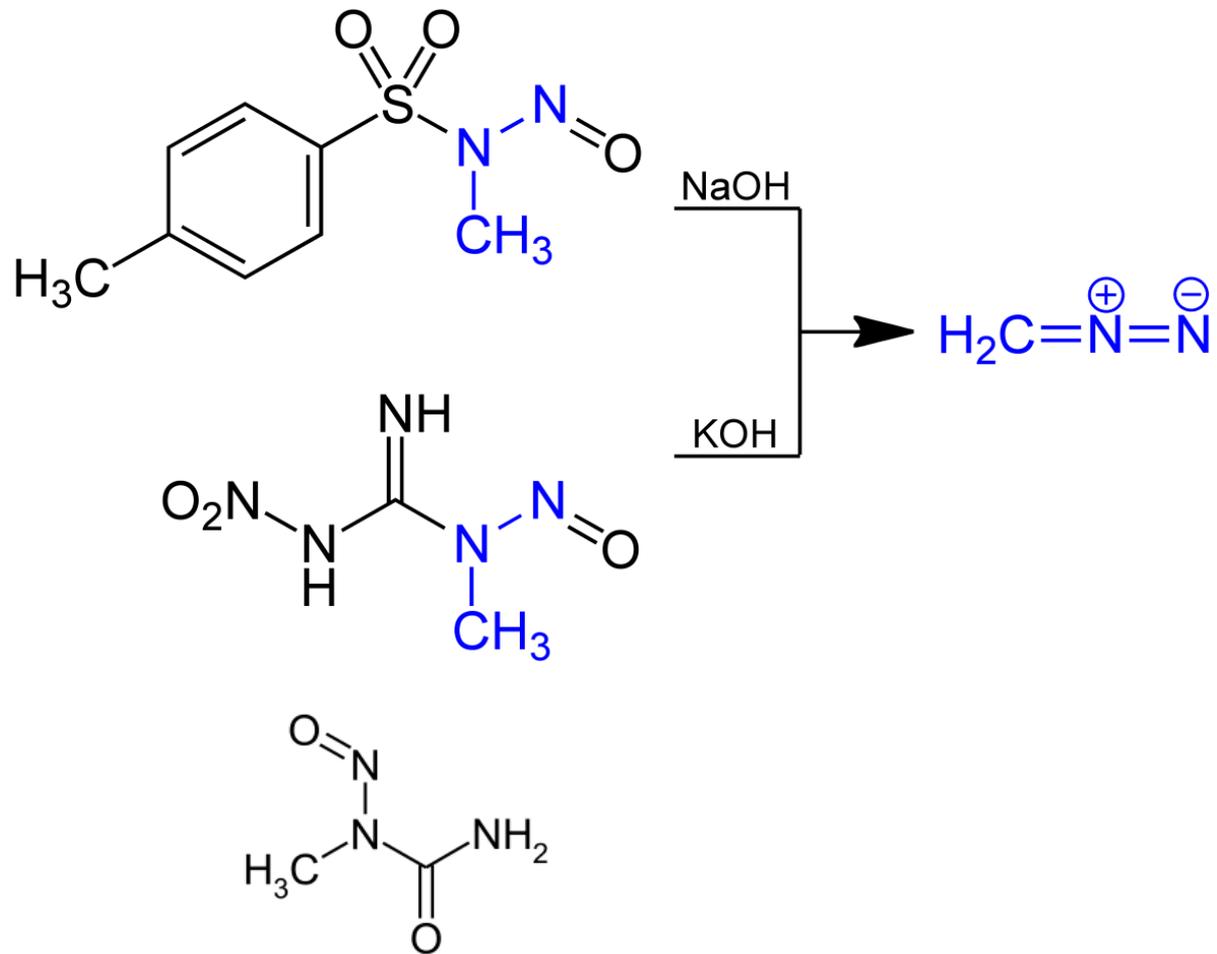


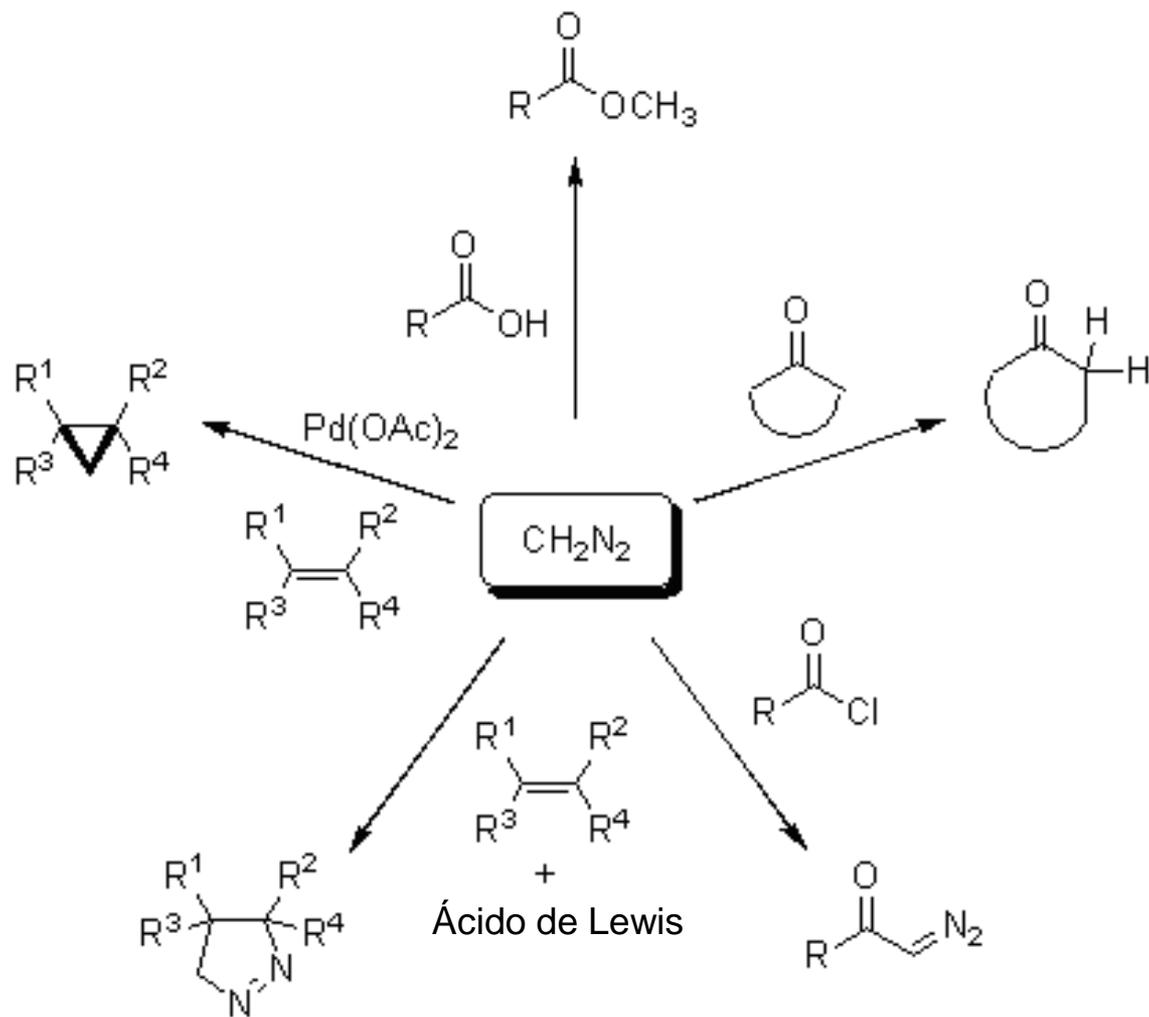
Con
diazometano

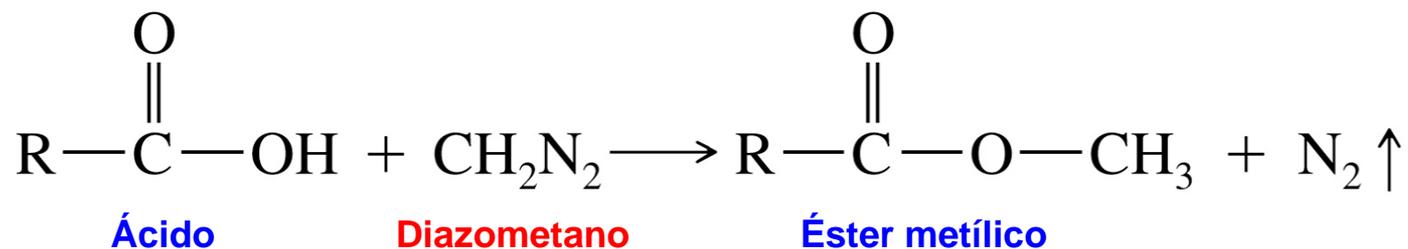




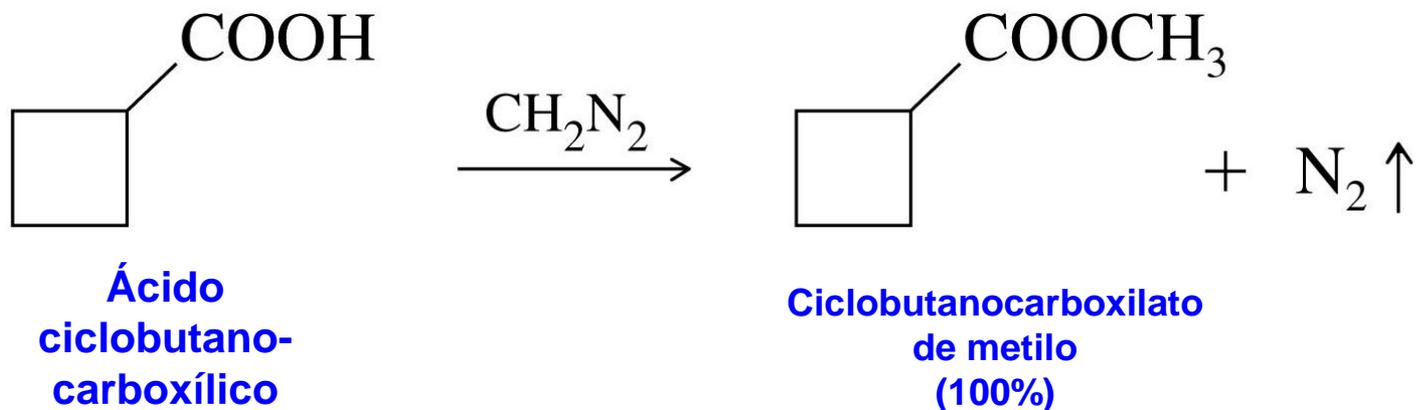
Diazometano: generación





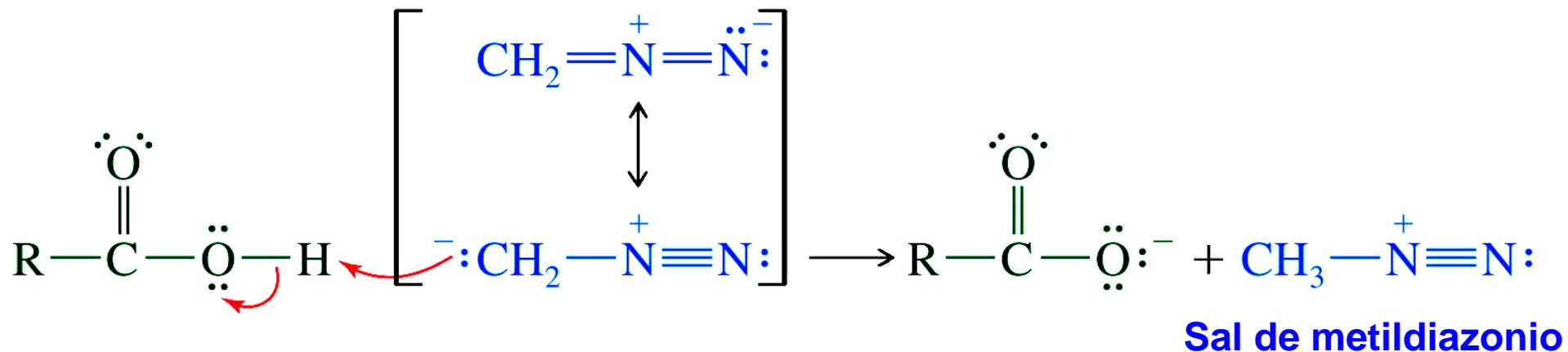


Ejemplo

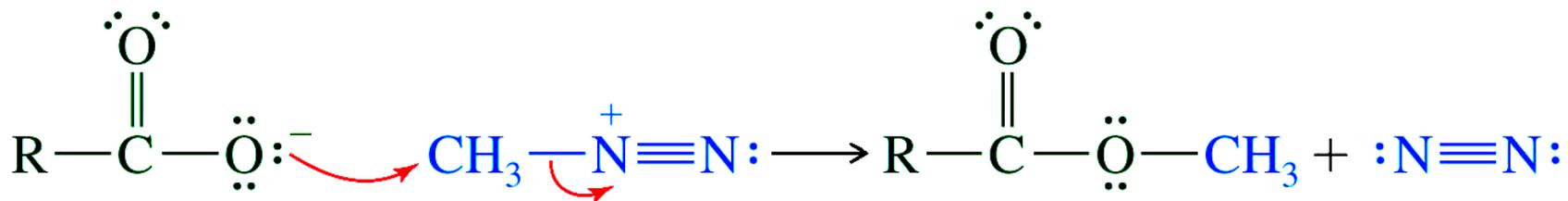


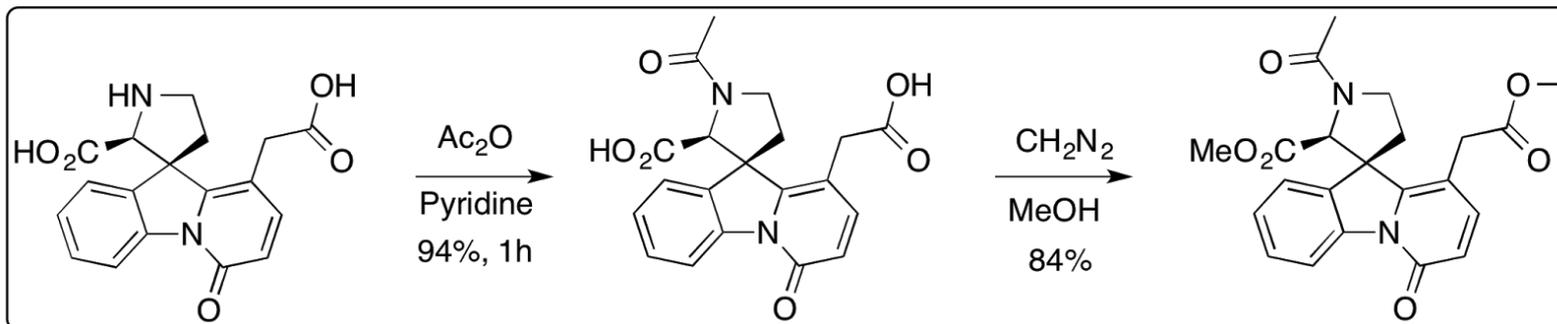
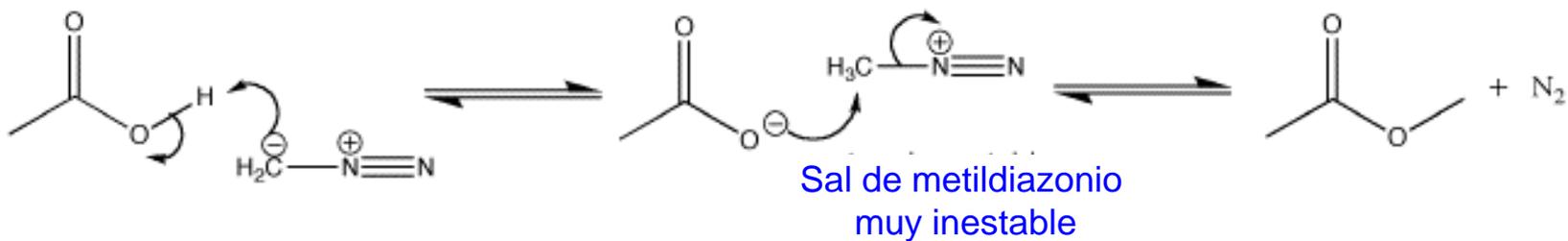
Mecanismo de esterificación con Diazometano

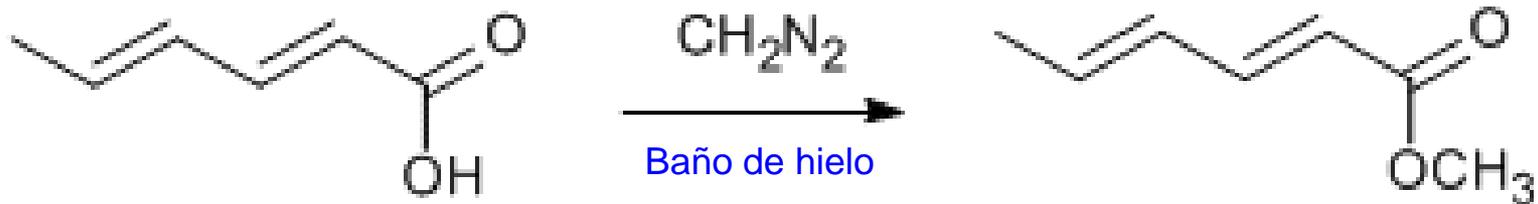
Paso 1. Transferencia de protón



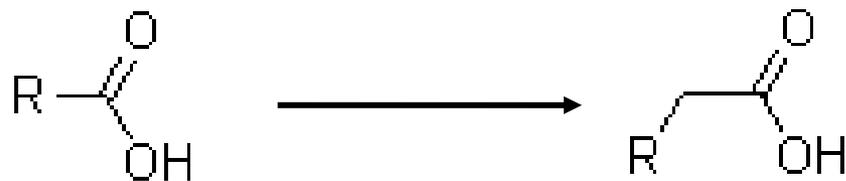
Paso 2. Ataque nucleofílico sobre el metilo



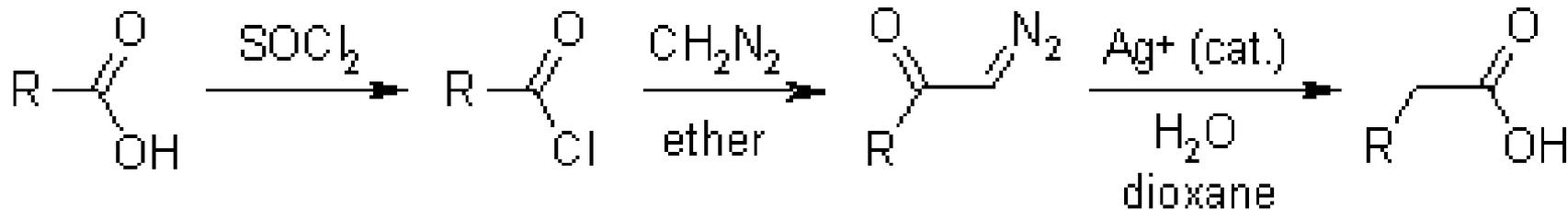




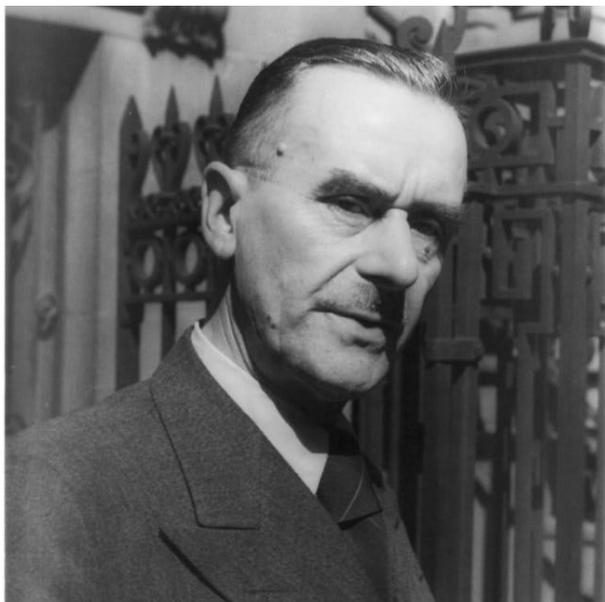
Síntesis Arndt-Eistert



Homólogo superior



Síntesis Arndt-Eistert

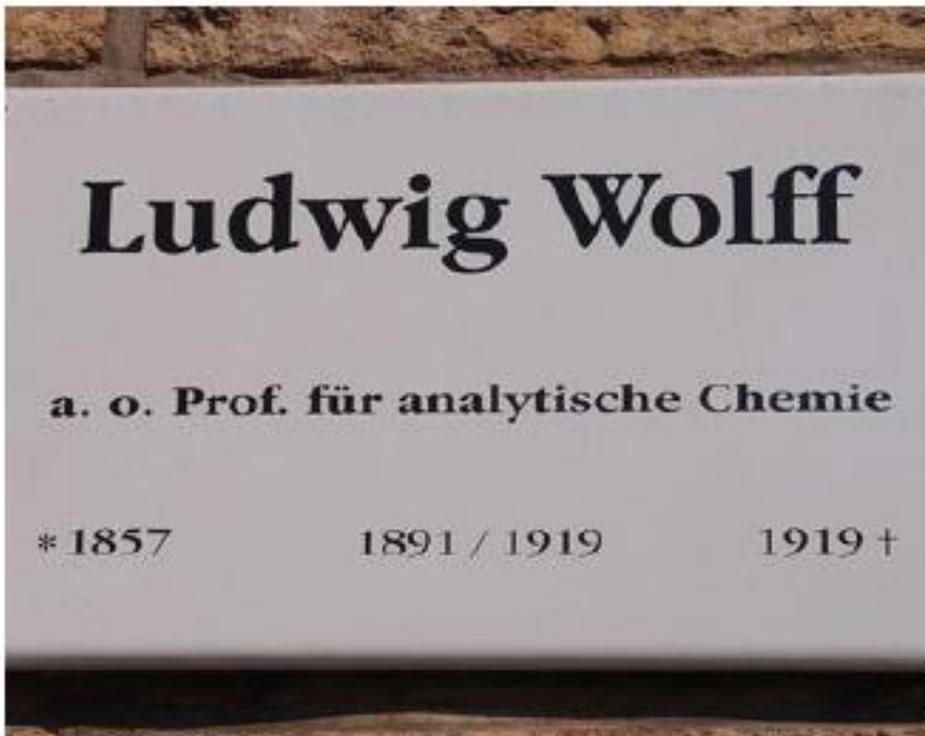
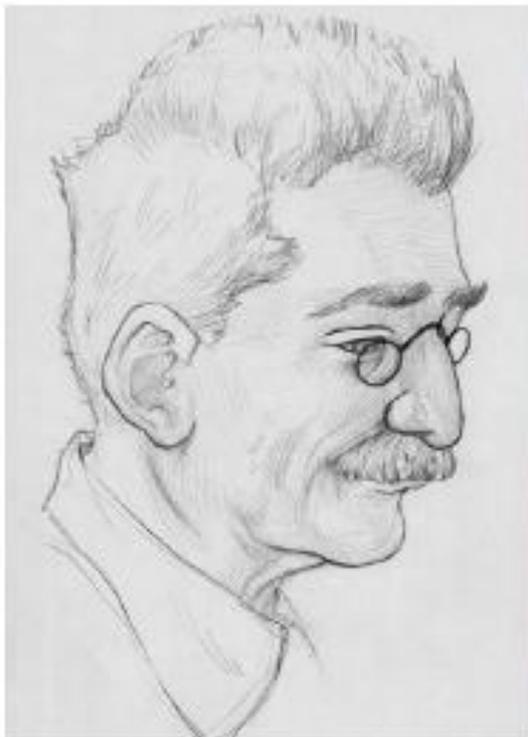


Fritz Arndt
Químico alemán
(1885-1969)



Bernd Karl Georg Eistert
Químico alemán
(1902-1978)



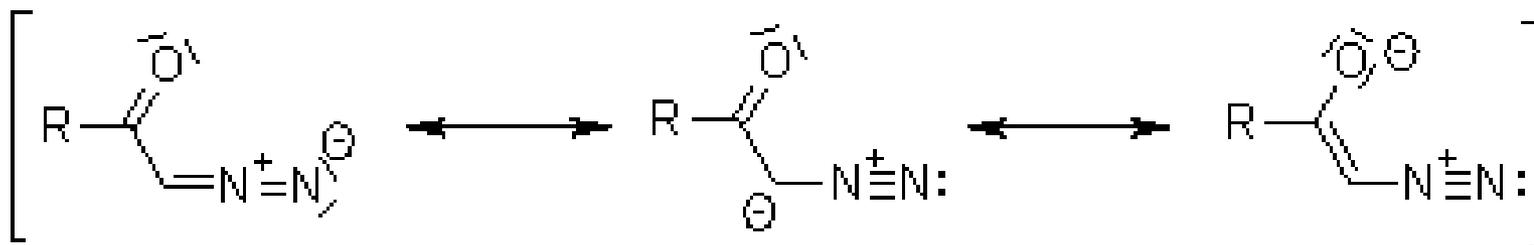
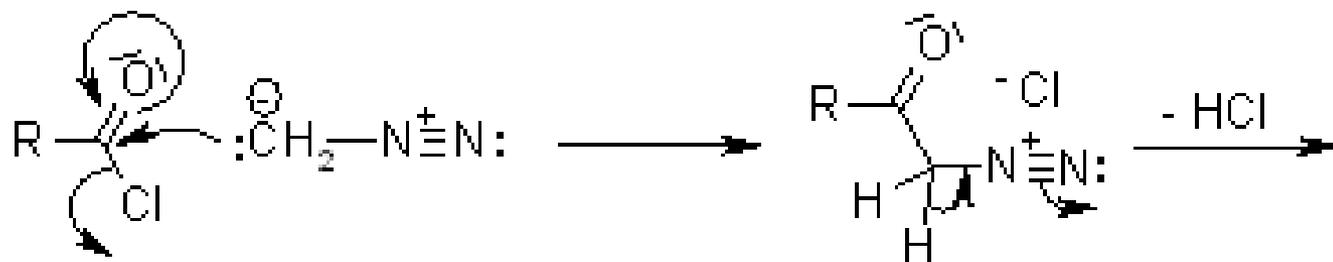
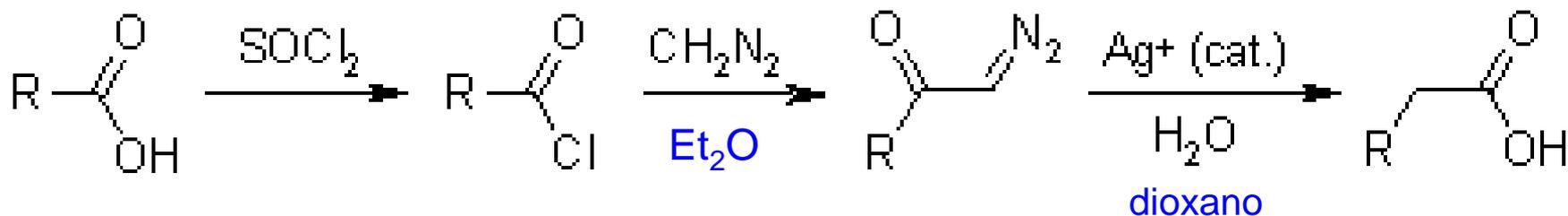


Ludwig Wolff. Line drawing by Sierra Lomo and reproduced with permission. Plaque by Evergreen68 and licensed under the Creative Commons Attribution-Share Alike 4.0 International license.

Ludwig Wolff. Dibujo lineal de Sierra Lomo y reproducido con permiso. Placa de Evergreen68 y con licencia Creative Licencia internacional Commons Attribution-Share Alike 4.0.

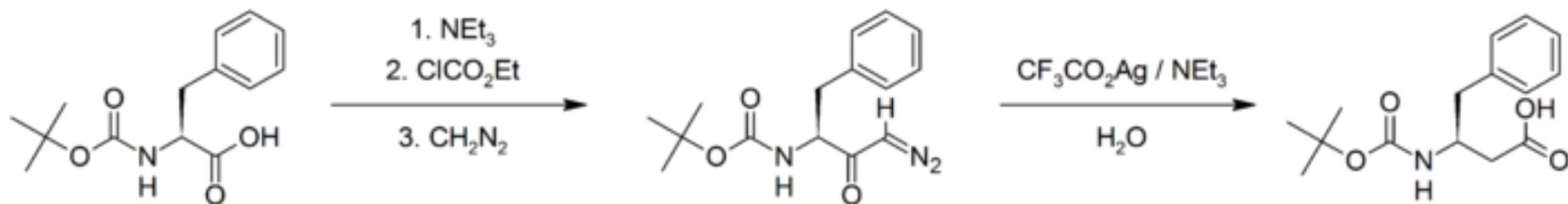
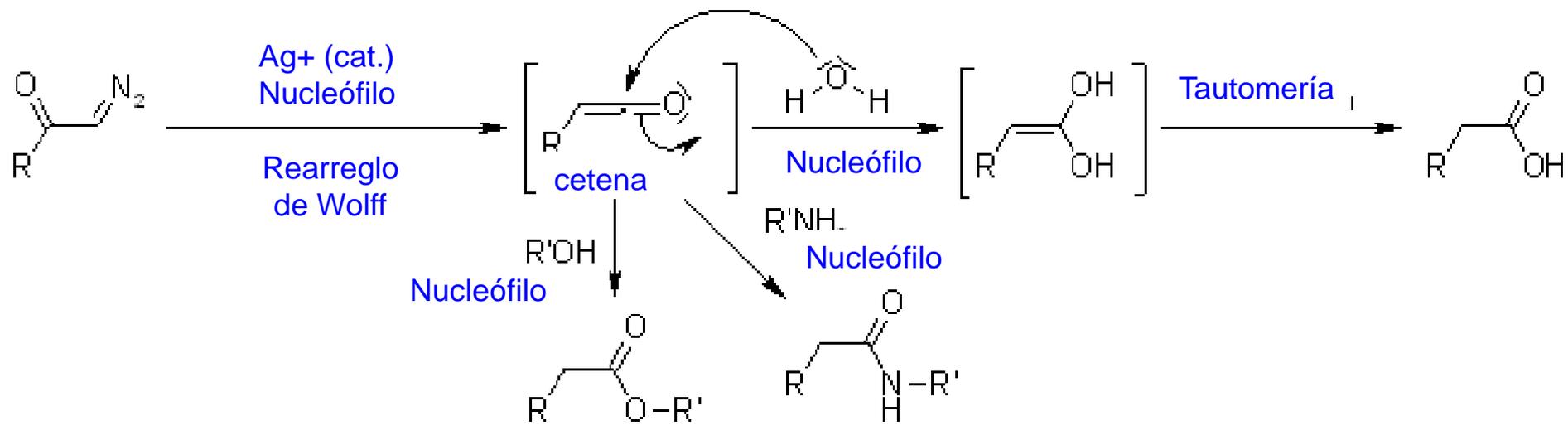


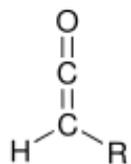
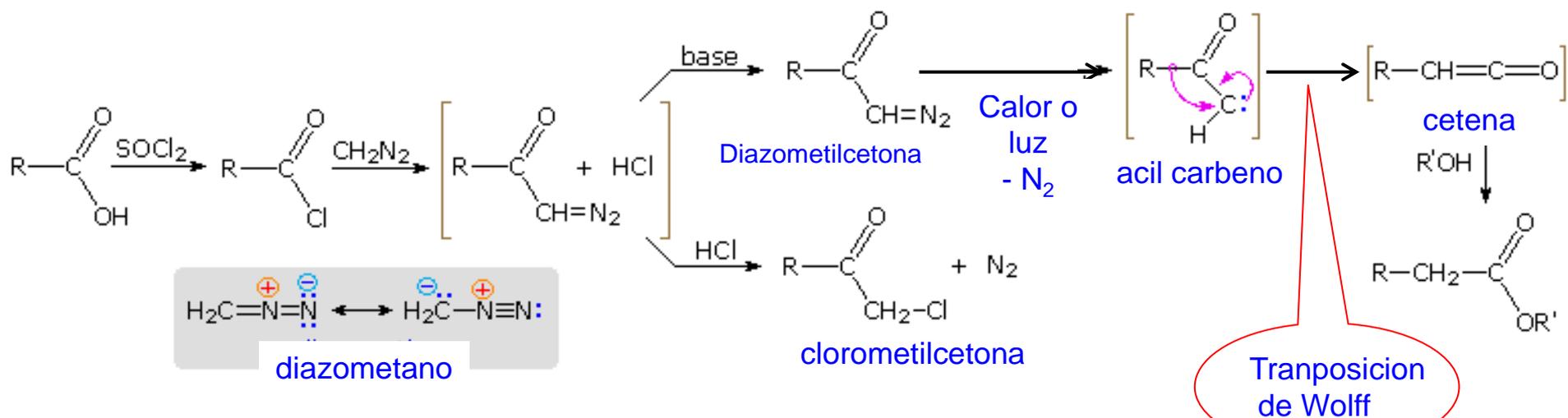
Síntesis Arndt-Eistert



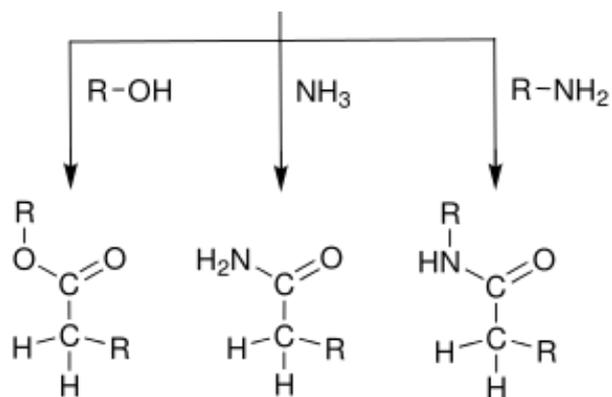
Diazocetona

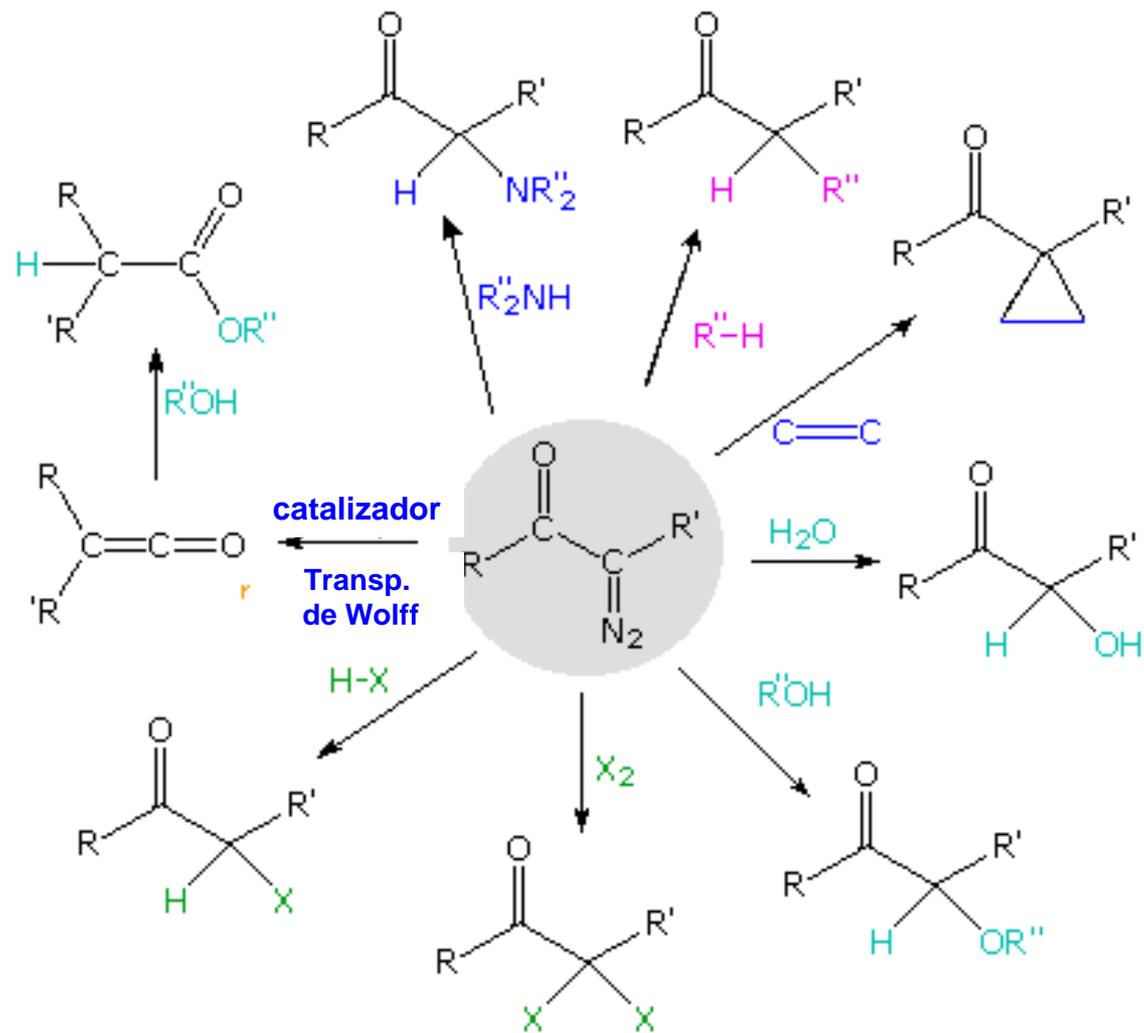


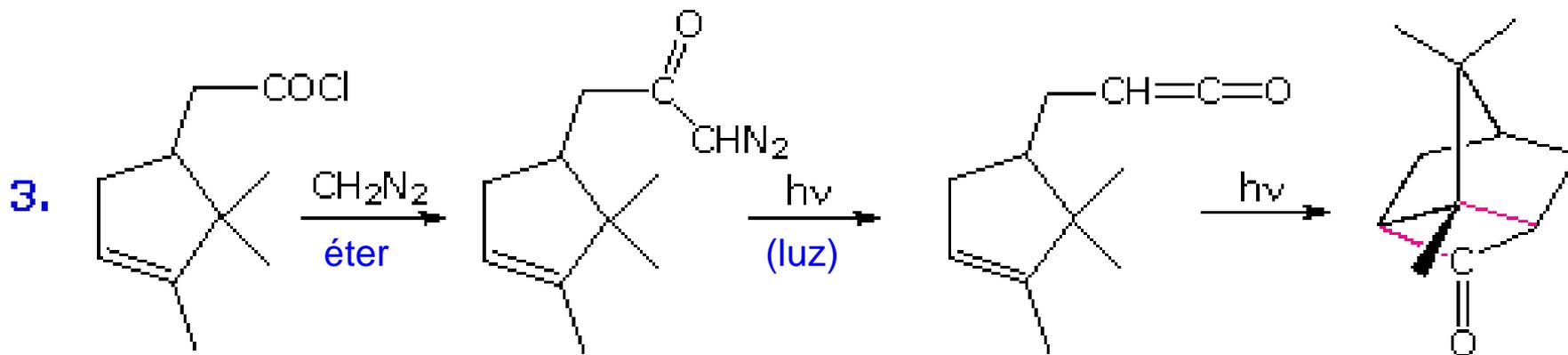
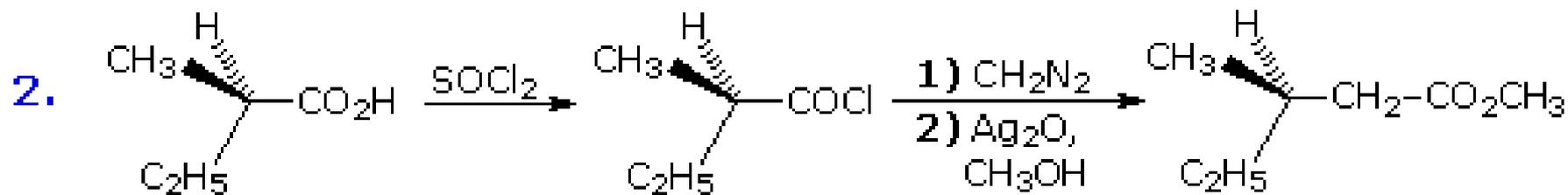
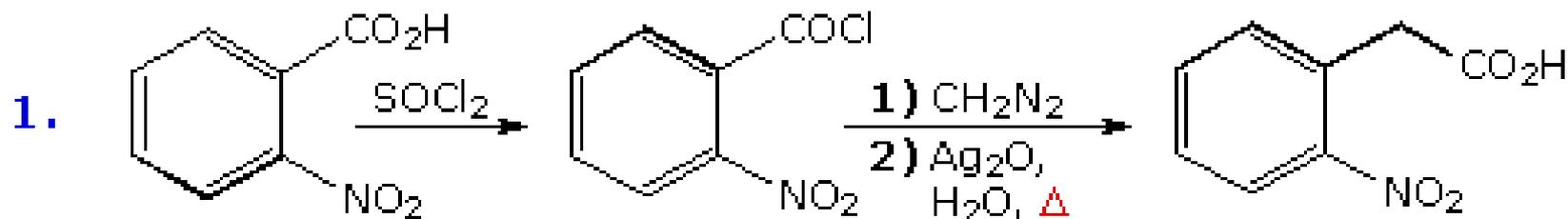


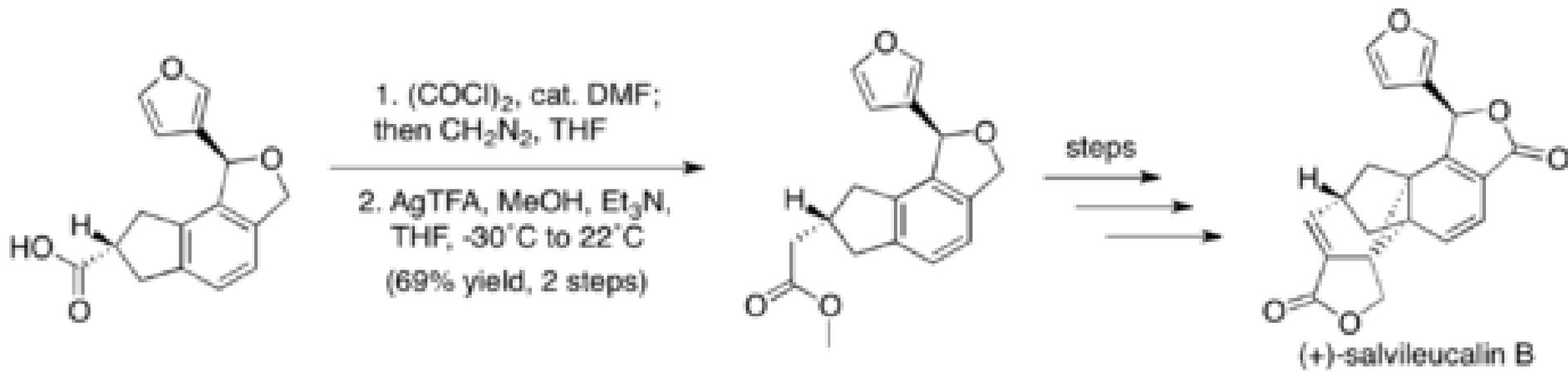


ceteno









Levin, S. Nani, R. R. Reisman, S. E.
"Enantioselective total synthesis of (+)-salvileucalin B".
J. Am. Chem. Soc., **2011**, 133 (4): 774–6



Oxidación de Baeyer-Villiger de cetonas

La oxidación de cetonas con peroxiácidos da lugar a ésteres por medio de un reordenamiento





Johann Friedrich Wilhelm Adolf von Baeyer
Químico alemán
(1835–1917)



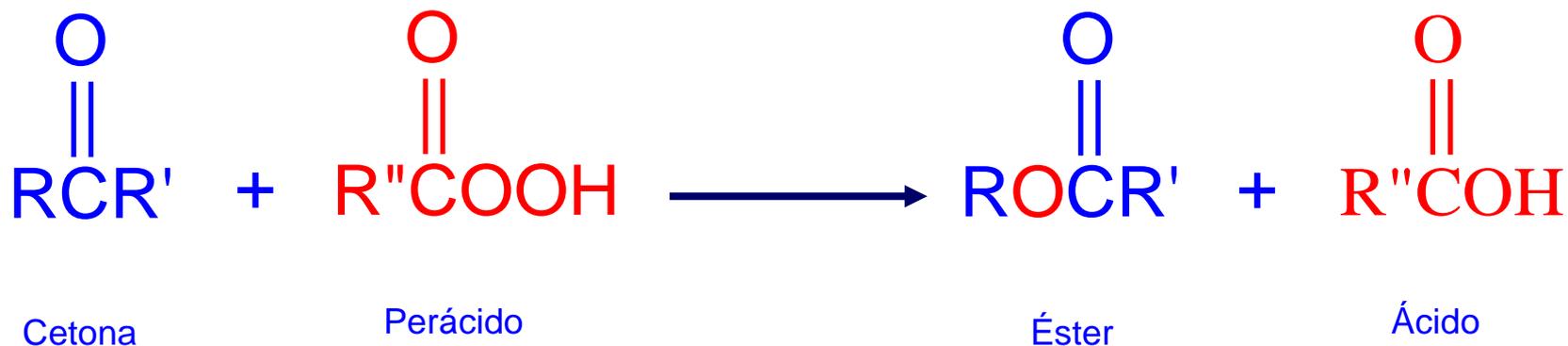
Victor Villiger
Químico suizo
(1868–1934)



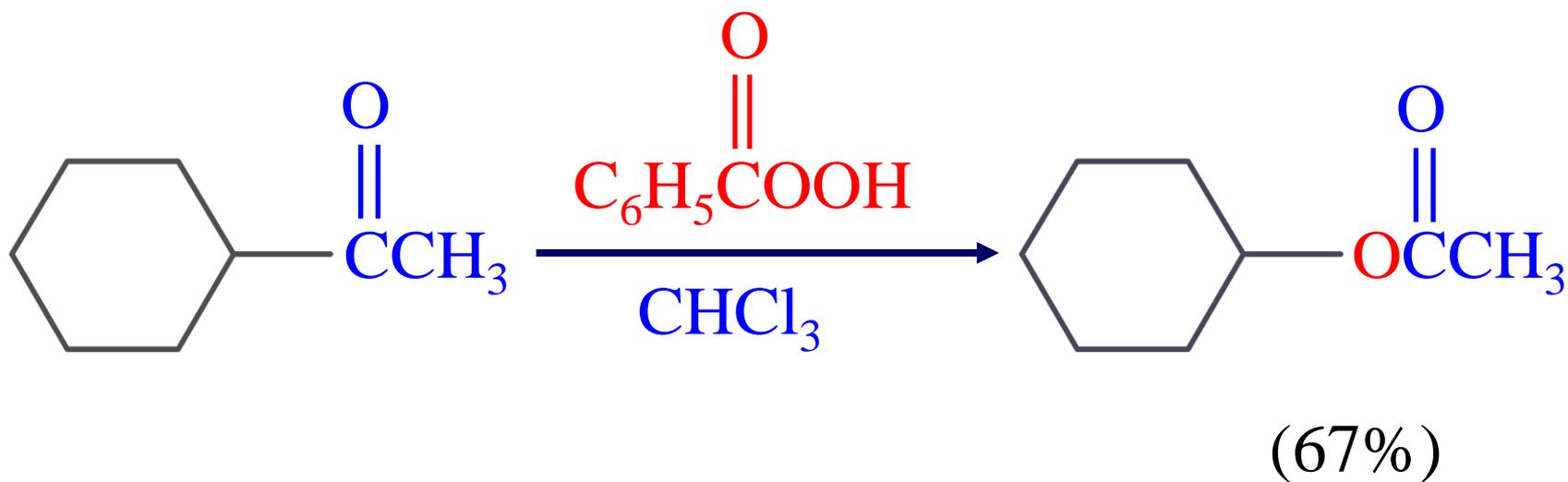
Bavarian Academy of Sciences Munchen (Ludwig-Maximilians-Universität München), Faculty of Chemistry and Pharmacy, Organic Chemistry Laboratory



En general



Ejemplo

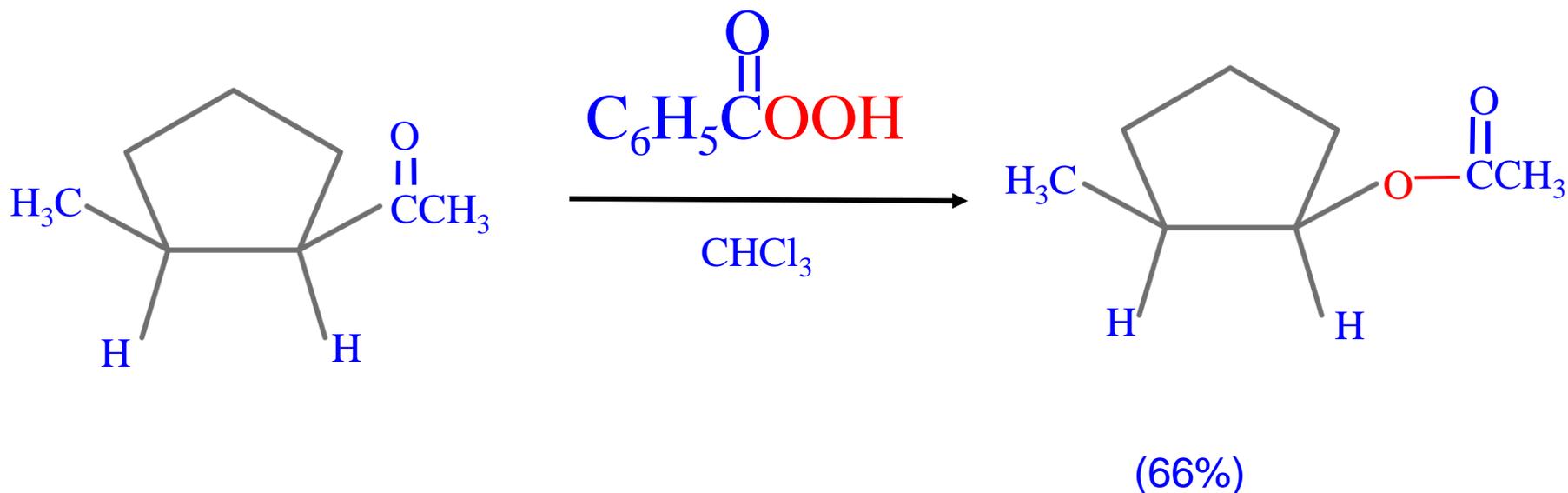


La inserción del oxígeno se lleva a cabo entre el carbono del grupo carbonilo y el grupo más grande.

Las metilcetonas dan ésteres acetato



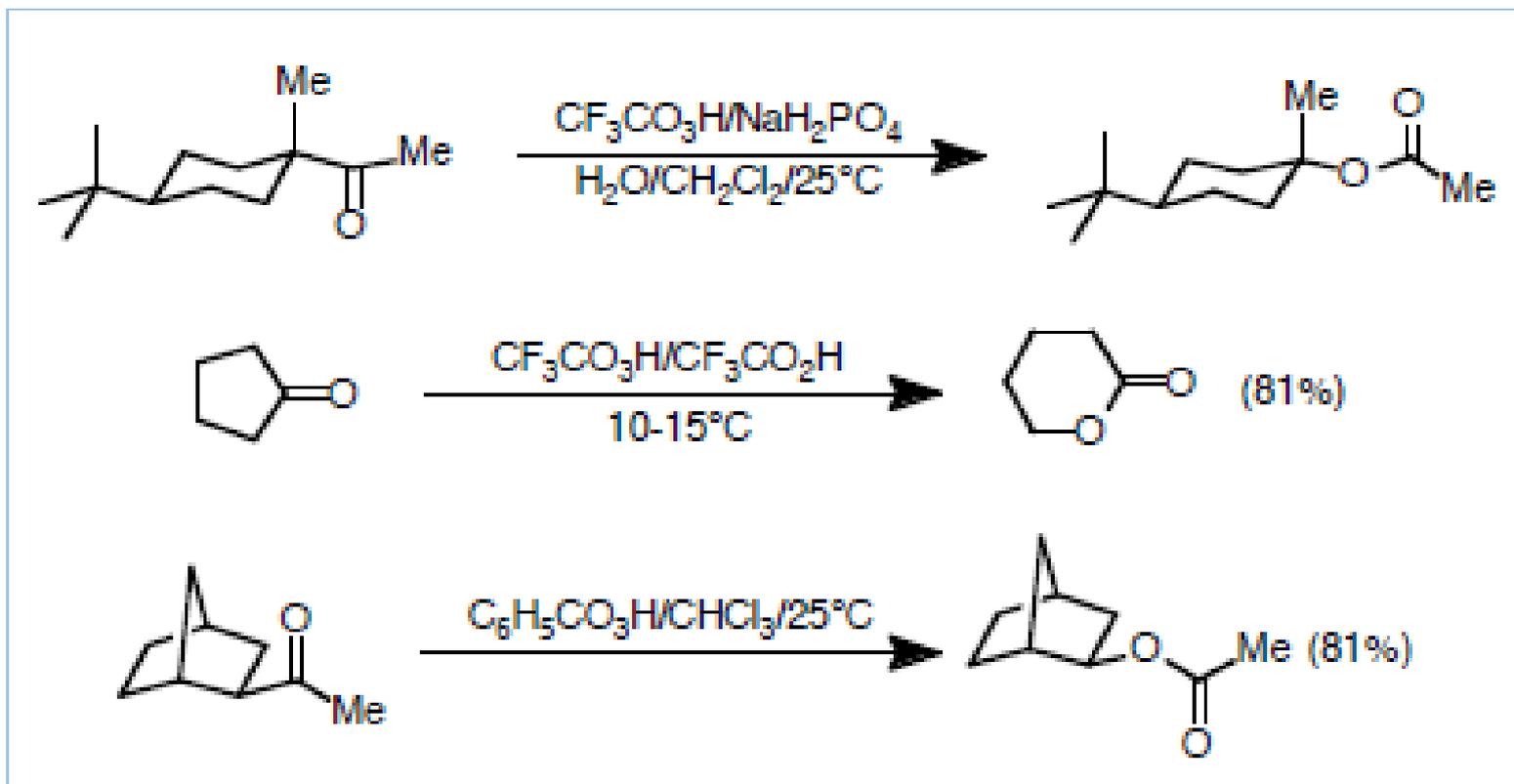
Estereoquímica



La reacción es estereoespecífica. La inserción del oxígeno se lleva a cabo con retención de la configuración.



Ejemplos



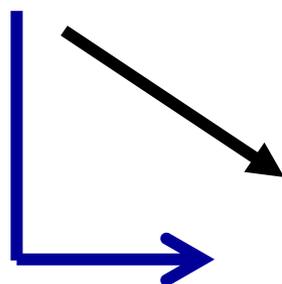
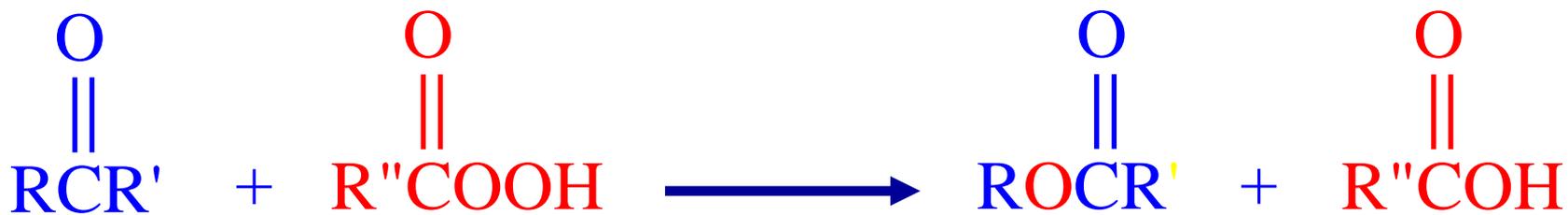
Aptitud migratoria

acilo > terciario > secundario \geq Ar \geq H > primario > metilo

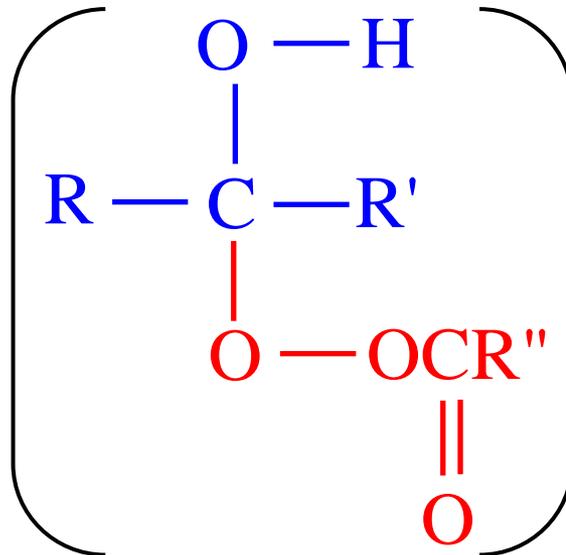


Mecanismo

El primer paso es la adición nucleofílica del peroxiácido al grupo carbonilo de la cetona



adición

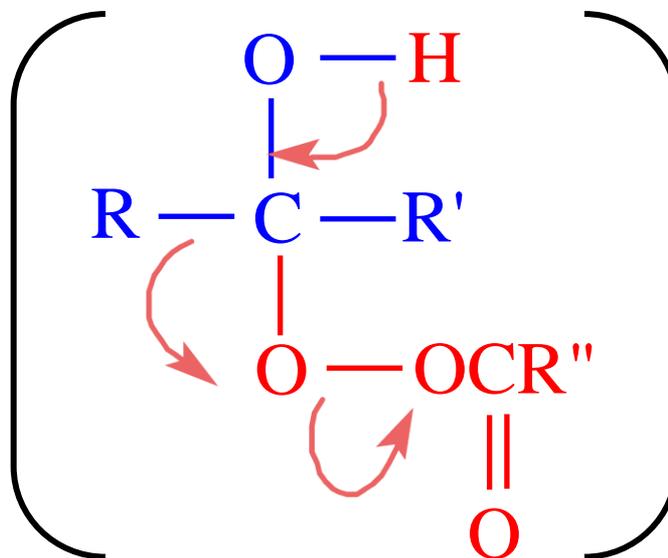


Mecanismo

El segundo paso es la transposición de un grupo alquilo para romper la unión O-O



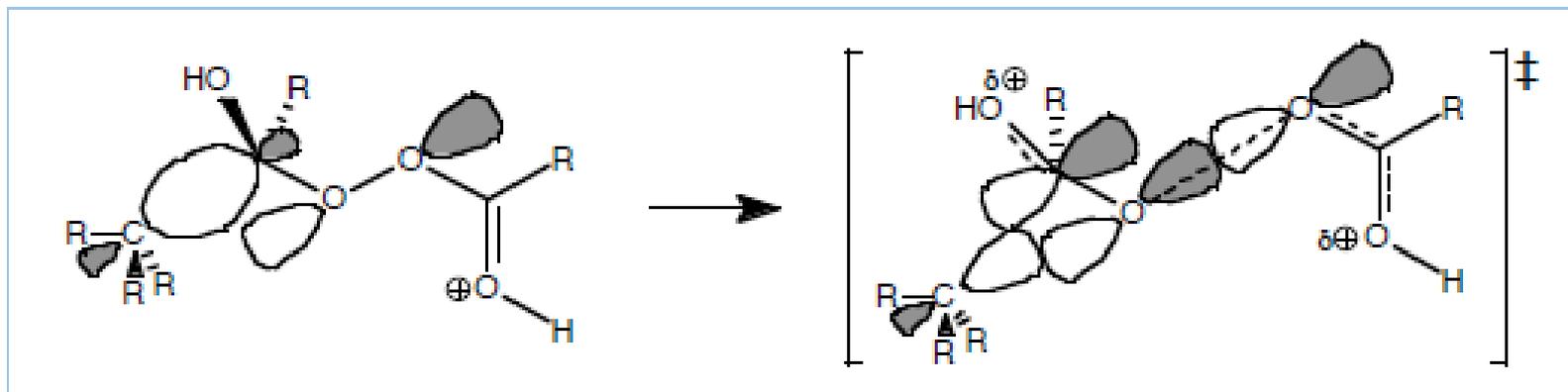
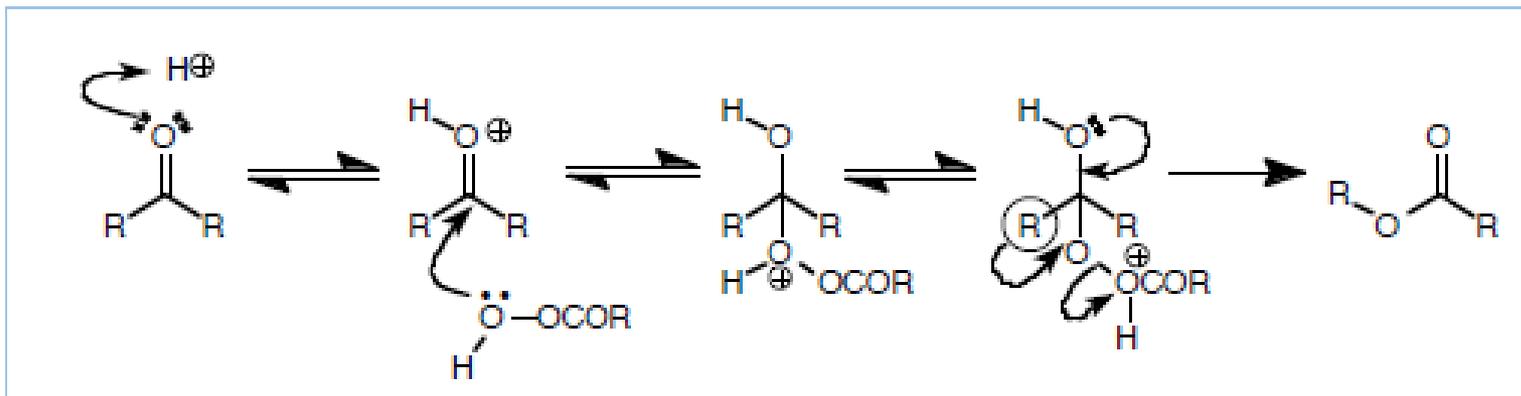
adición



transposición



Baeyer-Villiger

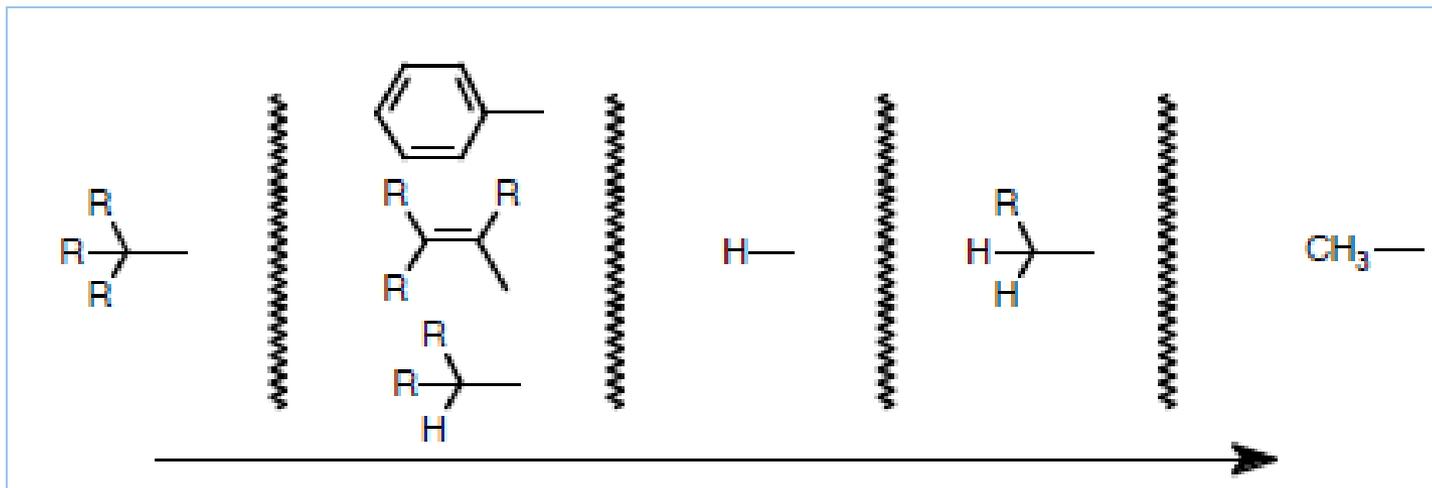


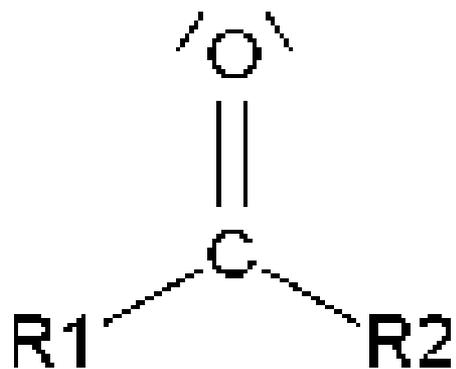
Baeyer-Villiger

Aptitud migratoria de diferentes sustituyentes (orden decreciente)

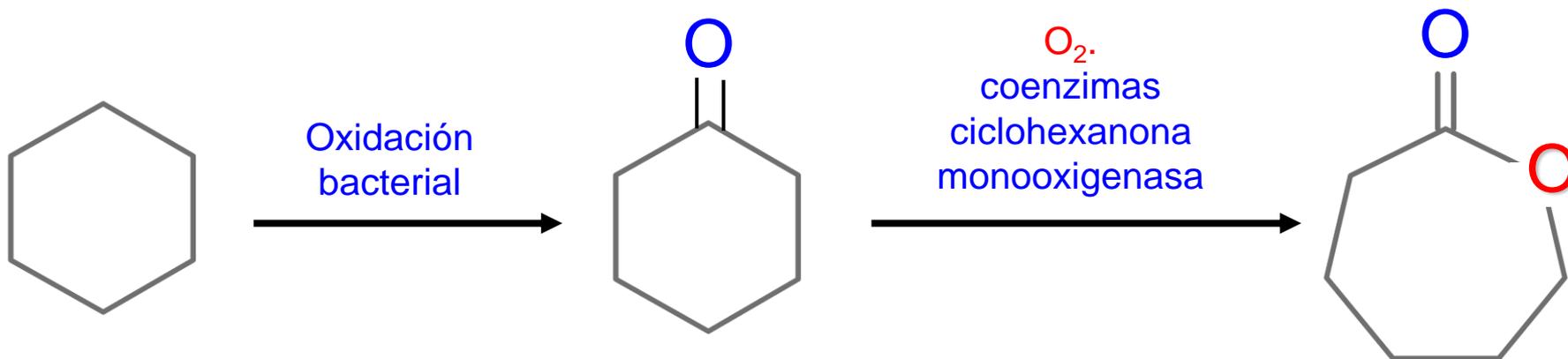
Algunas tendencias generales en la aptitud migratoria de diferentes grupos

- 1) Los grupos arilo exhiben una mayor propensión a la migración que la de los grupos alquilo.
- 2) La aptitud migratoria del hidrógeno es impredecible. Por tanto, se obtiene una mezcla de productos migrados.
- 3) En el caso de los grupos arilo, aquellos con **sustituyentes donadores de electrones** en las posiciones *meta* o *para* migran preferentemente sobre aquellos que contienen sustituyentes en la posición *orto*.
- 4) Los grupos arilo que contienen **sustituyentes aceptores de electrones** muestran una aptitud migratoria reducida.





Oxidación biológica tipo Baeyer-Villiger

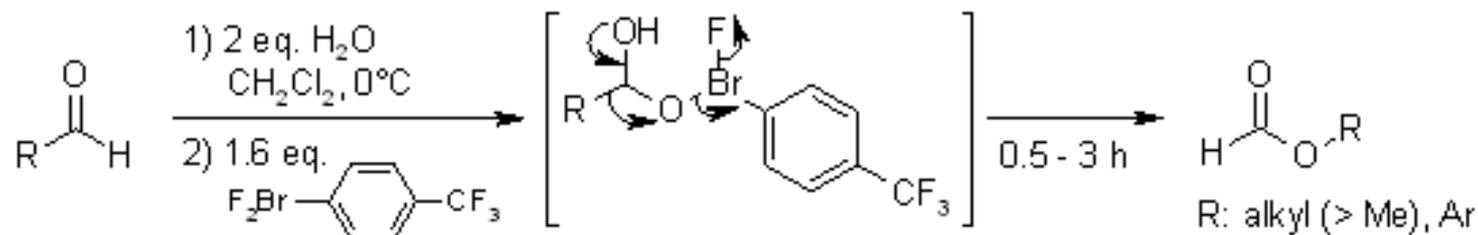


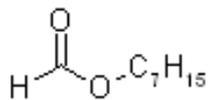
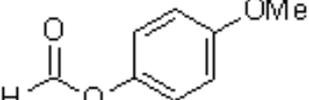
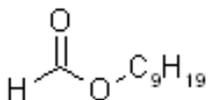
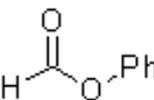
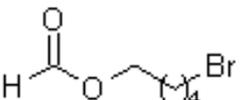
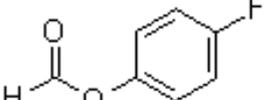
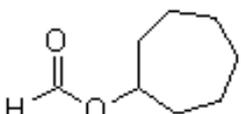
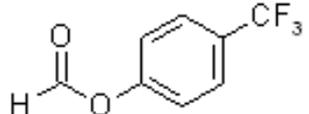
Ciertas bacterias usan a los hidrocarburos como una fuente de carbon. La oxidación procede a través de cetonas, las cuales experimentan una oxidación tipo Baeyer-Villiger.



Hypervalent λ^3 -Bromane Strategy for Baeyer-Villiger Oxidation: Selective Transformation of Primary Aliphatic and Aromatic Aldehydes to Formates, Which is Missing in the Classical Baeyer-Villiger Oxidation

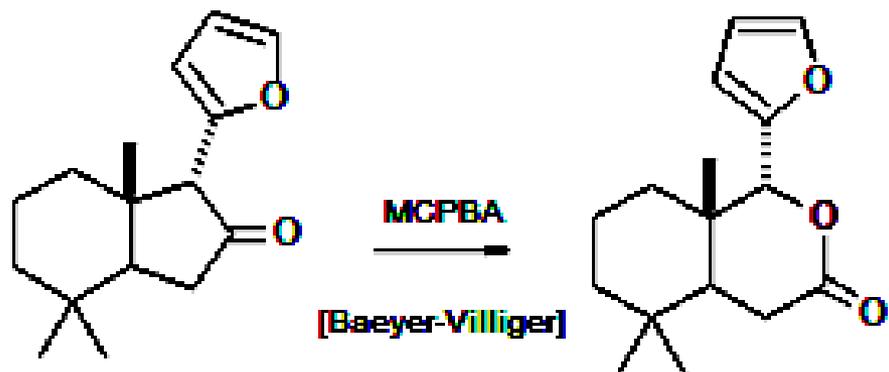
Y. Yoshida, K. Murakami, H. Yorimitsu, K. Oshima, *J. Am. Chem. Soc.*, **2010**, *132*, 9236-9239.



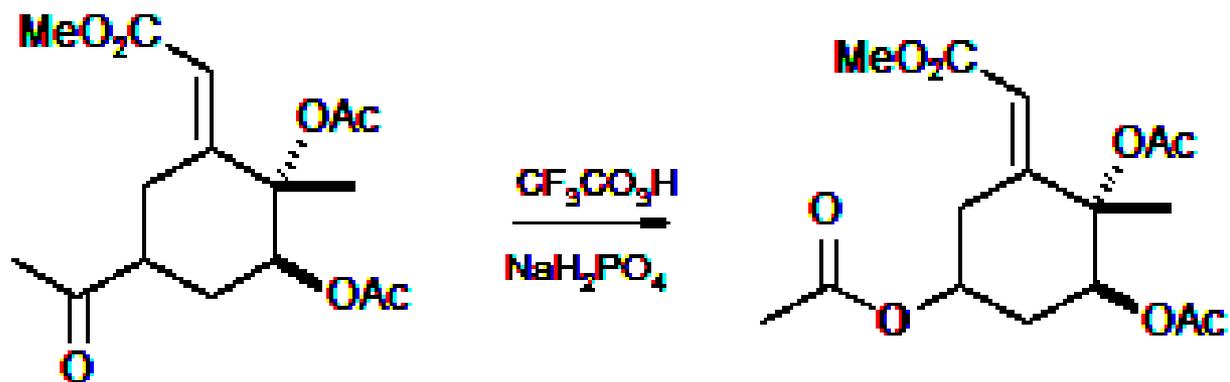
product	t (h)	yield (% , isol.)	product	t (h)	yield (% , isol.)
	1	89		1	35
	1	80		1	91
	3	55		1	60
	0.5	63		2	33

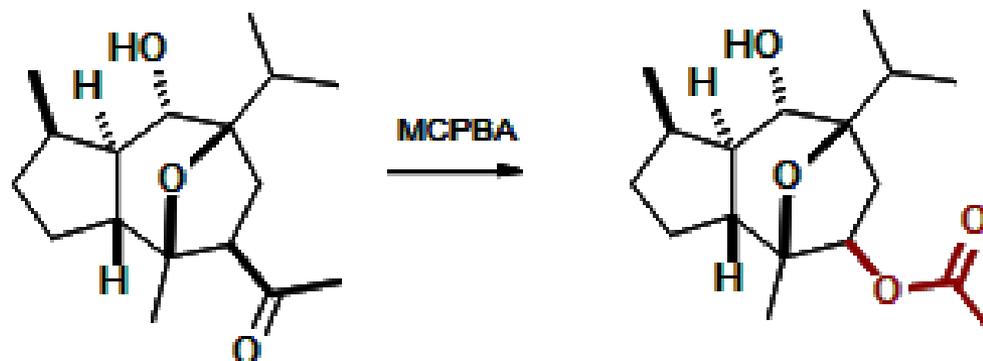


Genudin Model (insect antifeedant): Renoud-Grappin, M.; Vanucci, C.; Lhomet, G. *J. Org. Chem.* **1994**, *59*, 3902.



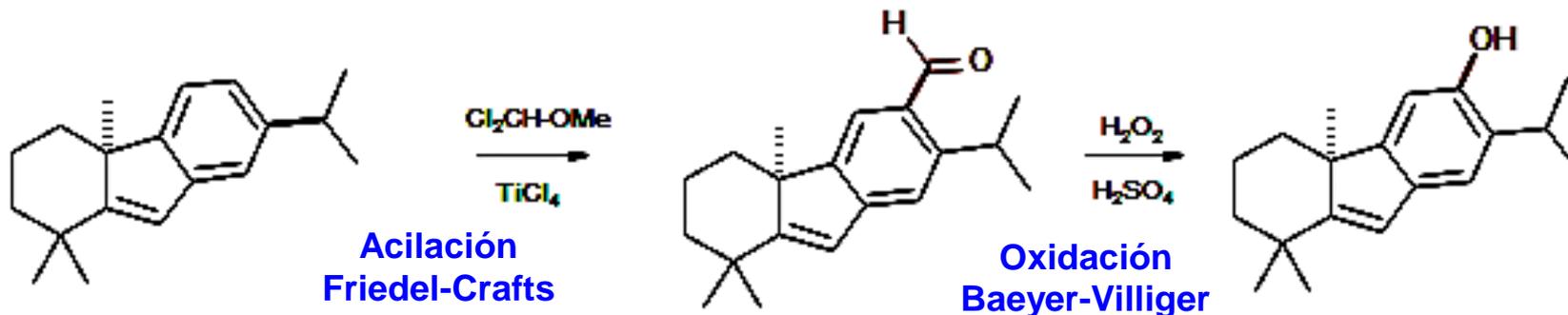
1 α ,25-Dihydroxycholecalciferol: Baggiolini, *J. Am. Chem. Soc.* **1982**, *104*, 2945.



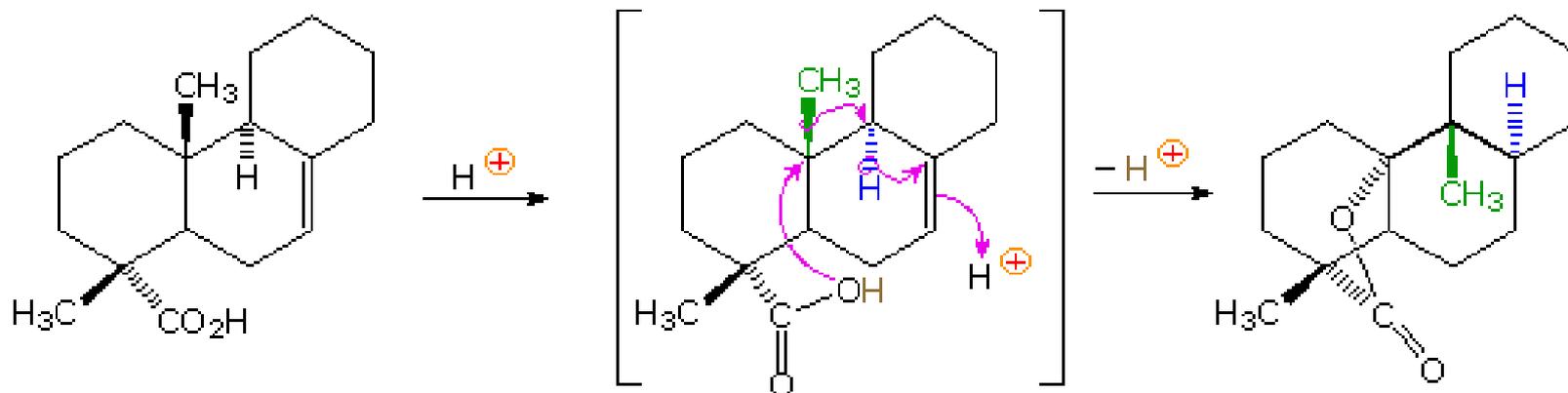


En ocasiones se utiliza la oxidación de Baeyer-Villiger para introducir grupos hidroxilo en anillos aromáticos (síntesis de fenoles) por una secuencia acilación Friedel-Crafts – oxidación de Baeyer-Villiger

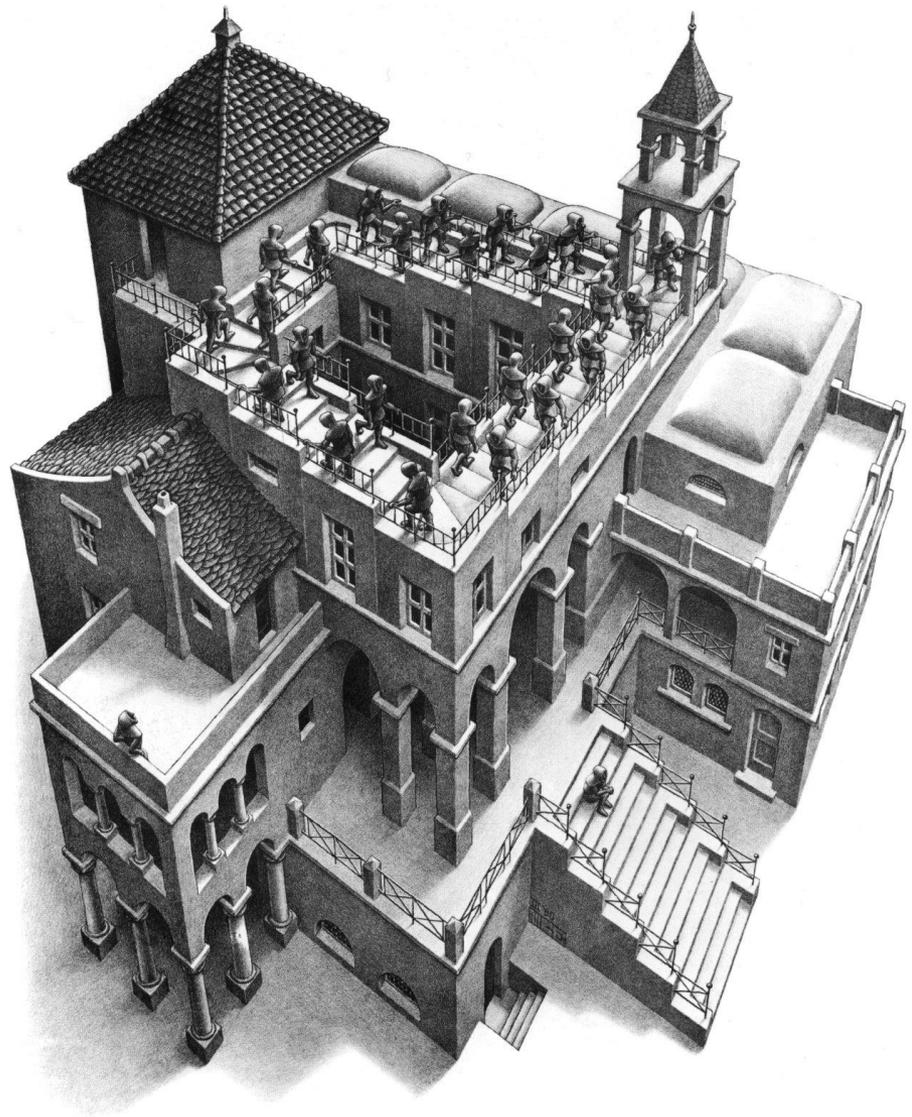
Dichroanone: McFadden, R. M.; Stoltz, B. M. *J. Am. Chem. Soc.* **2006**, *128*, 7738



Reacción de lactonización a través de un rearrreglo

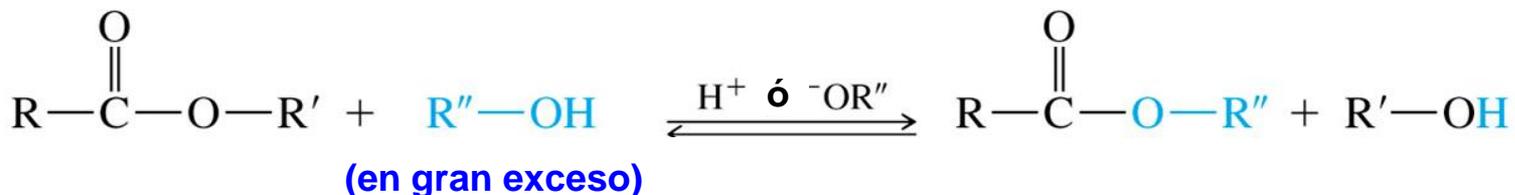


Ascending & Descending
M.C. Escher
Date: 1960

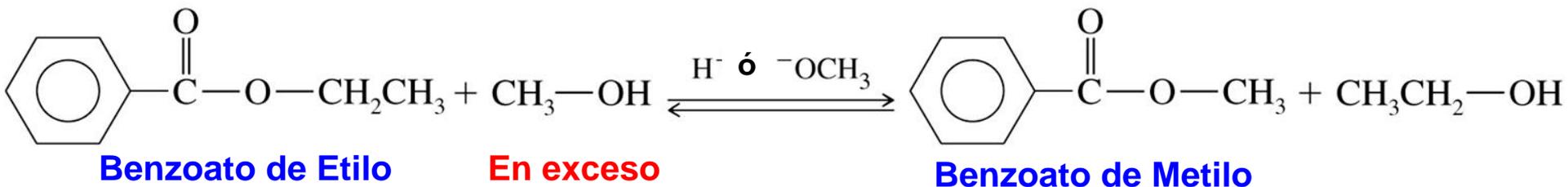


Transesterificación

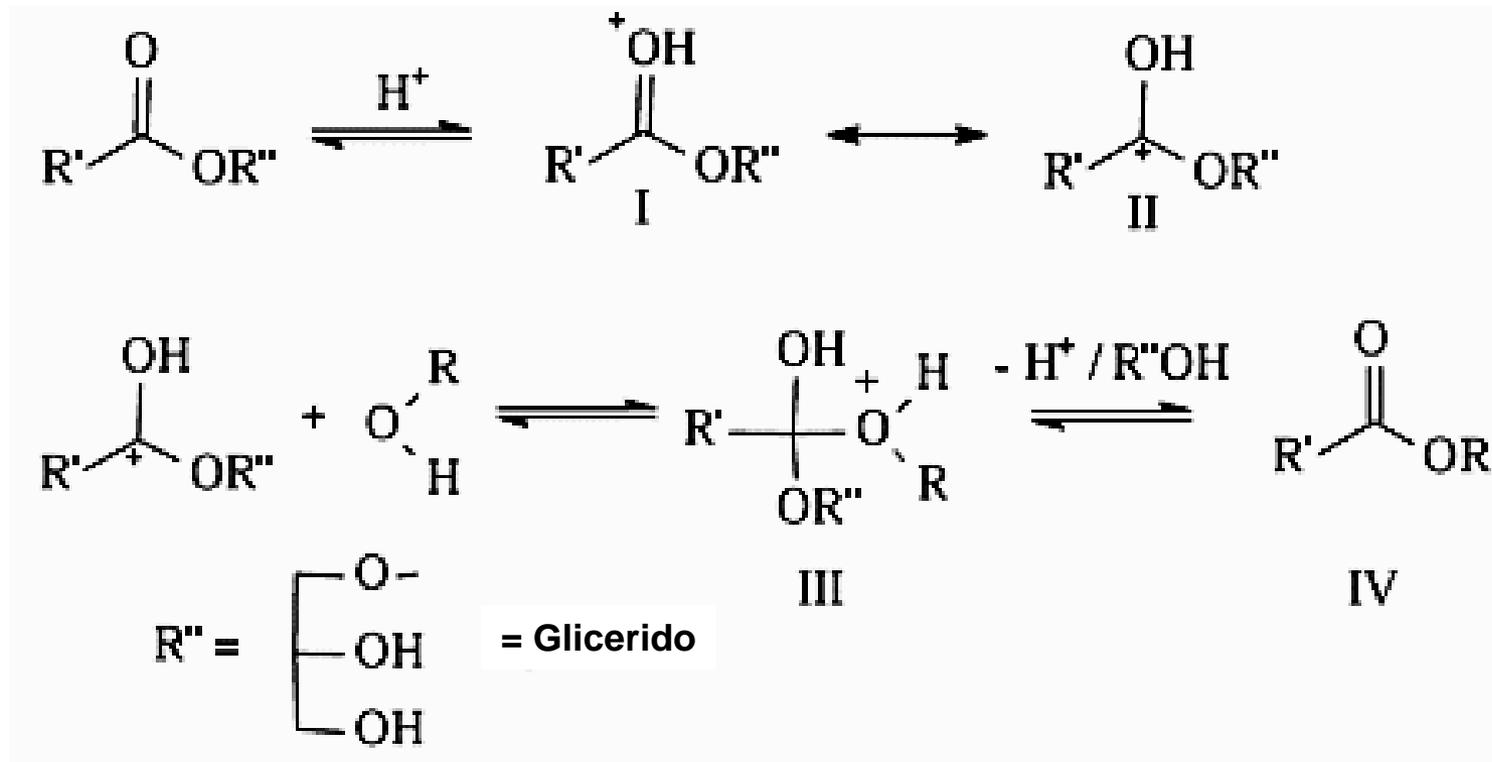
TRANSESTERIFICACIÓN



EJEMPLO



Transesterificación catalizada con ácido

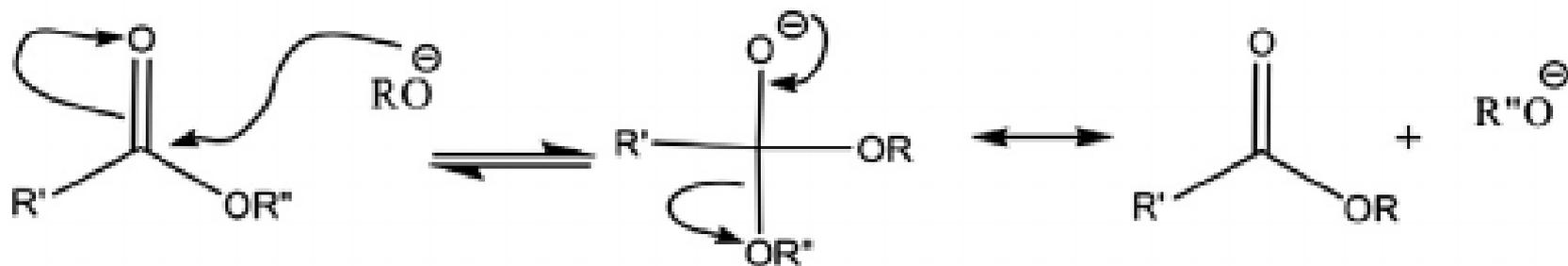


R' = CADENA HIDROCARBONADA DE UN ÀCIDO GRASO
R = GRUPO ALQUILO DEL ALCOHOL

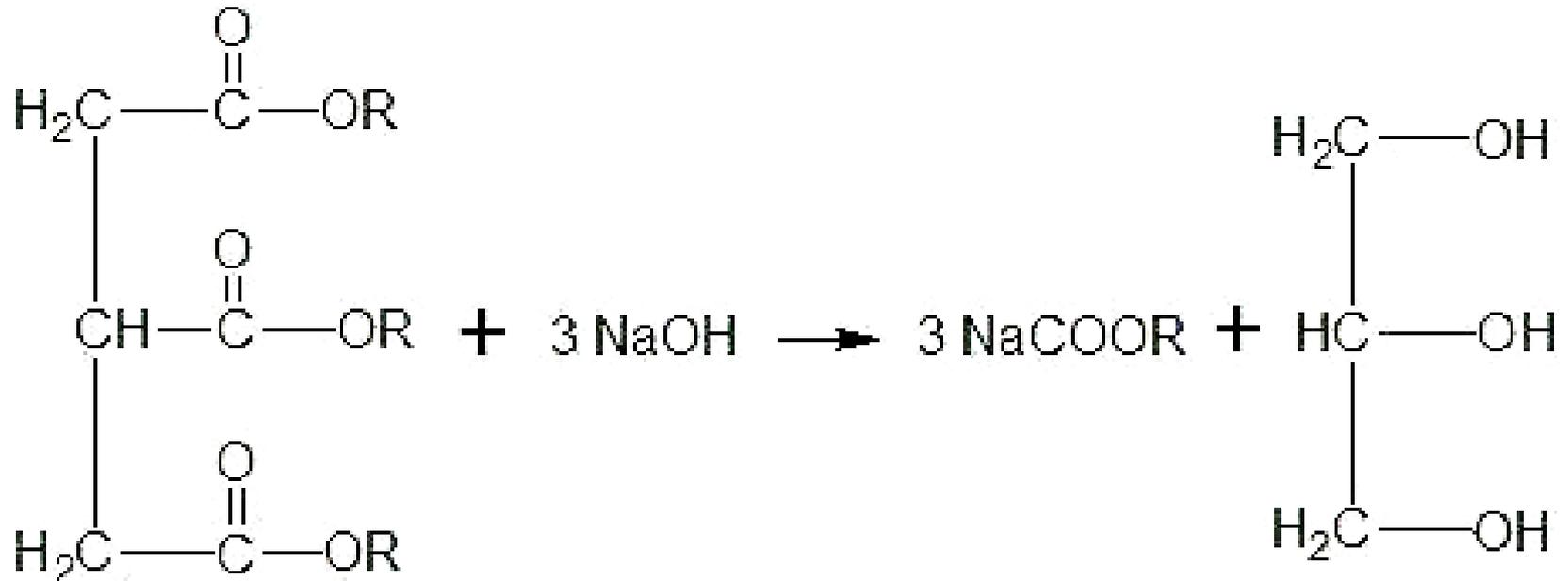
http://www.scielo.br/scielo.php?script=sci_arttext&pid=S0103-50531998000300002



Transesterificación catalizada con base



Reacción de hidrólisis catálisis básica Saponificación



Acidos Grasos + Solución Alcalina = Jabón + Glicerina

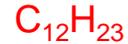
http://www.ecured.cu/index.php/Archivo:F%C3%B3rmula_saponificaci%C3%B3n.jpg



Diesel

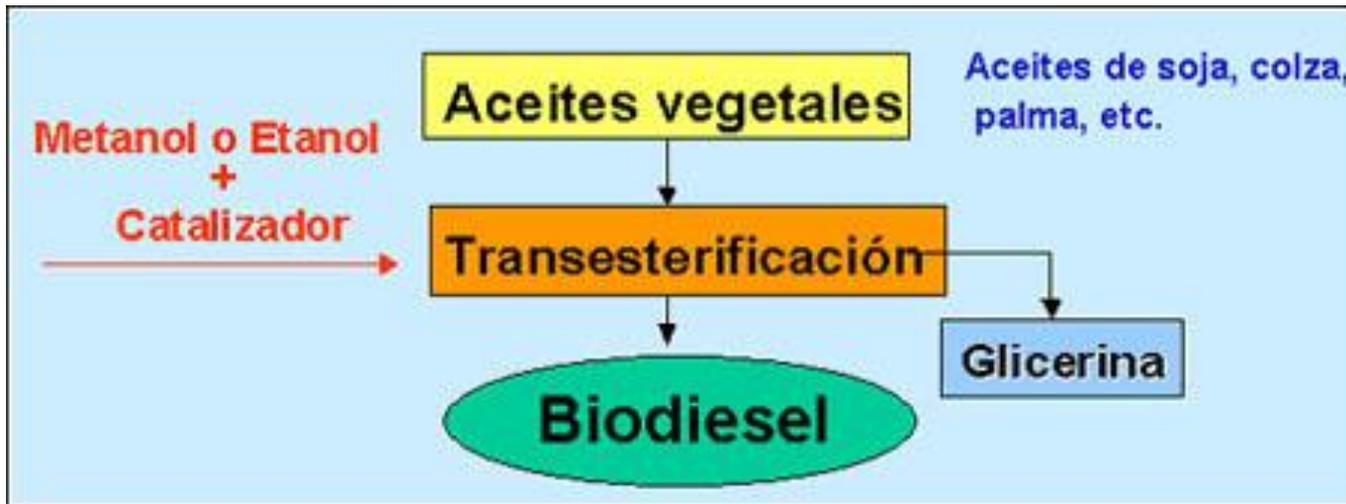
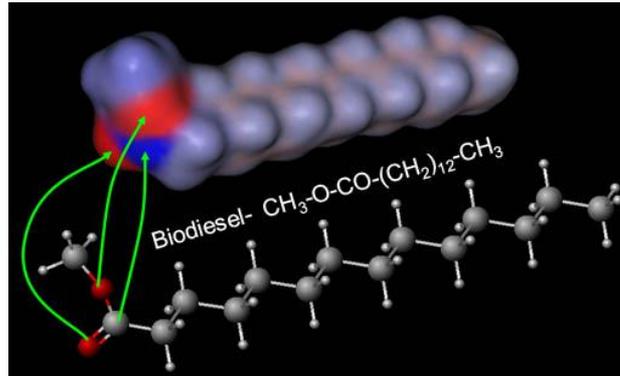
El gasóleo (o diesel) derivado del petróleo está compuesto aproximadamente de:
75% de hidrocarburos saturados
(principalmente parafinas incluyendo isoparafinas y cicloparafinas)
25% de hidrocarburos aromáticos (incluyendo naftalenos y bencenos)

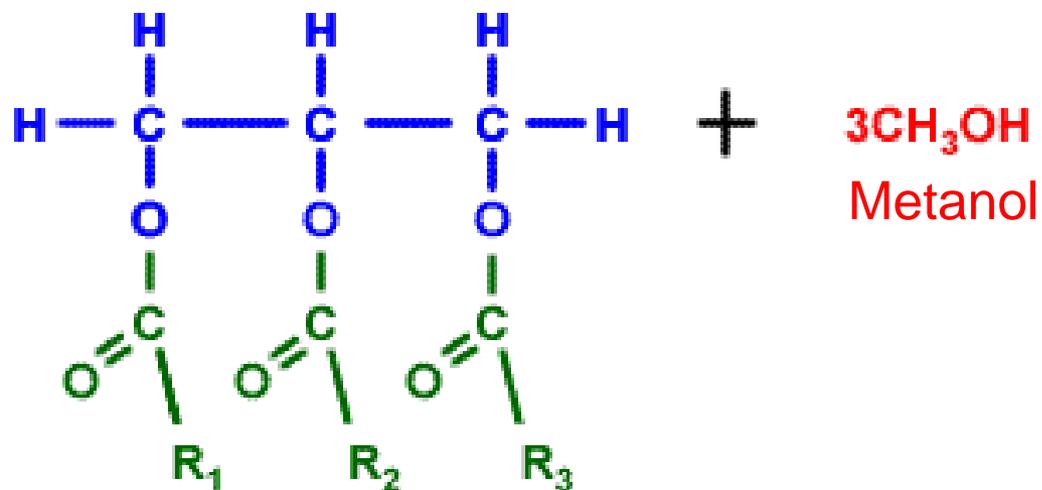
La fórmula química general del gasóleo común es



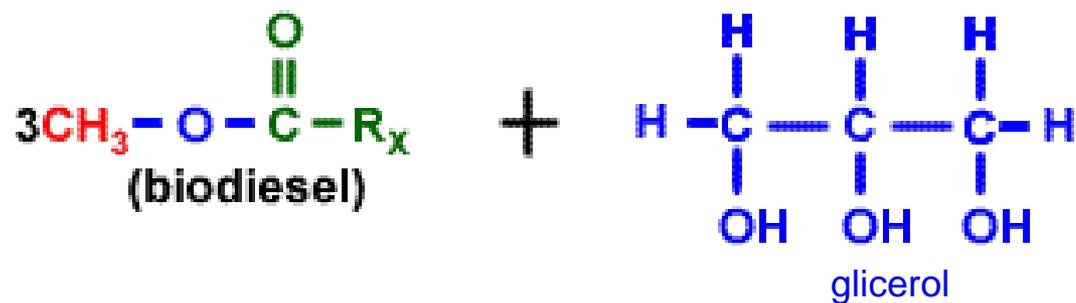
incluyendo cantidades pequeñas de otros hidrocarburos cuyas fórmulas van desde

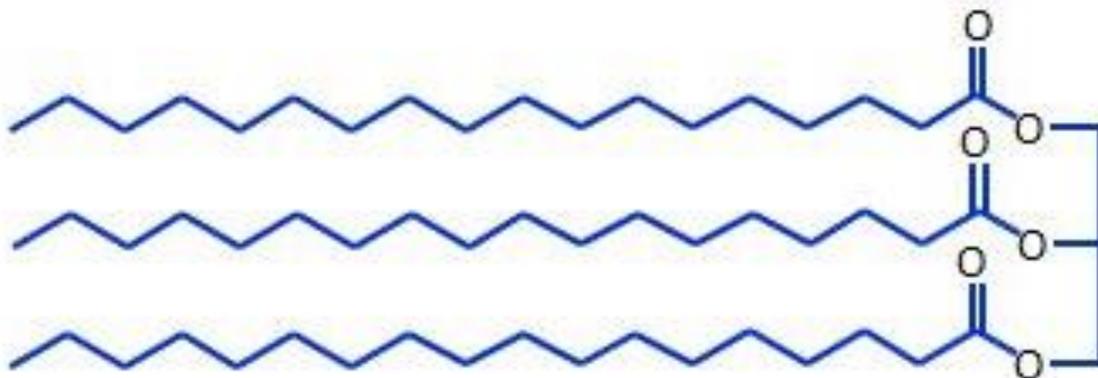






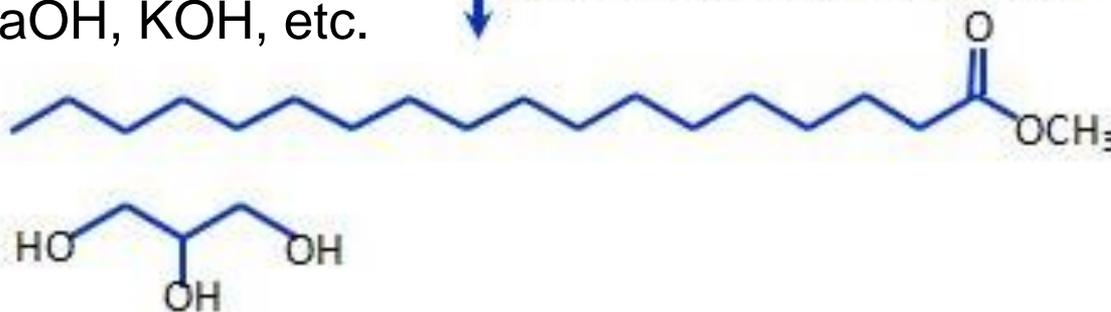
Catalizador: e.g.
NaOH





CATALIZADOR:
 CH_3ONa ,
puede ser
 NaOH , KOH , etc.

CH_3OH
(concentrado o absoluto)

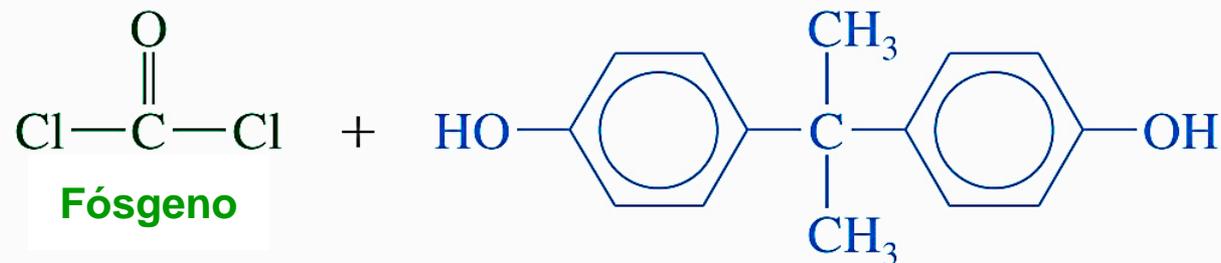




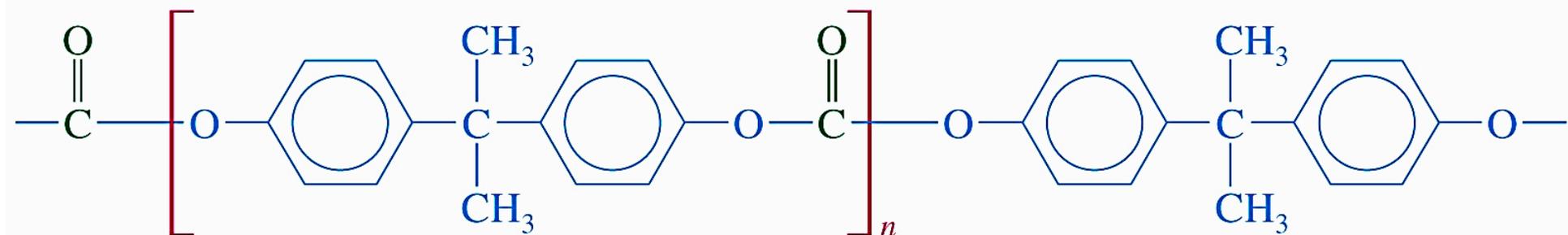
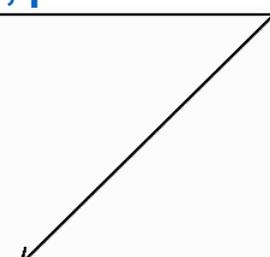
BIODIESEL



Síntesis de un policarbonato

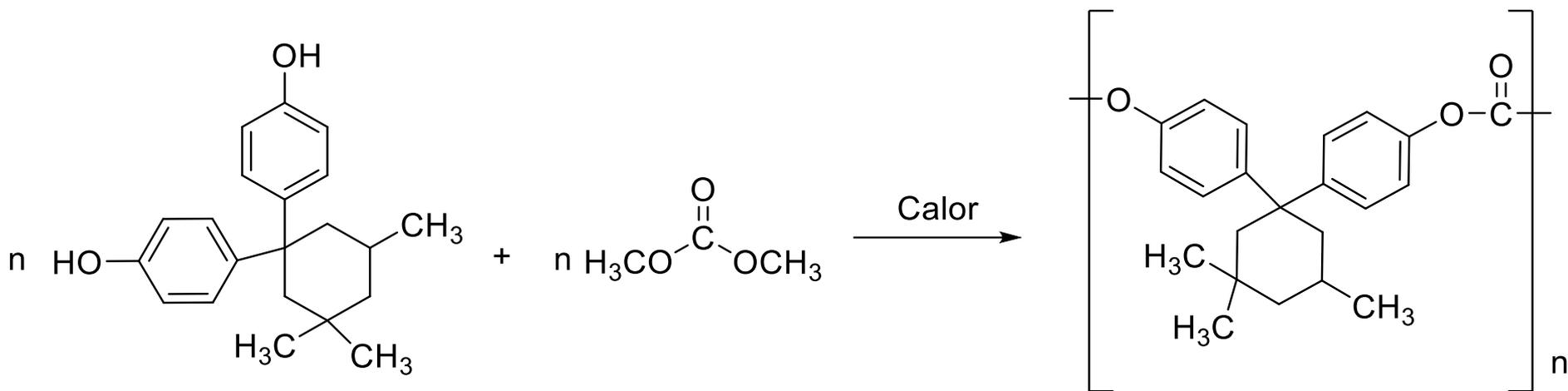
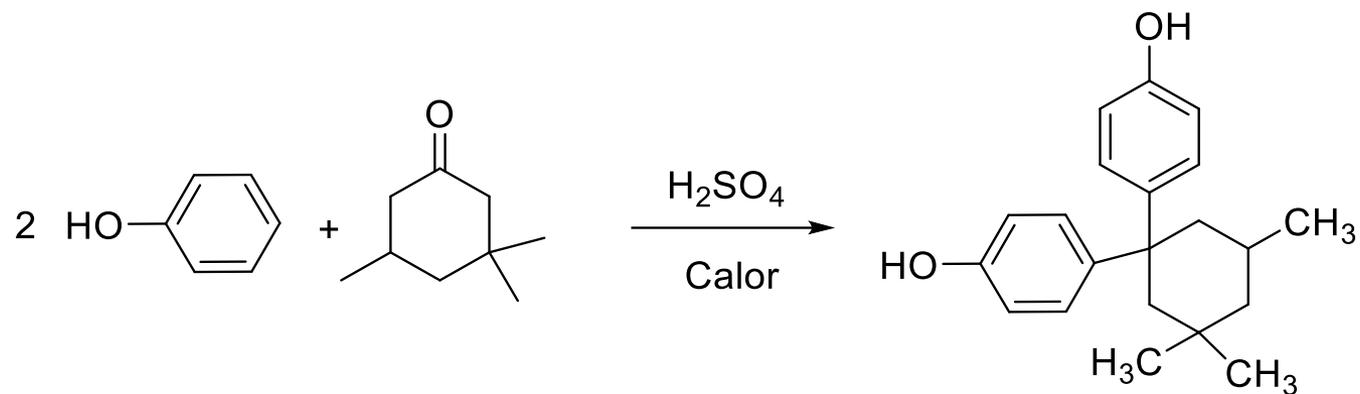


Calor, pérdida de 2 HCl



Lexán, un policarbonato





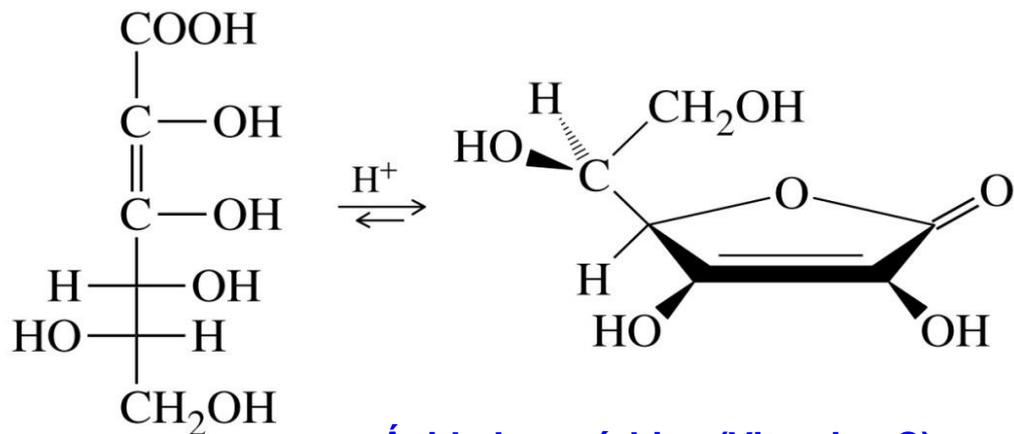
Polycarbonato



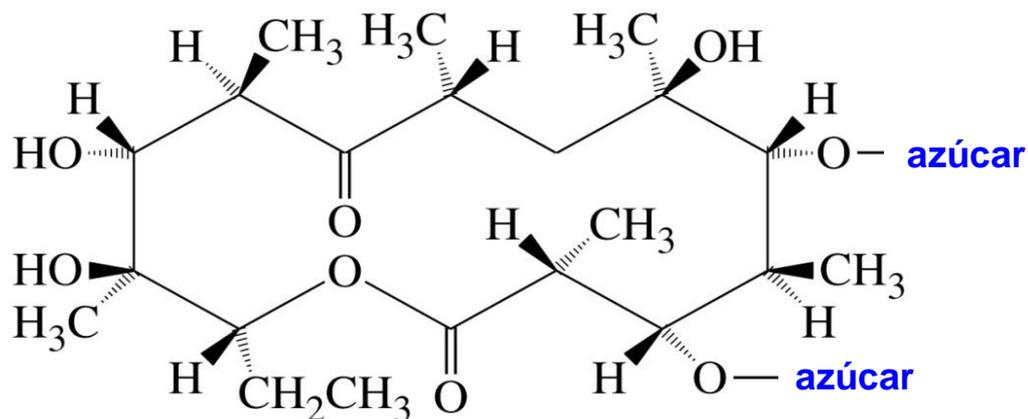
LACTONAS ESTERES CÍCLICOS



Ácido L-Ascórbico y la Eritromicina



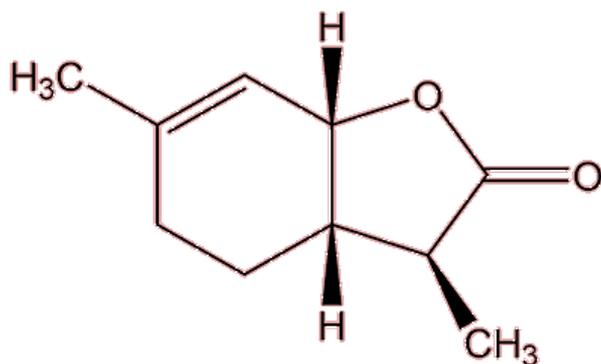
Ácido L-ascórbico (Vitamina C)



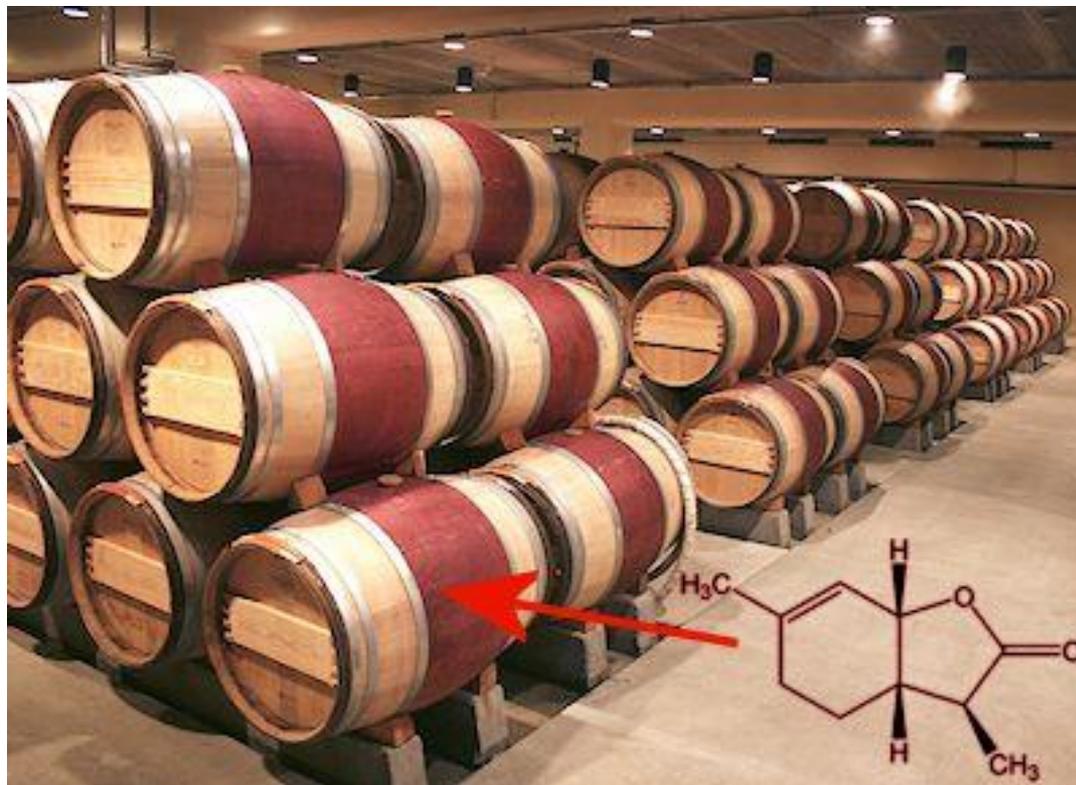
Eritromicina

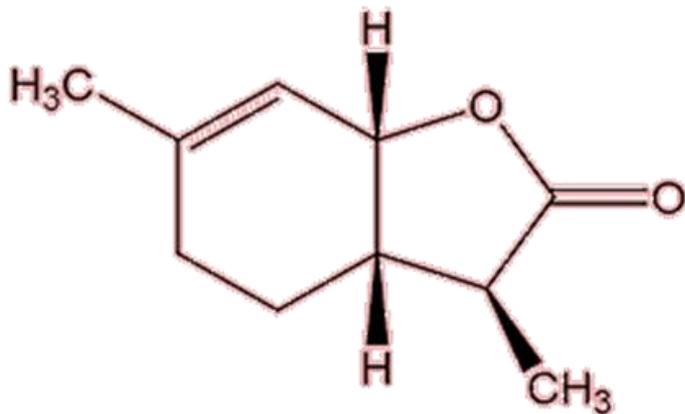


La lactona del vino es un compuesto con un olor agradable, el cual se encuentra en forma natural en las manzanas, el jugo e naranja, jugo de uva , el aceite esencial de la naranja, el aceite de la cáscara de clementina. Se descubrió por primera vez en el aceite esencial como metabolito de en la orina del Koala por Southwell en 1975. Después se descubrió en el vino blanco en 1996 y de ahí se le dio el nombre de lactona del vino

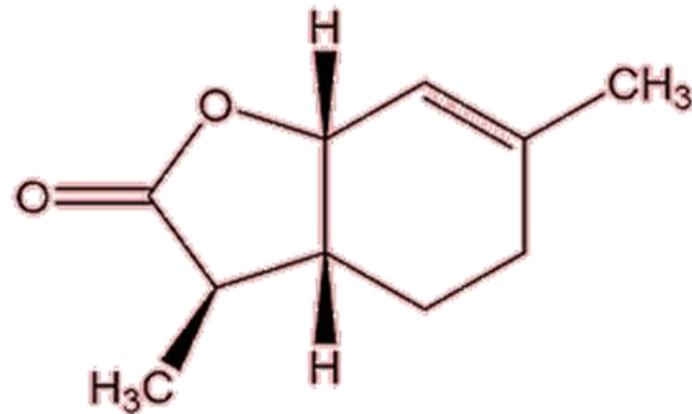


Lactona del vino
(3S,3aS,7aR)-3,6-Dimetil-
3a,4,5,7a-tetrahidro-3H-1-
benzofuran-2-ona





umbral de olor
0.00001 – 0.00004 ng/L aire

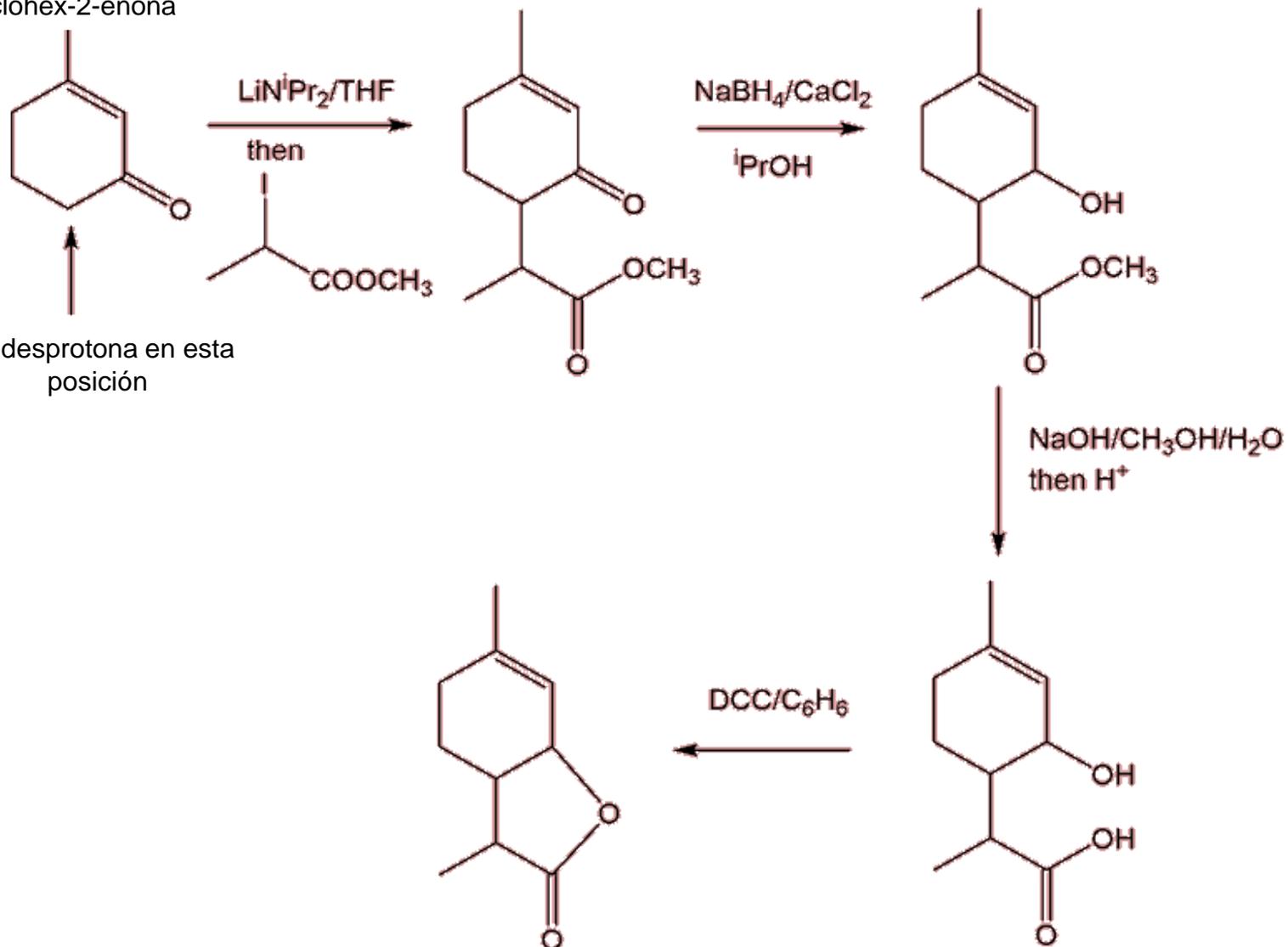


umbral de olor
> 1000 ng/L aire



3-metilciclohex-2-enona

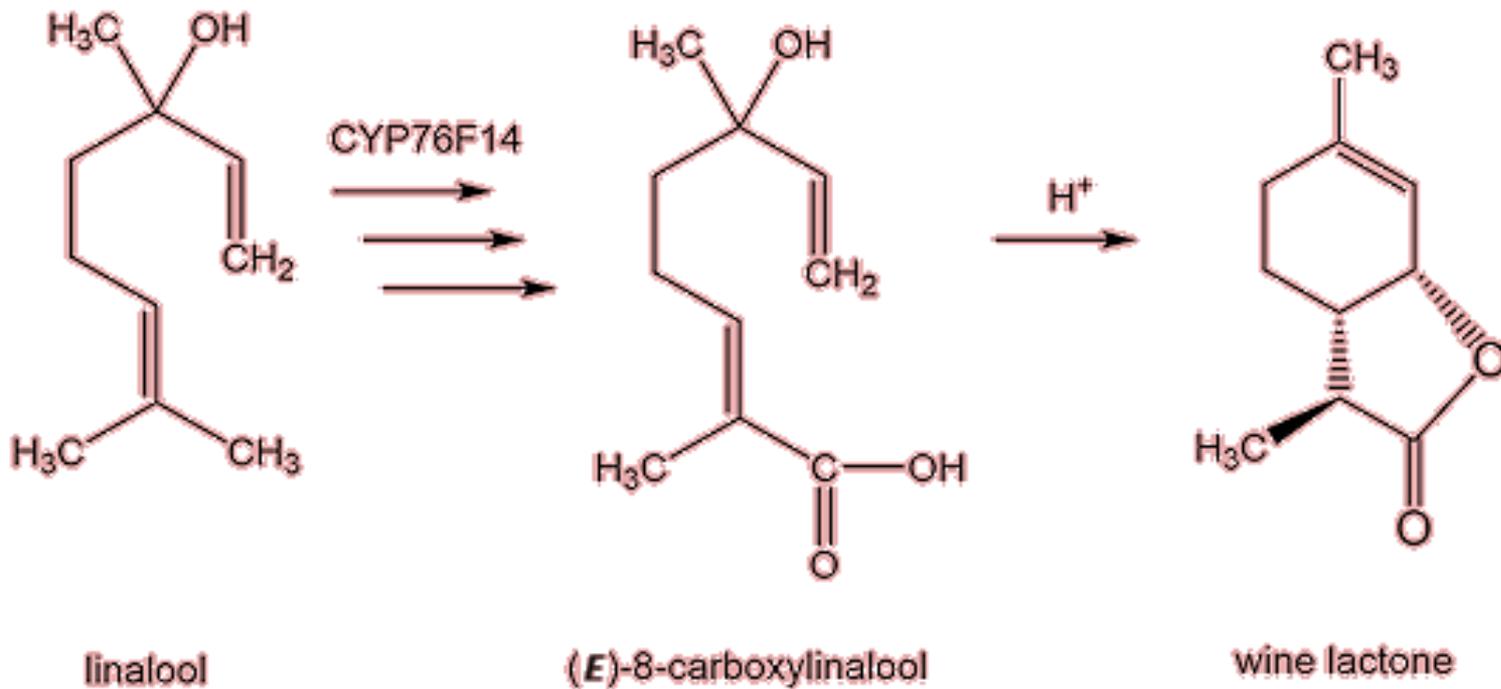
Se desprotona en esta posición



H. Guth, *Helv. Chim. Acta.*, **1996**, 79, 1559.



No se ha encontrado lactona de vino en las uvas, pero se cree que se genera principalmente a medida que el vino madura. Una posible vía de formación involucra al linalool (MOTM Octubre 2013), que está presente en la uva; Se sabe que el linalool es oxidado por una enzima del citocromo P450 CYP76F14 a (*E*)-8-carboxilinalool (también conocido como ácido mentiafólico), y esto, a su vez, se convierte en lactona de vino en una reacción catalizada por ácido muy lenta.

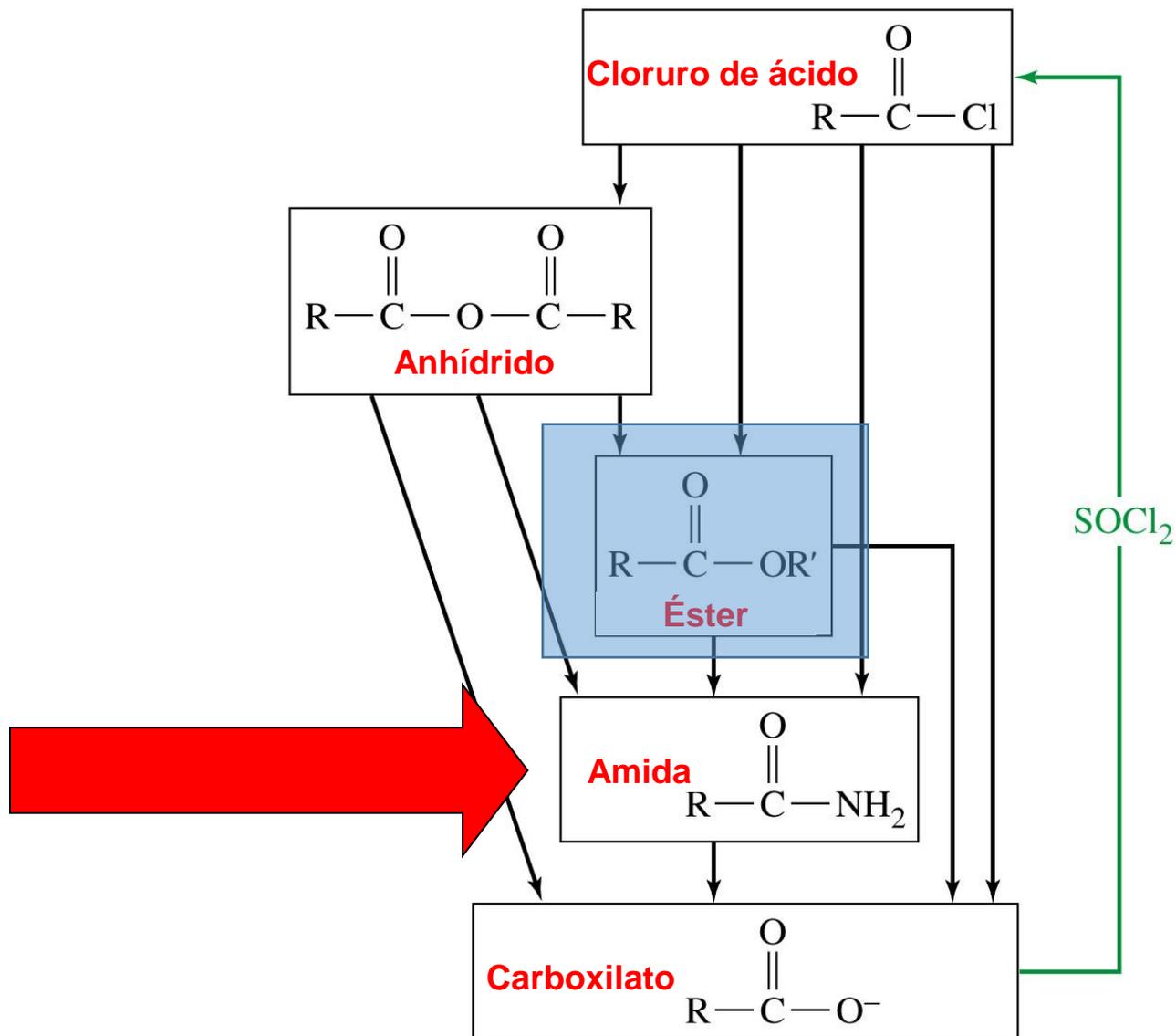


IR REGIÓN 2000-1650 cm⁻¹

2000-1650	weak	C-H bending	aromatic compound	overtone
1870-1540				
1818	strong	C=O stretching	anhydride	
1750				
1815-1785	strong	C=O stretching	acid halide	
1800-1770	strong	C=O stretching	conjugated acid halide	
1775	strong	C=O stretching	conjugated anhydride	
1720				
1770-1780	strong	C=O stretching	vinyl / phenyl ester	
1760	strong	C=O stretching	carboxylic acid	monomer
1750-1735	strong	C=O stretching	esters	6-membered lactone
1750-1735	strong	C=O stretching	δ-lactone	γ: 1770
1745	strong	C=O stretching	cyclopentanone	
1740-1720	strong	C=O stretching	aldehyde	
1730-1715	strong	C=O stretching	α,β-unsaturated ester	or formates
1725-1705	strong	C=O stretching	aliphatic ketone	or cyclohexanone or cyclopentenone
1720-1706	strong	C=O stretching	carboxylic acid	dimer
1710-1680	strong	C=O stretching	conjugated acid	dimer
1710-1685	strong	C=O stretching	conjugated aldehyde	
1690	strong	C=O stretching	primary amide	free (associated: 1650)
1690-1640	medium	C=N stretching	imine / oxime	
1685-1666	strong	C=O stretching	conjugated ketone	
1680	strong	C=O stretching	secondary amide	free (associated: 1640)
1680	strong	C=O stretching	tertiary amide	free (associated: 1630)
1650	strong	C=O stretching	δ-lactam	γ: 1750-1700 β: 1760-1730

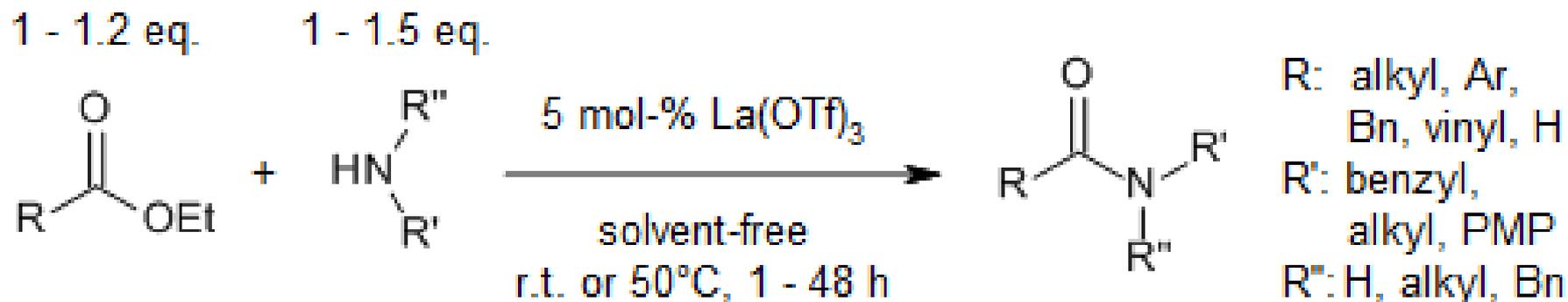


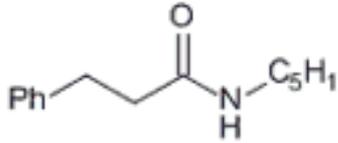
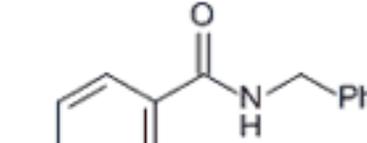
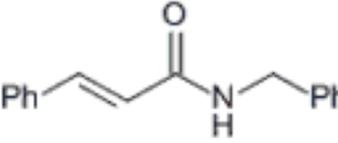
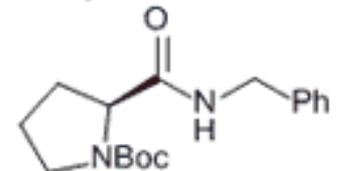
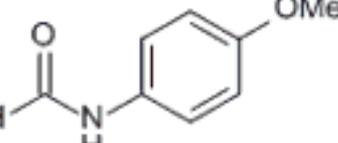
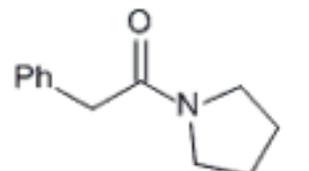
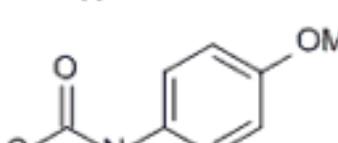
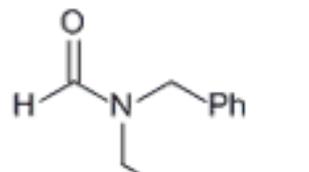
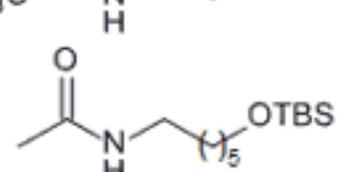
Interconversión de los derivados de ácido



Lanthanum(III) Triflate Catalyzed Direct Amidation of Esters

H. Morimoto, R. Fujiwara, Y. Shimizu, K. Morisaki, T. Ohshima, *Org. Lett.*, **2014**, *16*, 2018-2021.



product	ester:amine (eq.)	T (°C)	t (h)	yield (% (%, isol.)	product	ester:amine (eq.)	T (°C)	t (h)	yield (% (%, isol.)
	1:1.2	r.t.	48	95		1:1.2	50	24	99
	1:1.2	50	48	80		1:1.2	50	24	79
	1.2:1	r.t.	24	91		1:1.5	50	24	98
	1.2:1	r.t.	1	99		1.2:1	r.t.	3	86
 (2 mol-% catalyst)	1:1.2	r.t.	24	88					



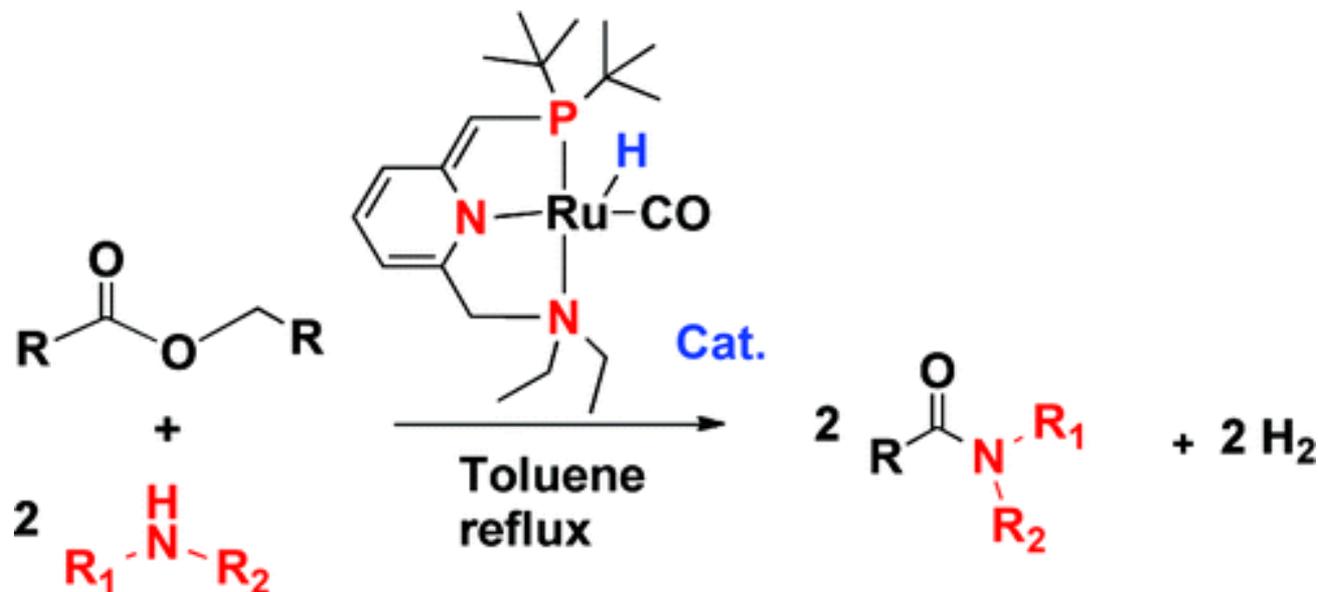
Entrada:	Apellidos
1	A a C
2	D a F
3	G a L
4	M a R
5	S a Z

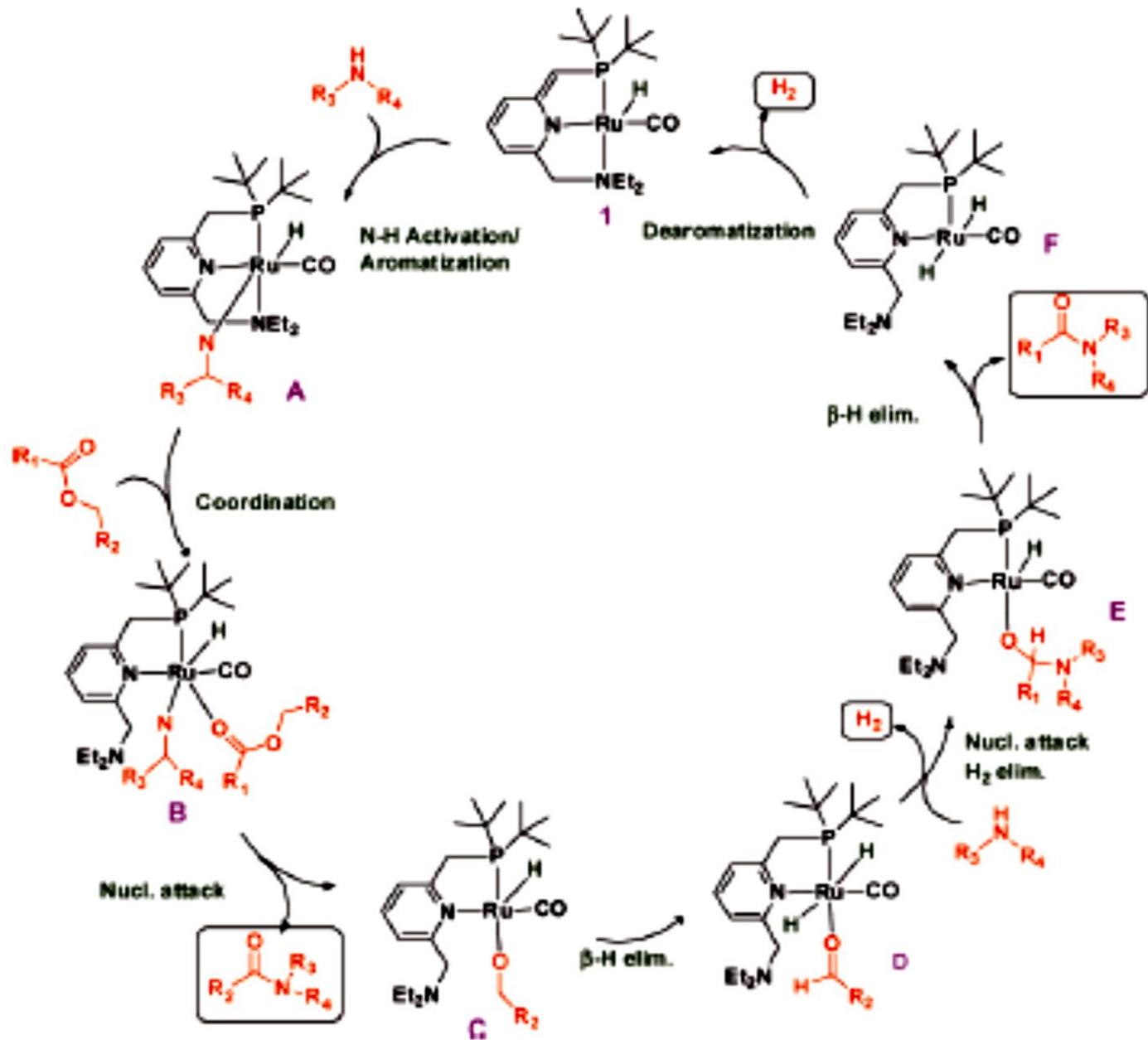


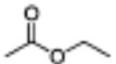
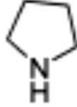
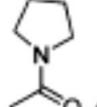
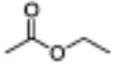
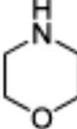
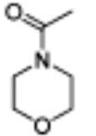
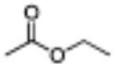
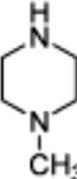
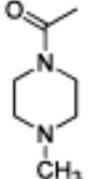
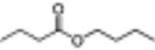
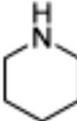
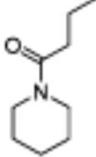
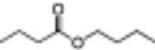
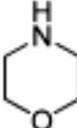
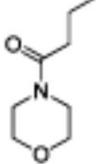
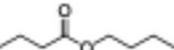
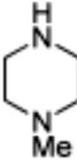
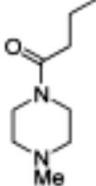
Synthesis of Amides from Esters and Amines with Liberation of H₂ under Neutral Conditions

Boopathy Gnanaprakasam and David Milstein

J. Am. Chem. Soc., **2011**, 133 (6), 1682–1685

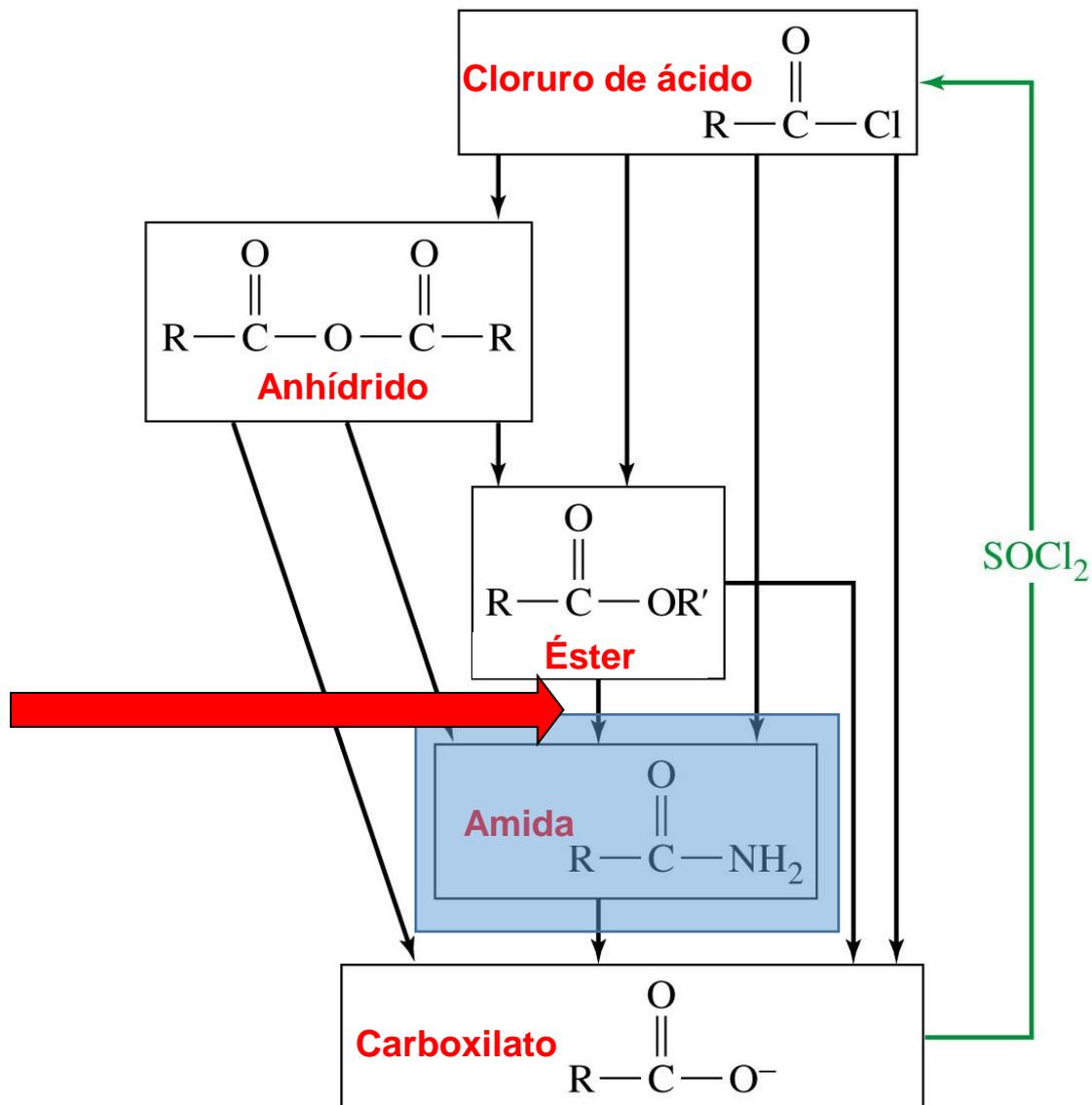




Entry	Ester	Amine	Conv. of amine/time % / hrs	Isolated Yields (%)
1 ^b			100/26	 99
2 ^b			69/36	 66
3 ^b			54/24	 52
4			100/19	 94
5			100/21	 95
6			100/24	 94



Interconversión de los derivados de ácido



N,N-dimetilformamida

La DMF fue preparada por primera vez en 1893 por el químico francés Albert Verley (1867 - 1959), destilando una mezcla de clorhidrato de dimetilamina y formiato de potasio

Albert Verley fue el único estudiante de composición de Satie. Según esto, cuando era joven, Verley había soñado con una carrera en la música, pero se formó como químico; Luego, un grave accidente en el laboratorio dañó gravemente su mano derecha. (¡Los peligros de una carrera química!) Y así se separó del piano y se dedicó por completo a la química.



Verley, A. (1893). "Sur la préparation des amides en général" [On the preparation of amides in general]. Bulletin de la Société chimique de Paris. 3rd series (in French). 9: 690–692. On p. 692, Verley states that DMF is prepared by a procedure analogous to that for the preparation of dimethylacetamide (see p. 691), which would be by distilling dimethylamine hydrochloride and potassium formate.

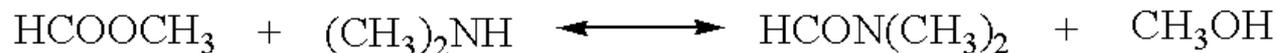


La síntesis de la Dimetilformamida se lleva a cabo a través de la reacción entre formiato de metilo y dimetilamina a una alta temperatura

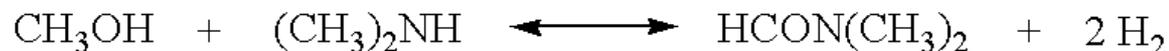
Paso 1



Paso 2



Global

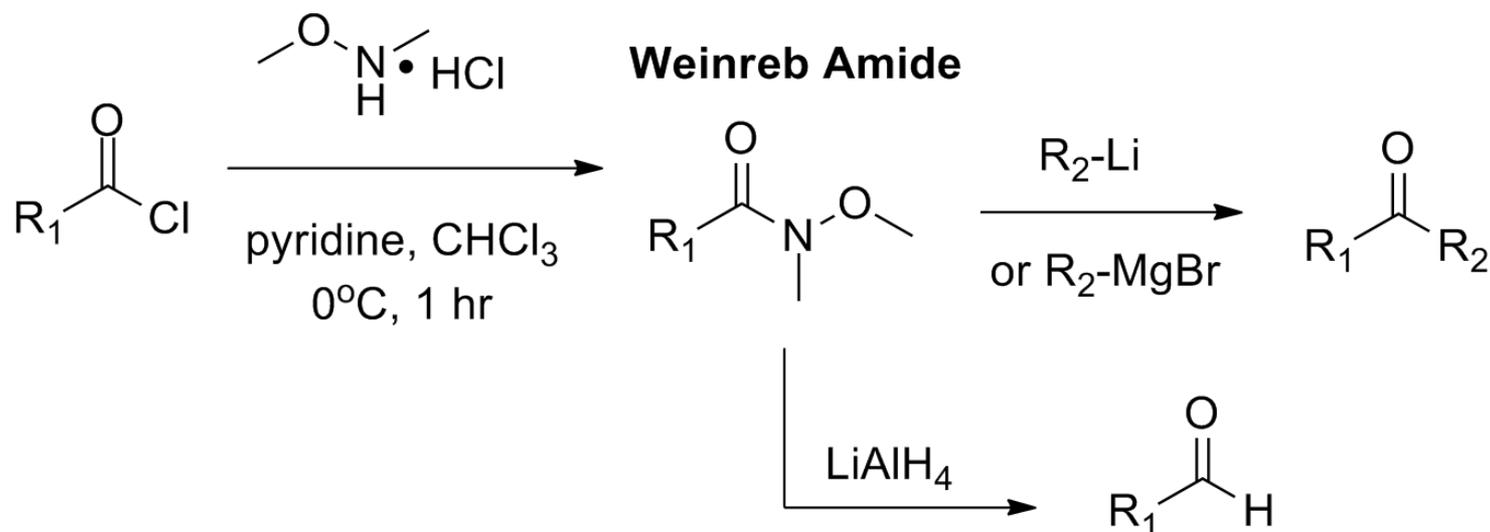


Maliszewskyj, R.J.; Turcotte, M.G.; Mitchell, J.W.; **2003**, US6723877B1



Síntesis de cetonas de Weinreb-Nahm

es una reacción utilizada en la química orgánica para formar enlaces carbono-carbono. Fue descubierta en 1981 por Steven M. Weinreb y Steven Nahm como un método para sintetizar cetonas. La reacción original involucró dos sustituciones de acilo nucleofílico posteriores: la conversión de un cloruro de ácido con N, O-dimetilhidroxilamina, para formar una amida de Weinreb-Nahm, y el tratamiento posterior de esta especie con un reactivo organometálico como un reactivo de Grignard o reactivo de organolitio. Nahm y Weinreb también informaron sobre la síntesis de aldehídos por reducción de la amida con un exceso de hidruro de litio y aluminio (ver reducción de amida).



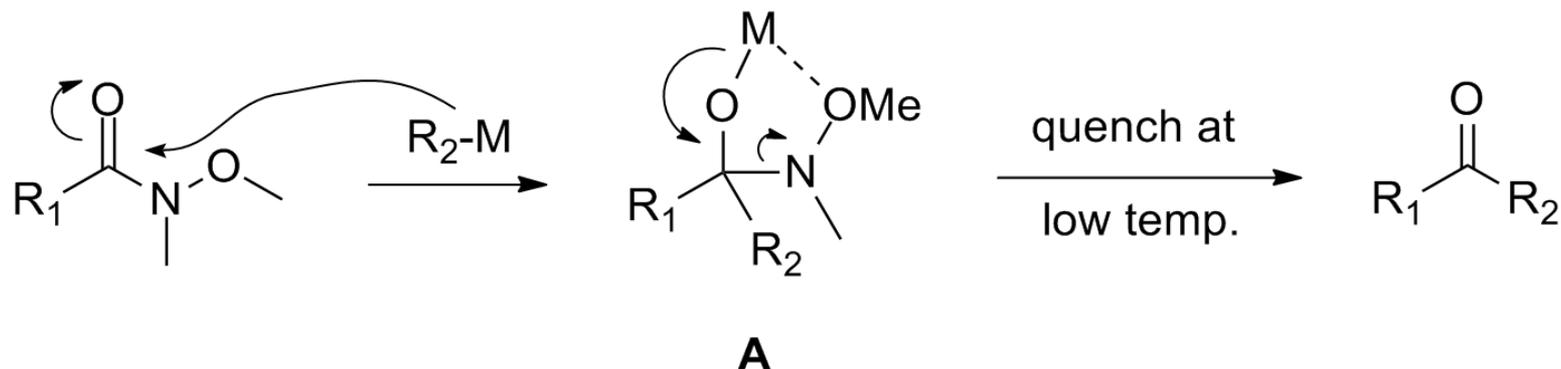
https://en.wikipedia.org/wiki/Weinreb_ketone_synthesis#/media/File:WeinrebAmideIntro.png

Nahm, S.; Weinreb, S. M. (1981), "N-methoxy-n-methylamides as effective acylating agents", *Tetrahedron Letters*, **22** (39): 3815–3818,

Paek, S.-M.; Seo, S.-Y.; Kim, S.-H.; Jung, J.-W.; Lee, Y.-S.; Jung, J.-K.; Suh, Y.-G. (2005), "Concise Syntheses of (+)-Macrosphelides A and B", *Organic Letters*, **7** (15): 3159–3162,

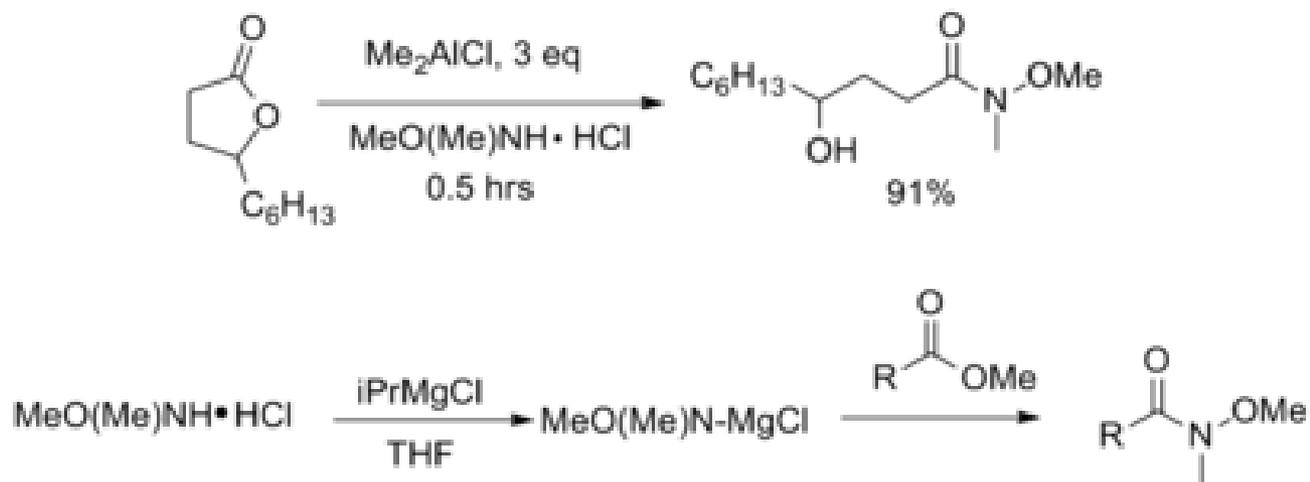


Mecanismo de la síntesis de cetonas de Weinreb-Nahm

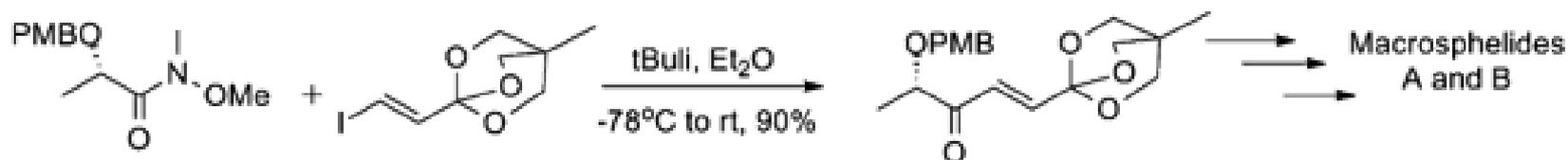
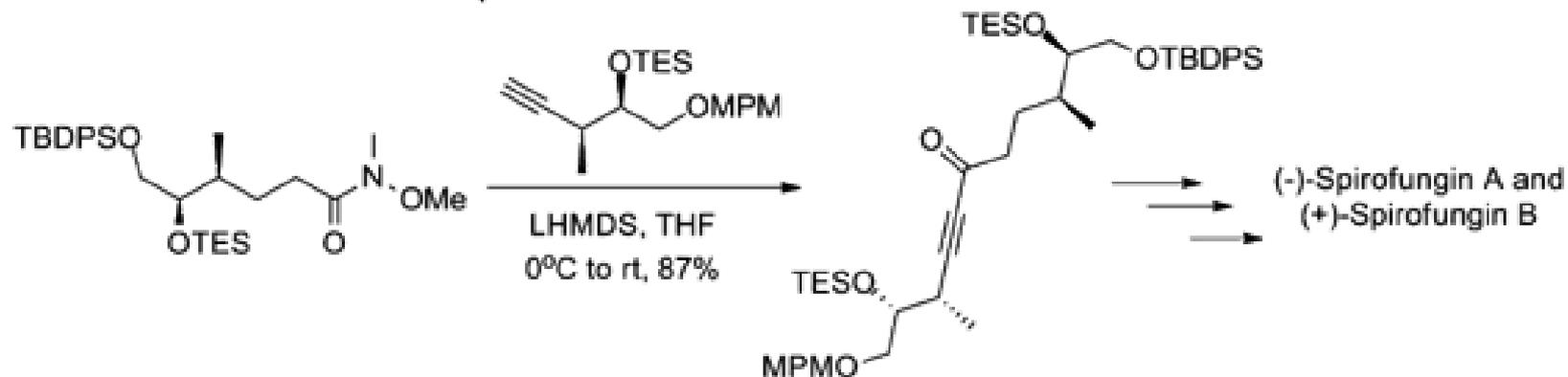
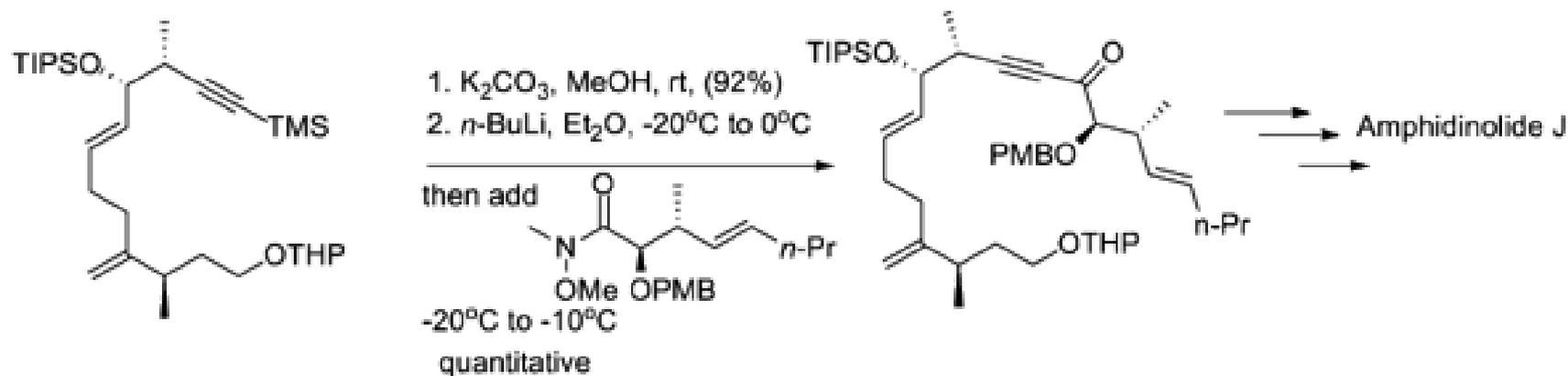


https://en.wikipedia.org/wiki/Weinreb_ketone_synthesis#/media/File:Weinrebmechanism.png

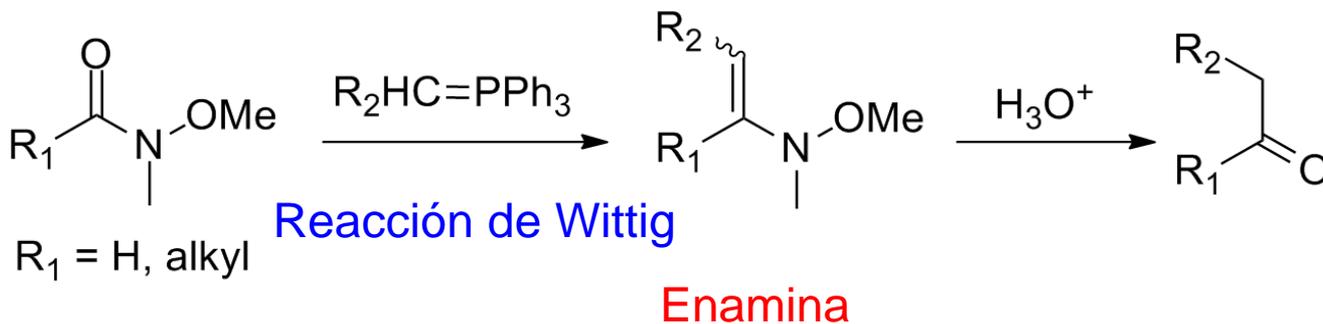
Obtención de las amidas de Weinreb-Nahm



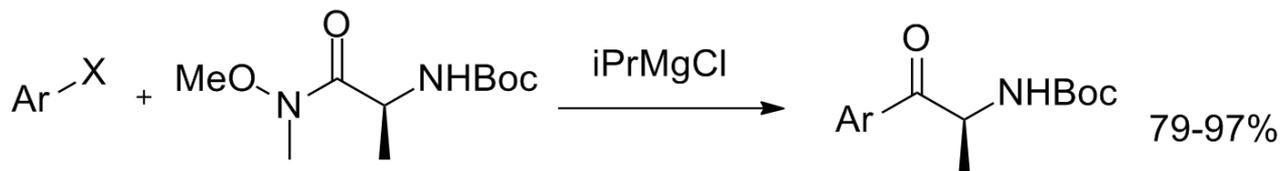
Síntesis de cetonas de Weinreb-Nahm



Modificaciones a la síntesis de cetonas de Weinreb



https://en.wikipedia.org/wiki/Weinreb_ketone_synthesis#/media/File:WeinrebWittig.png

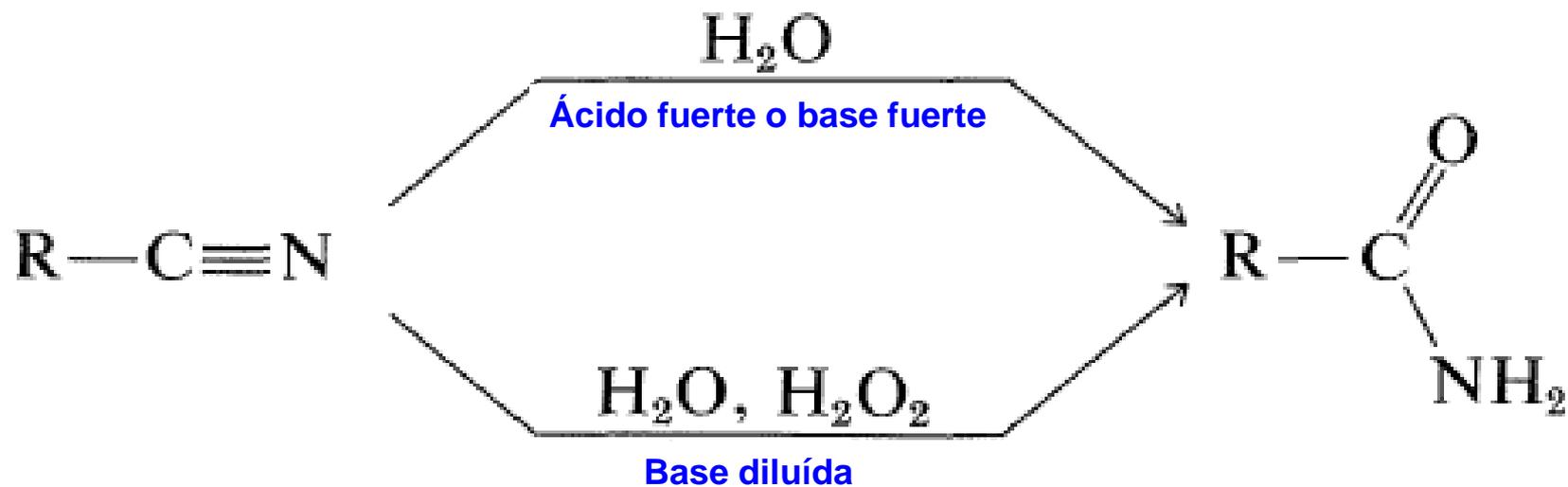


For X = I, Ar = any aryl

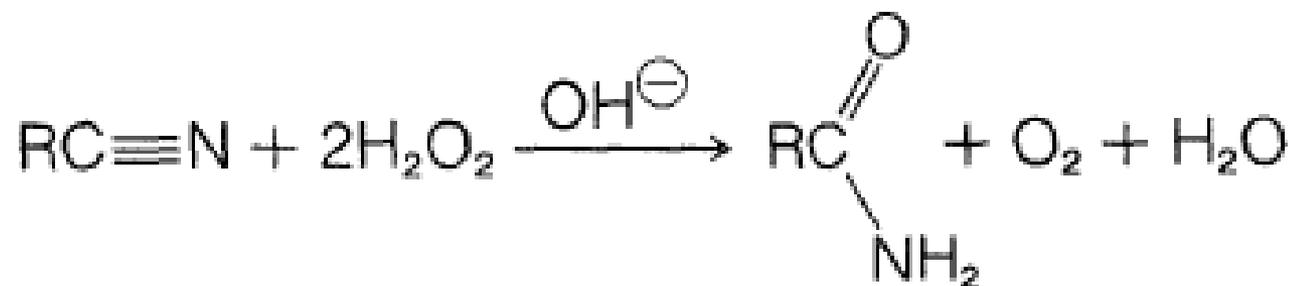
For X = Br, Ar = electron-poor aryl

Generación *in situ* del carbanión
Reactivo de Wittig como base fuerte





Base diluida. Cinética de la reacción

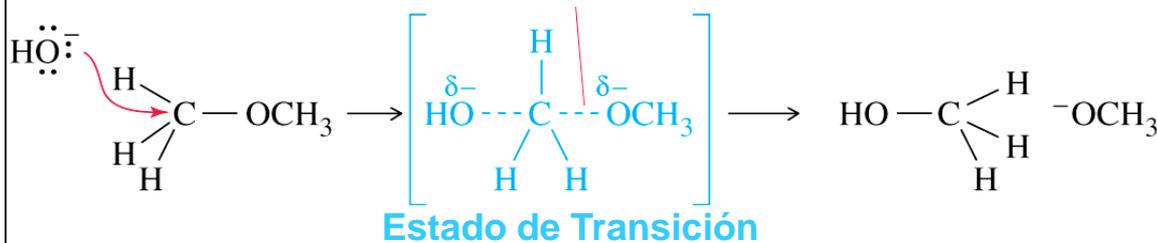


$$v = k [\text{H}_2\text{O}_2] [\text{OH}^\ominus] [\text{RC}\equiv\text{N}]$$



S_N2

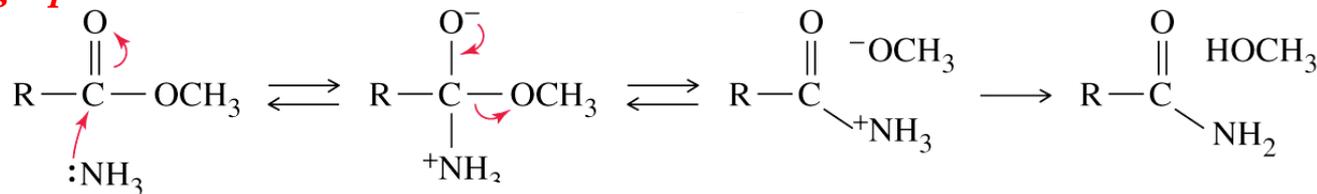
El enlace con el métoxido esta medio roto



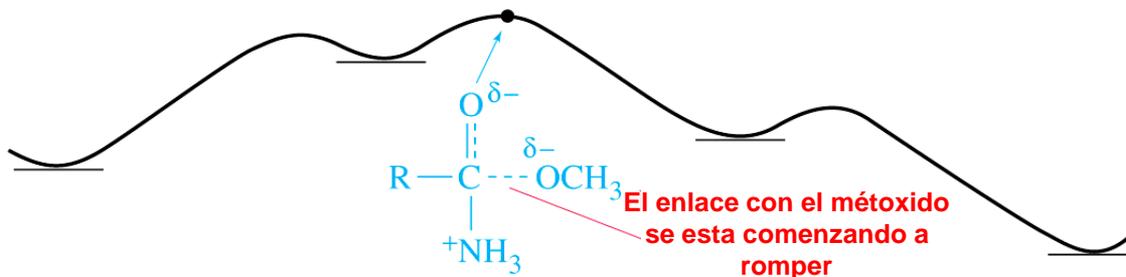
S_N2 vs. S_NAc

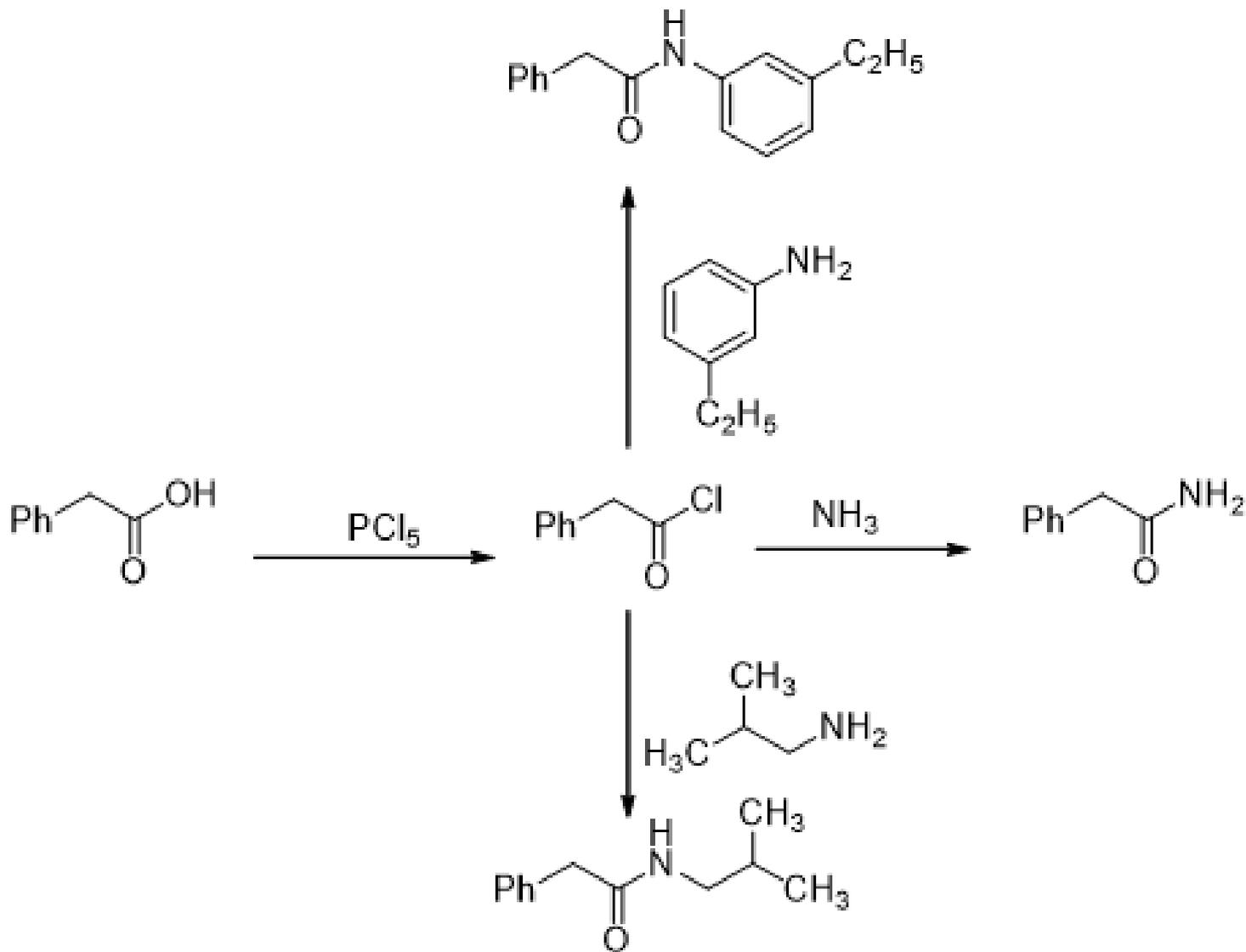
Sustitución sobre el grupo acilo

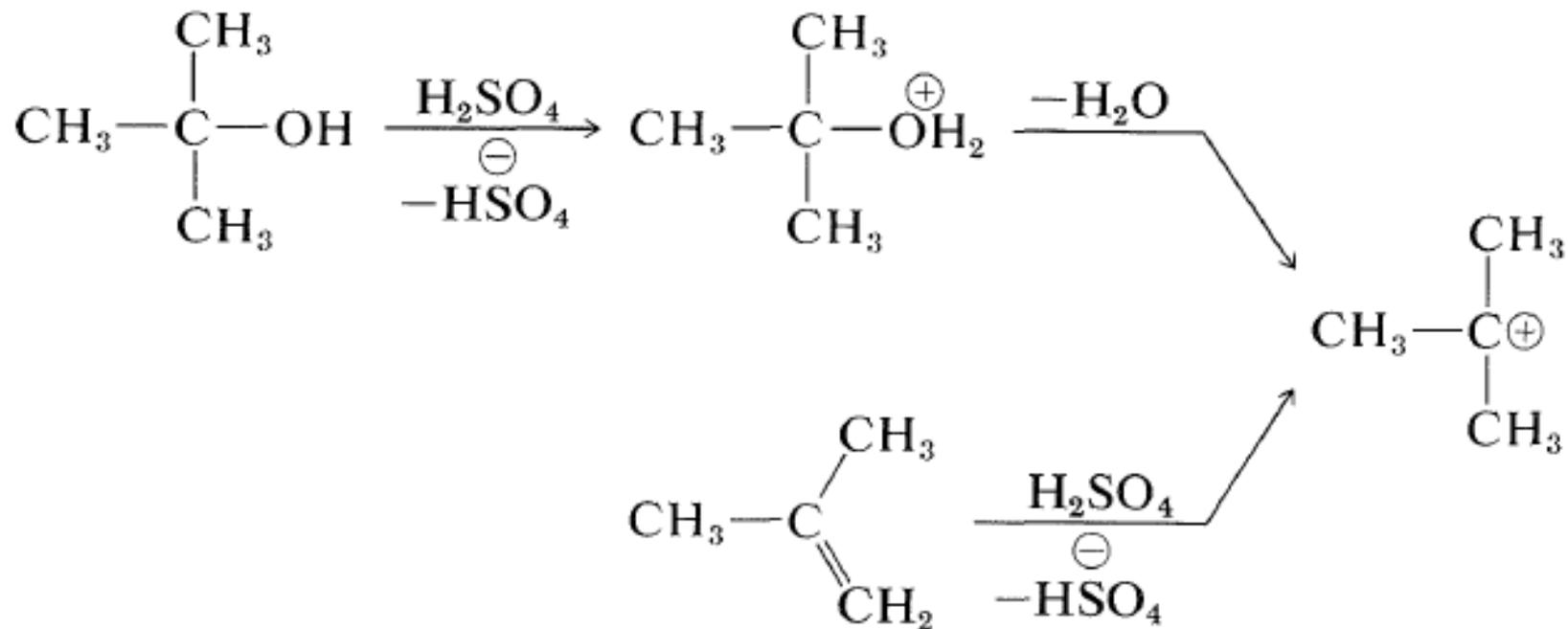
El $^-:\text{OCH}_3$ se elimina en un paso exotérmico

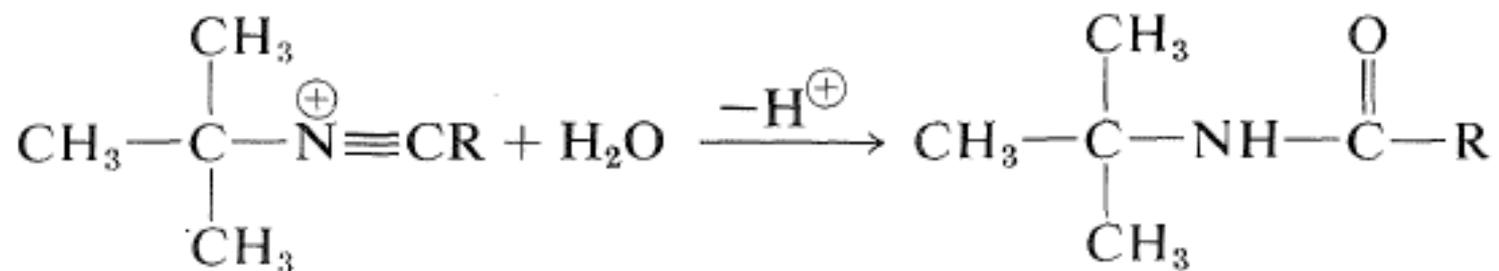
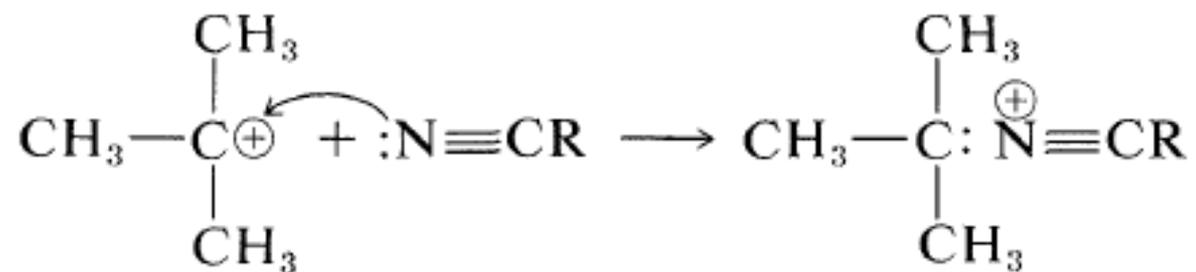


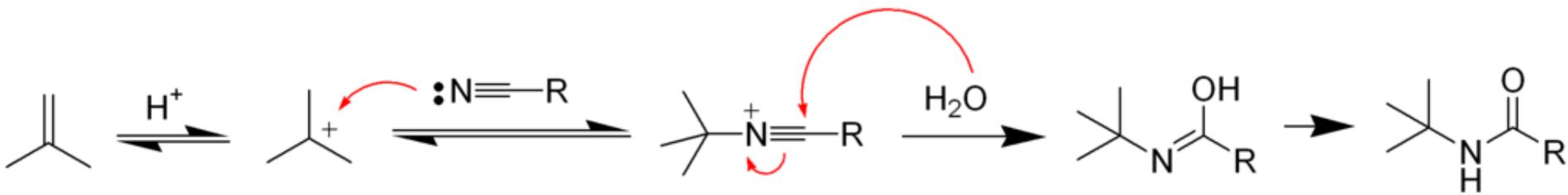
Estado de Transición





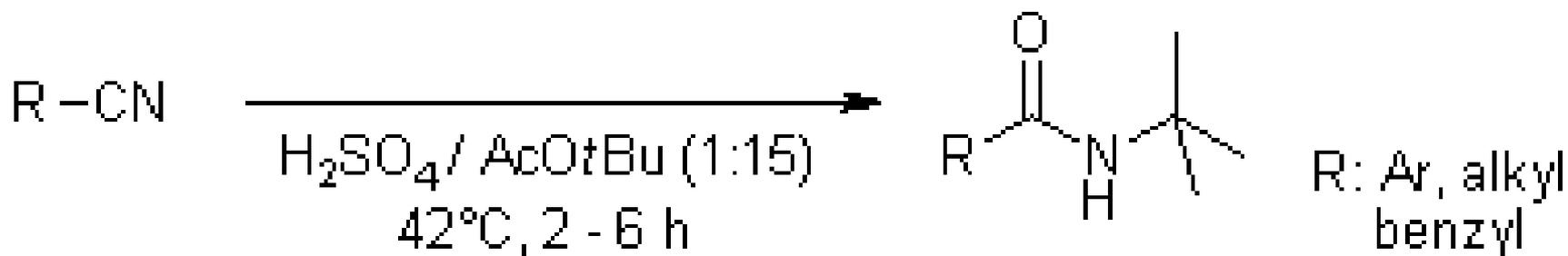


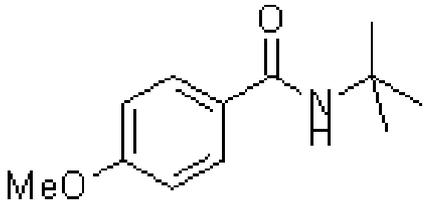
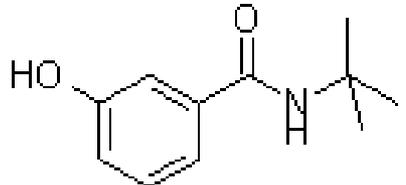
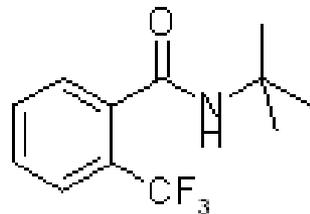
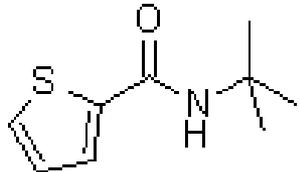
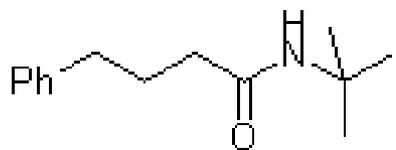




An efficient method for the conversion of aromatic and aliphatic nitriles to the corresponding *N*-*tert*-butyl amides: a modified Ritter reaction

K. L. Reddy, *Tetrahedron Lett.*, **2003**, *44*, 1453-1455.

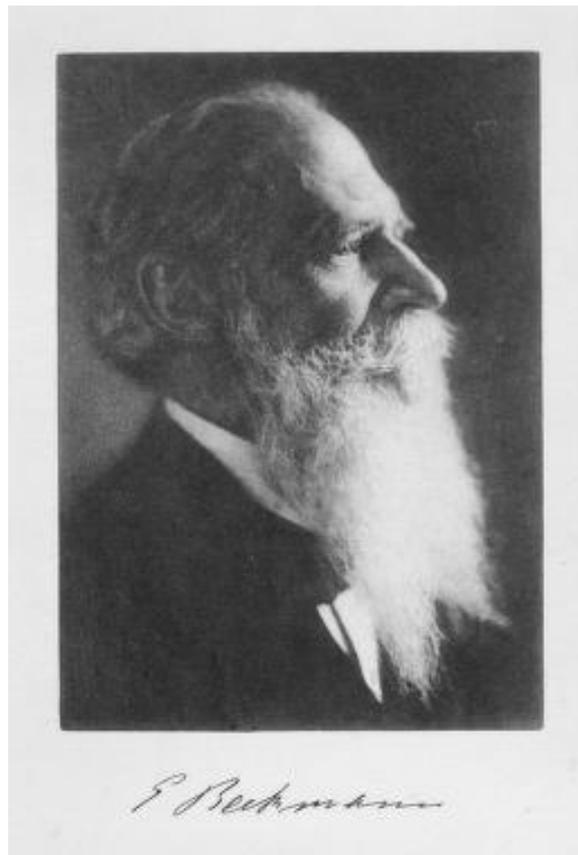


	product	t (h)	yield (% , isol.)
1)		2	95
2)		1.5	93
3)		5	88
4)		1	92
5)		2	93



Entrada:	Apellidos
1	A a C
2	D a F
3	G a L
4	M a R
5	S a Z

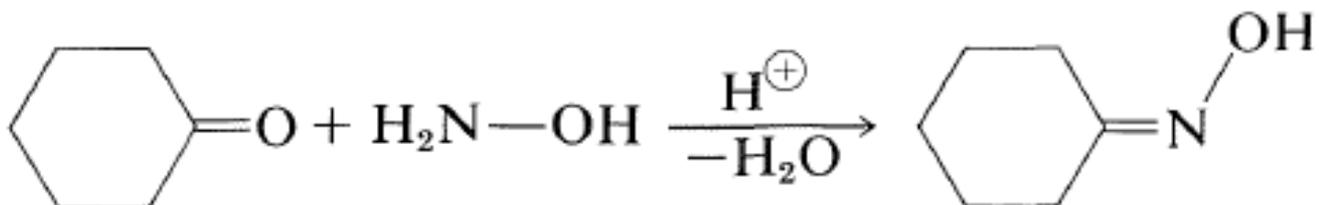




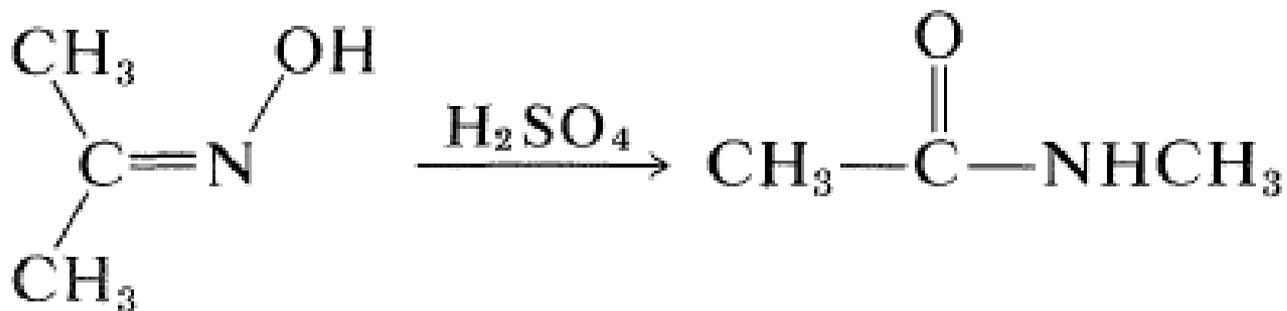
Ernst Otto Beckmann
(1853 – 1923)
Farmacéutico y químico alemán



Transposición de Beckmann



Oxima de la ciclohexanona



Oxima de la acetona

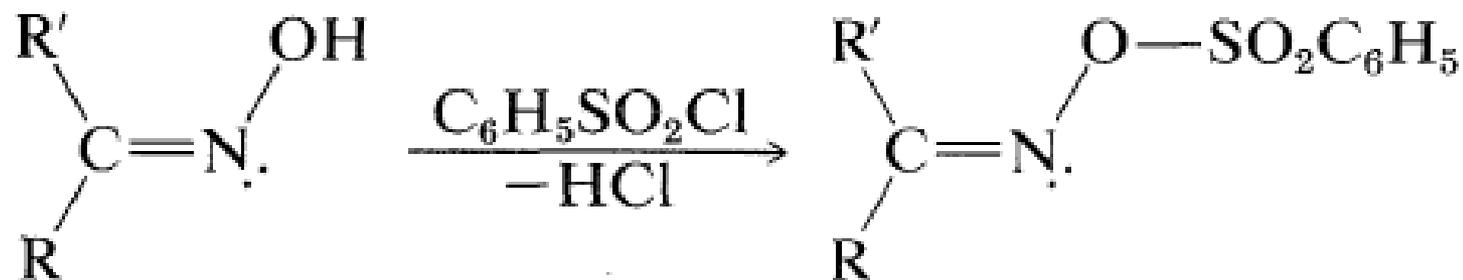
N-metil acetamida



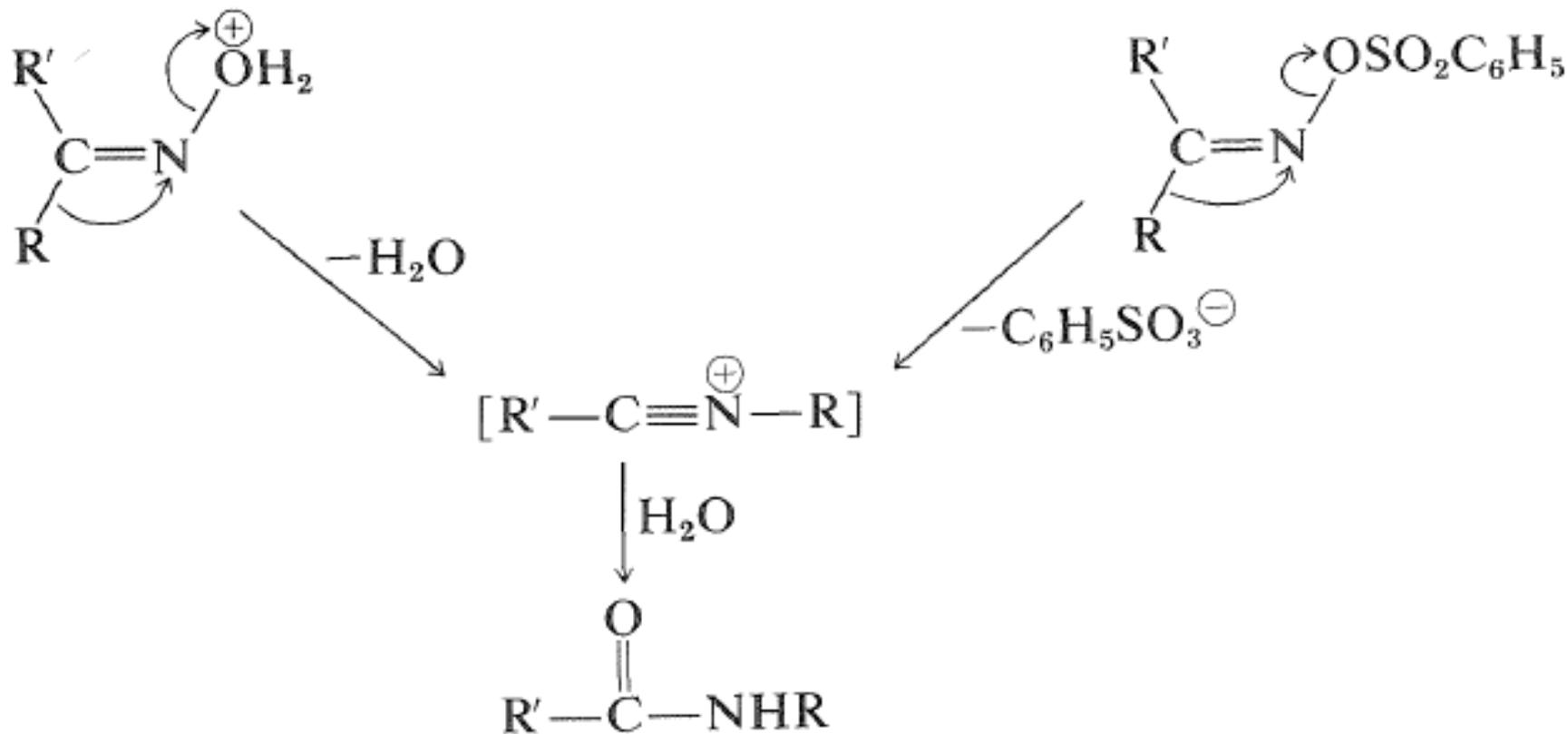
Mecanismo de la transposición de Beckmann

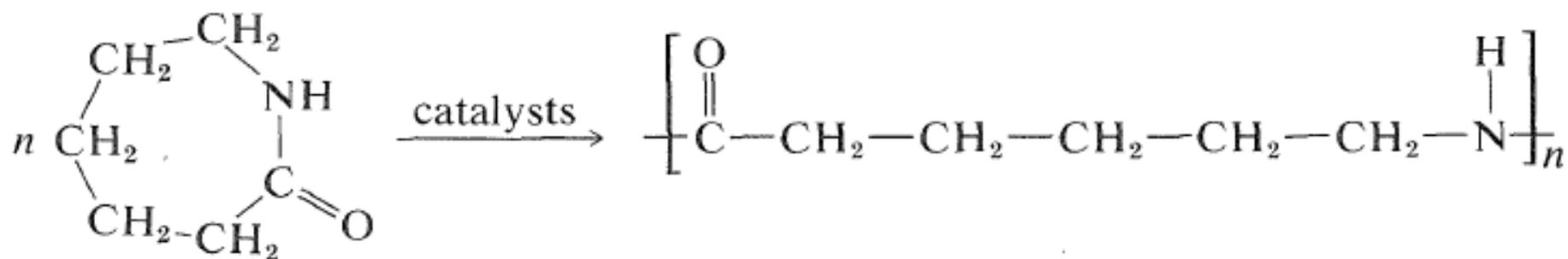
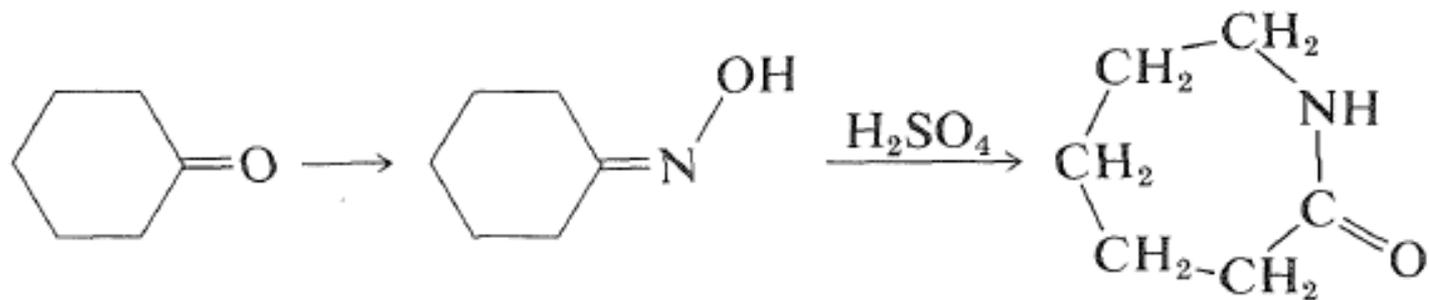
1er. Paso: funcionalización del OH.

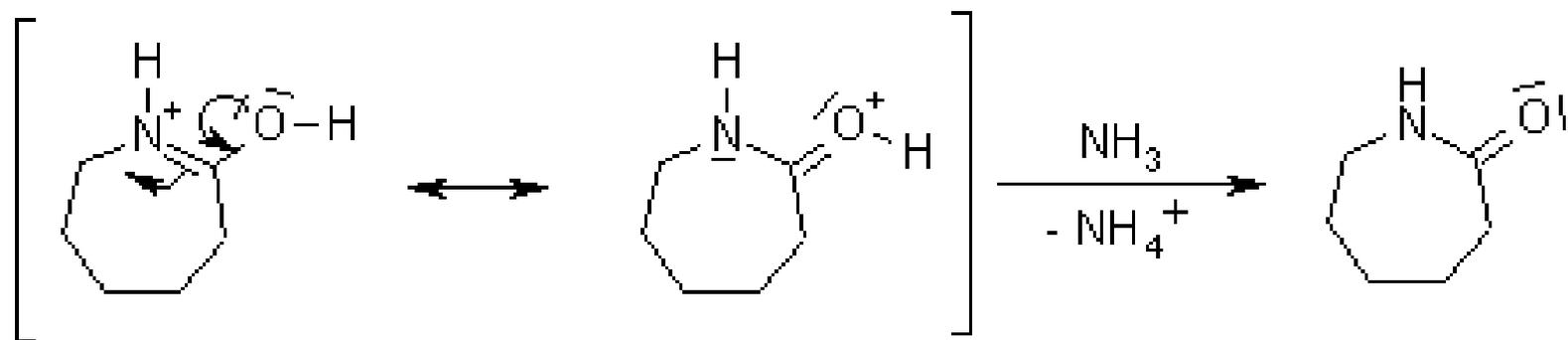
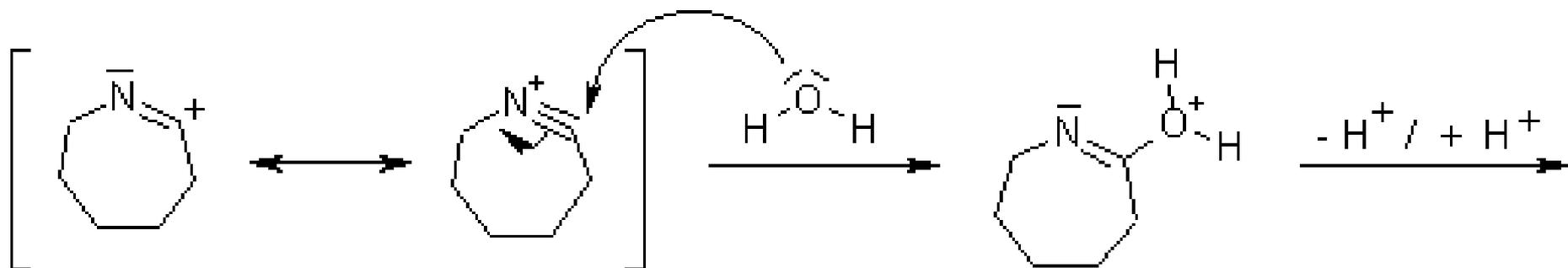
Transformación en un buen grupo saliente

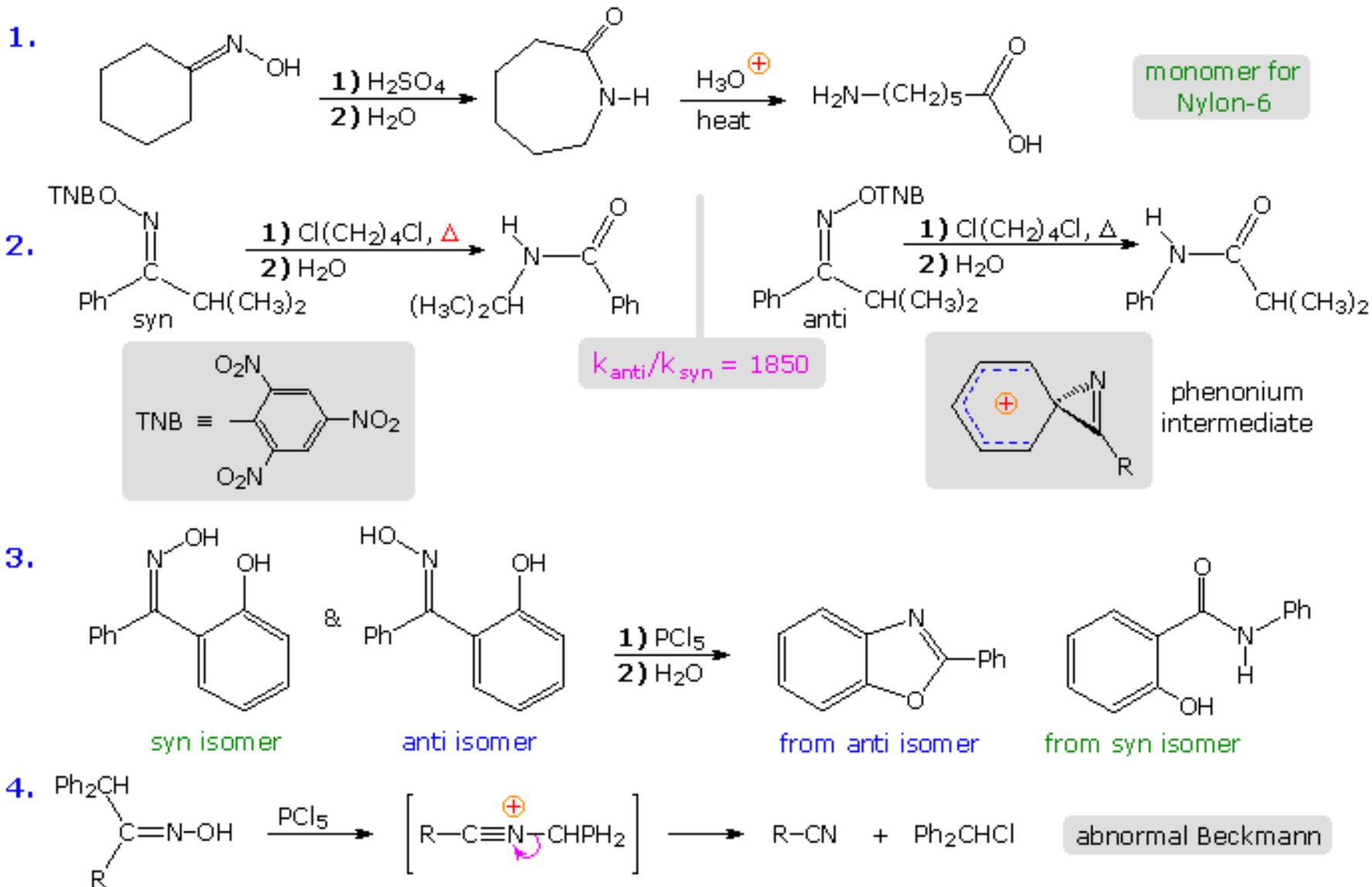


Mecanismo de la transposición de Beckmann







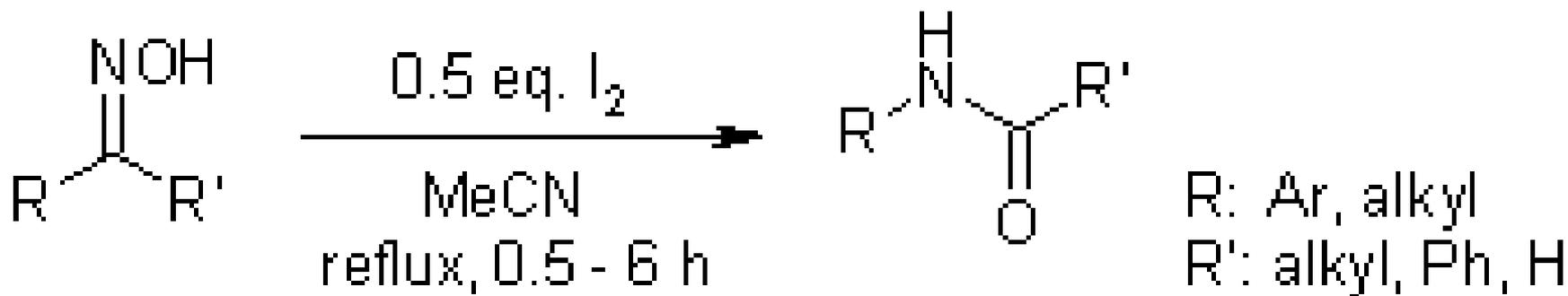


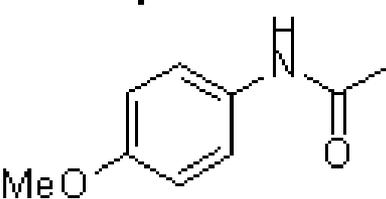
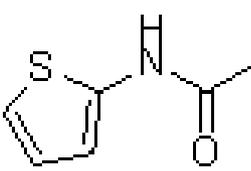
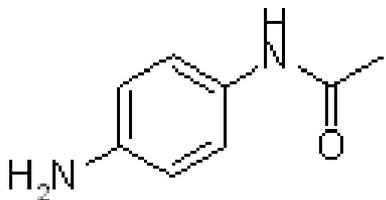
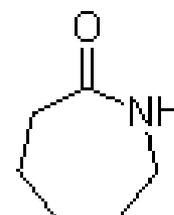
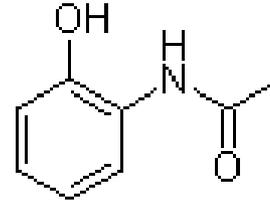
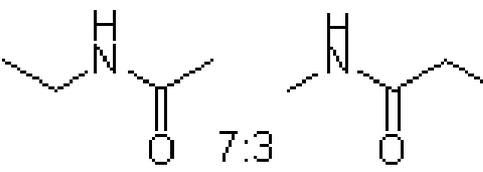
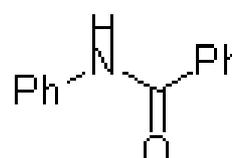
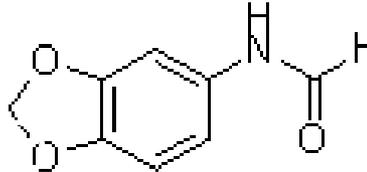
<https://www2.chemistry.msu.edu/faculty/reusch/virttxtjml/rearrang.htm>



Efficient Iodine-Mediated Beckmann Rearrangement of Ketoximes to Amides under Mild Neutral Conditions

N. C. Ganguly, P. Mondal, *Synthesis*, **2010**, 3705-3709.



	product	t (h)	yield (% , isol.)		product	t (h)	yield (% , isol.)
1)		0.5	97	4)		4	86
2)		4	90			1	90
3)		6	85			2	95
		2	98	5)		5	15



Entrada:	Apellidos
1	A a C
2	D a F
3	G a L
4	M a R
5	S a Z



EEDQ: N-Ethoxycarbonyl-2-ethoxy-1,2-dihydroquinoline N-Etoxicarbonil-2-etoxi-1,2-dihidroquinolina

Reactivo de acoplamiento: formación de amidas a partir de ácidos carboxílicos

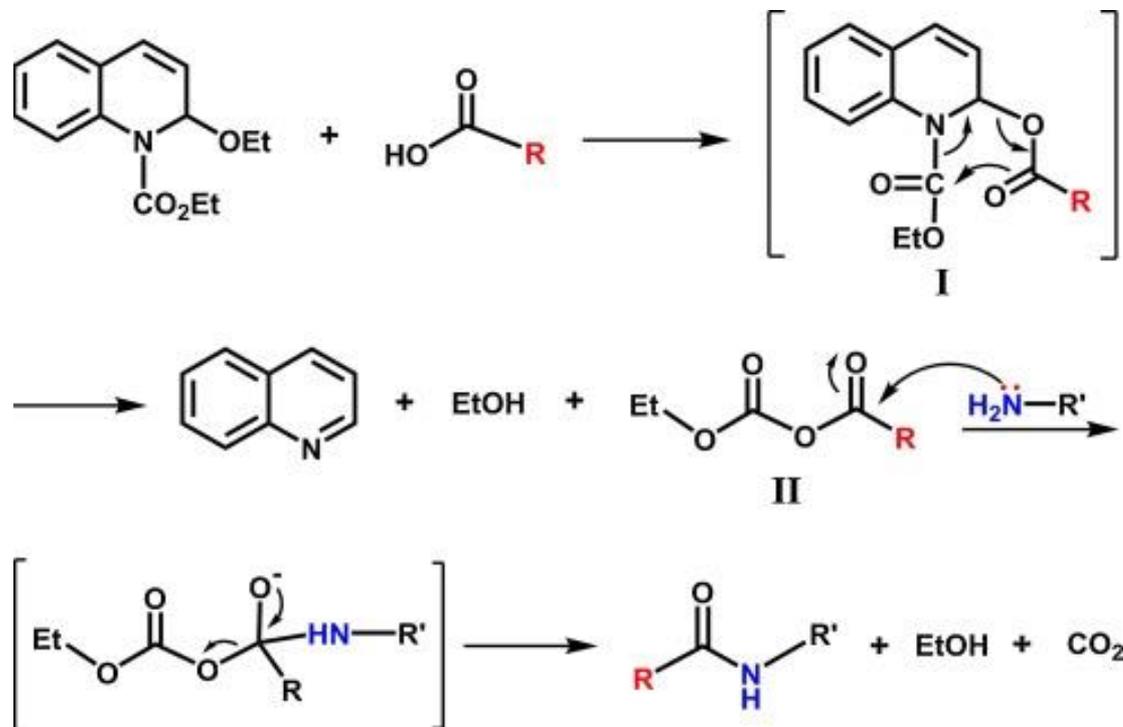


Table of IR Absorptions

Aldehyde C=O Stretch	1740 - 1690 (s)
Ketone C=O Stretch	1750 - 1680 (s)
Ester C=O Stretch	1750 - 1735 (s)
Carboxylic Acid C=O Stretch	1780 - 1710 (s)
Amide C=O Stretch	1690 - 1630 (s)
Amide N-H Stretch	3700 - 3500 (m)

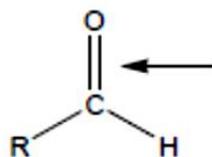
The carbonyl stretching absorption is one of the strongest IR absorptions, and is very useful in structure determination as one can determine both the number of carbonyl groups (assuming peaks do not overlap) but also an estimation of which types.

As with amines, an amide produces zero to two N-H absorptions depending on its type.



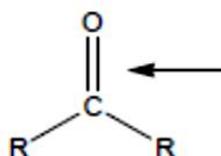
Carbonyl Highlights (stretching wave numbers)

Aldehydes



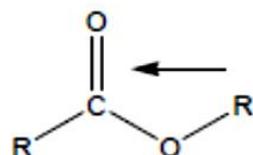
saturated = 1725
conjugated = 1690
aromatic = 1700

Ketones



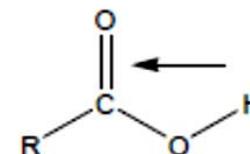
saturated = 1715
conjugated = 1680
aromatic = 1690
6 atom ring = 1715
5 atom ring = 1745
4 atom ring = 1780
3 atom ring = 1850

Esters



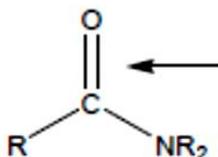
saturated = 1735
conjugated = 1720
aromatic = 1720
6 atom ring = 1735
5 atom ring = 1775
4 atom ring = 1840

Acids



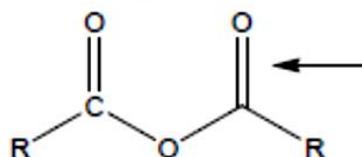
saturated = 1715
conjugated = 1690
aromatic = 1690

Amides



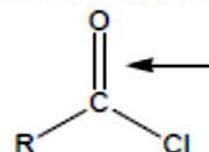
saturated = 1650
conjugated = 1660
aromatic = 1660
6 atom ring = 1670
5 atom ring = 1700
4 atom ring = 1745
3 atom ring = 1850

Anhydrides



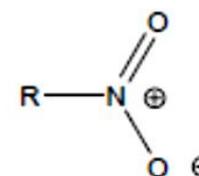
saturated = 1760, 1820
conjugated = 1725, 1785
aromatic = 1725, 1785
6 atom ring = 1750, 1800
5 atom ring = 1785, 1865

Acid Chlorides



saturated = 1800
conjugated = 1770
aromatic = 1770

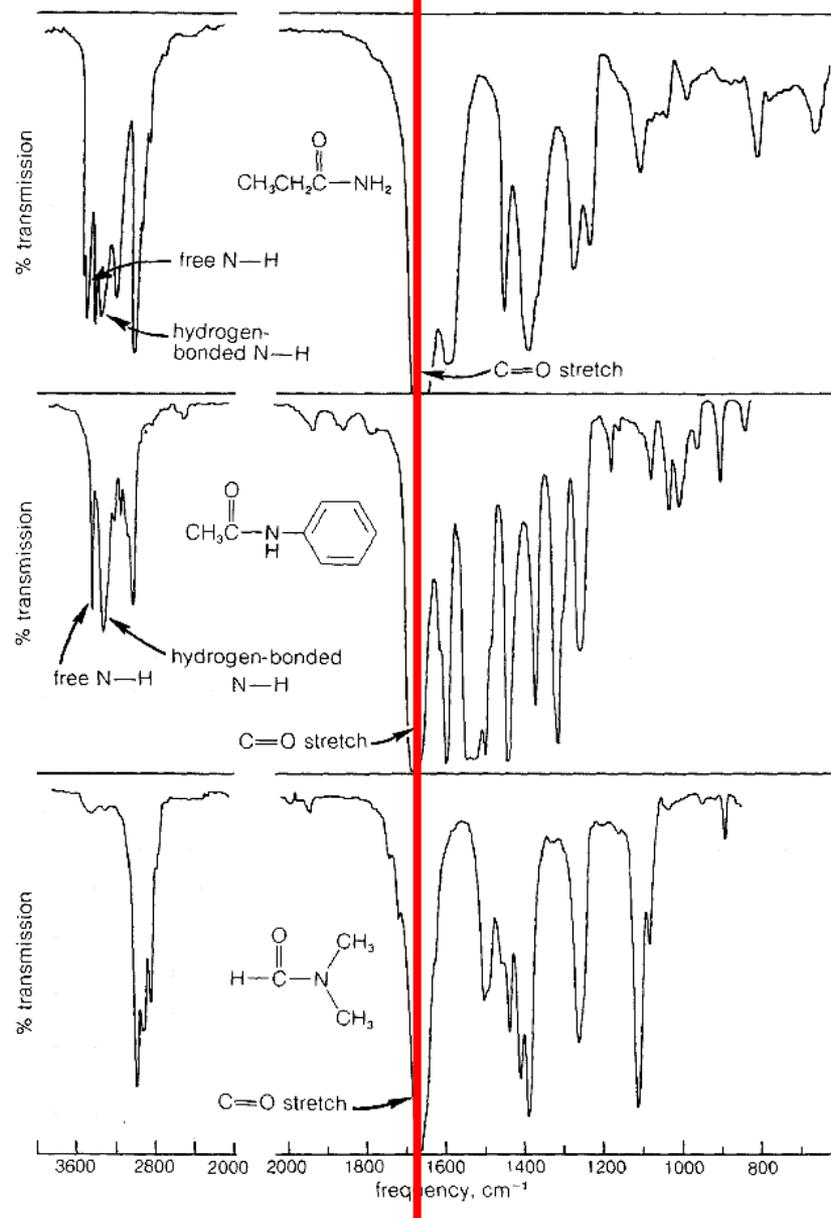
nitro

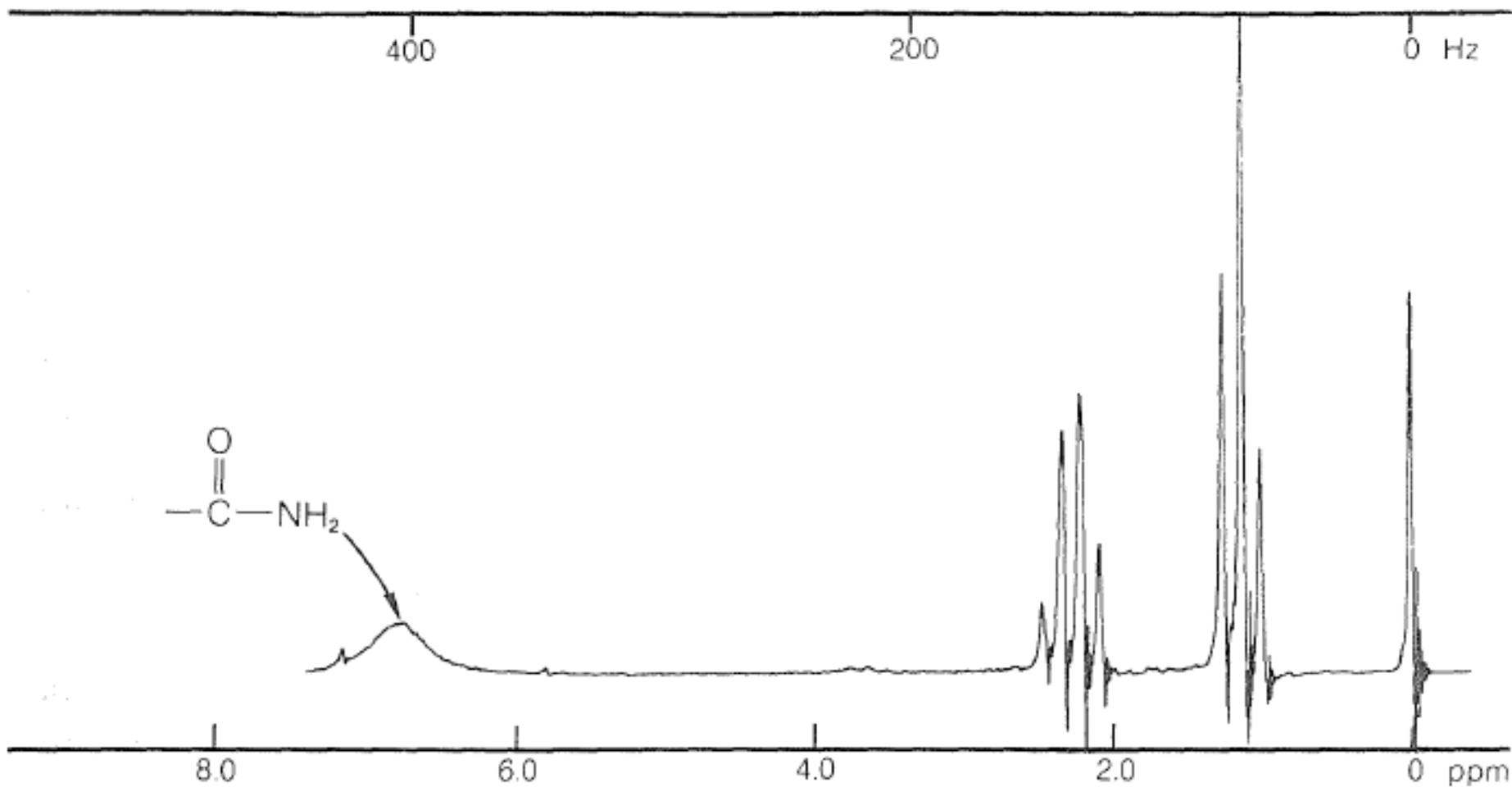


asymmetric = 1500-1600
symmetric = 1300-1390

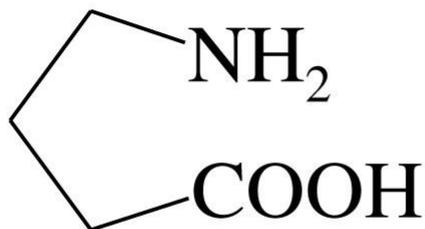
Very often there is a very weak C=O overtone at approximately $2 \times \bar{\nu}$ ($\approx 3400 \text{ cm}^{-1}$).
Sometimes this is mistaken for an OH or NH peak.



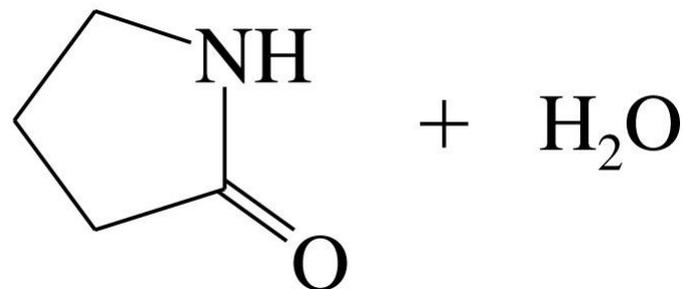




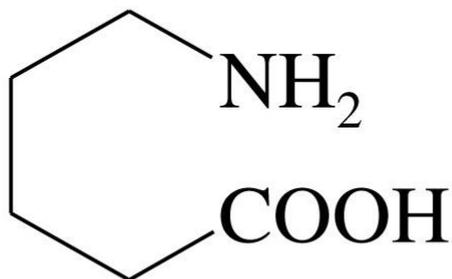
Formación de lactamas (amidas cíclicas)



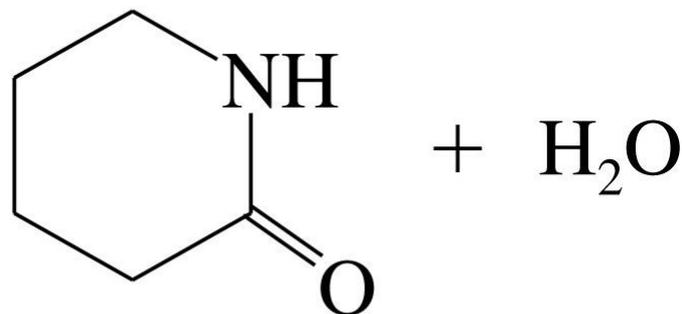
Ácido γ -aminobutírico



γ -butirolactama



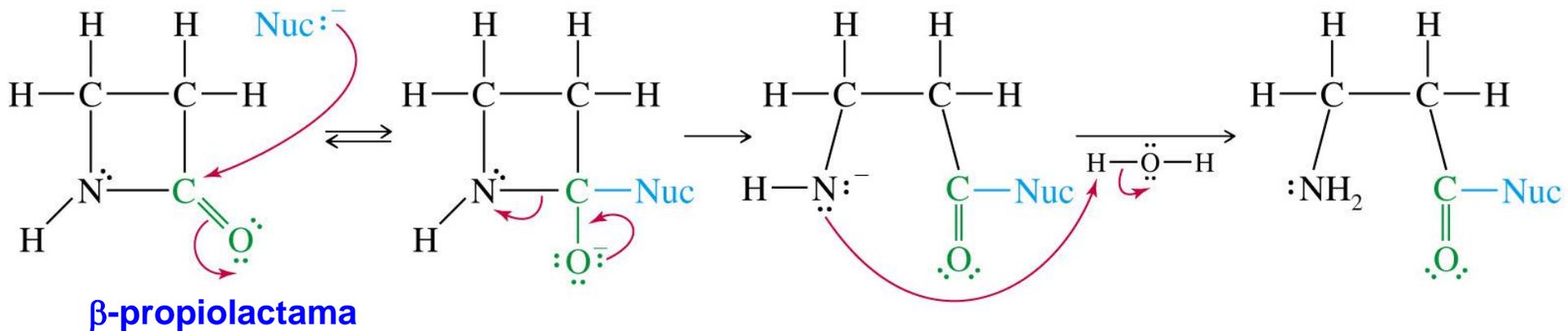
Ácido δ -aminovalérico



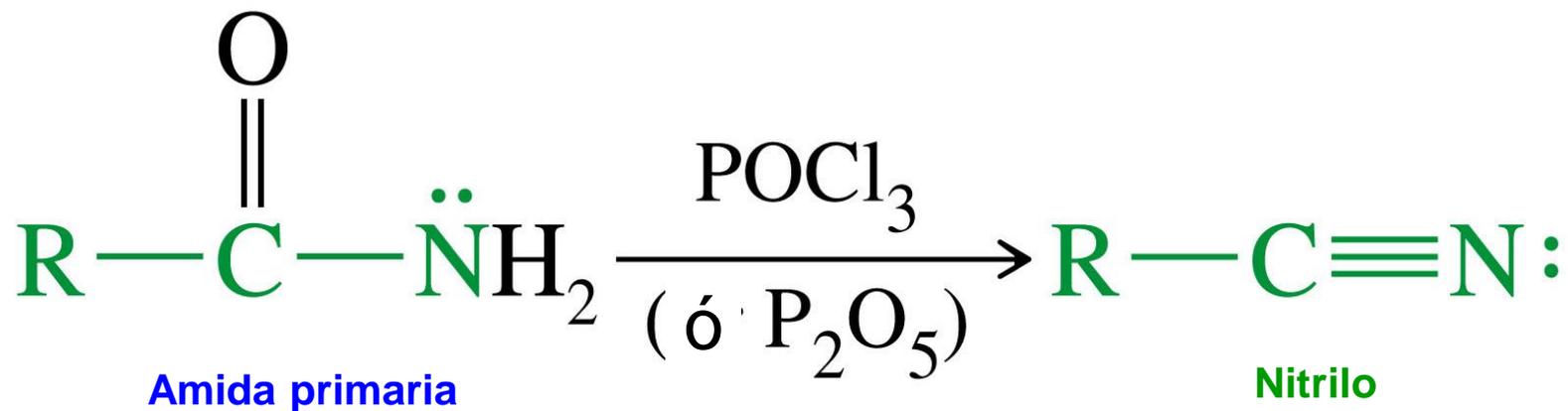
δ -valerolactama



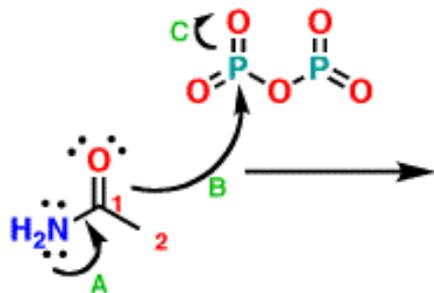
β -lactamas



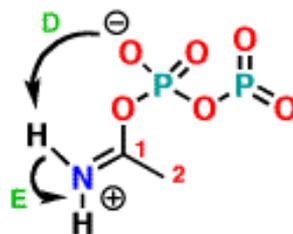
Deshidratación de amidas 1as. Formación de nitrilos



Step 1: 1,2-addition at phosphorus



Step 2: Proton transfer



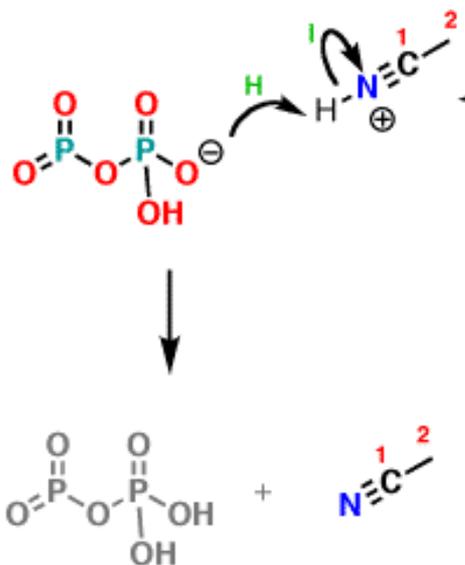
Bonds Formed

- A C₁-N (π)
- B O-P
- D O-H
- F C₁-N (π)
- H O-H

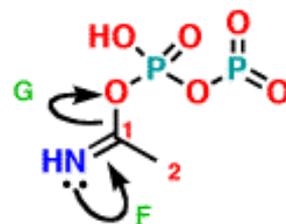
Bonds Broken

- B C₁-O (π)
- C O-P (π)
- E N-H
- G C₁-O
- I H-N

Step 4: Deprotonation

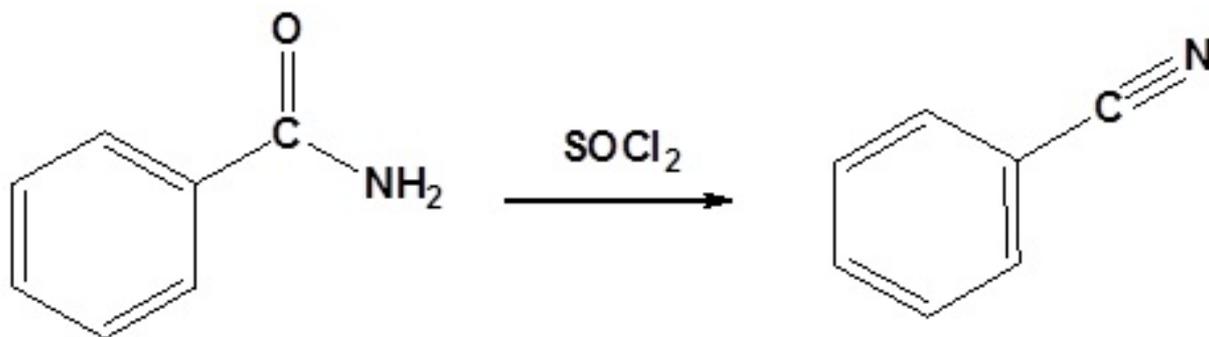
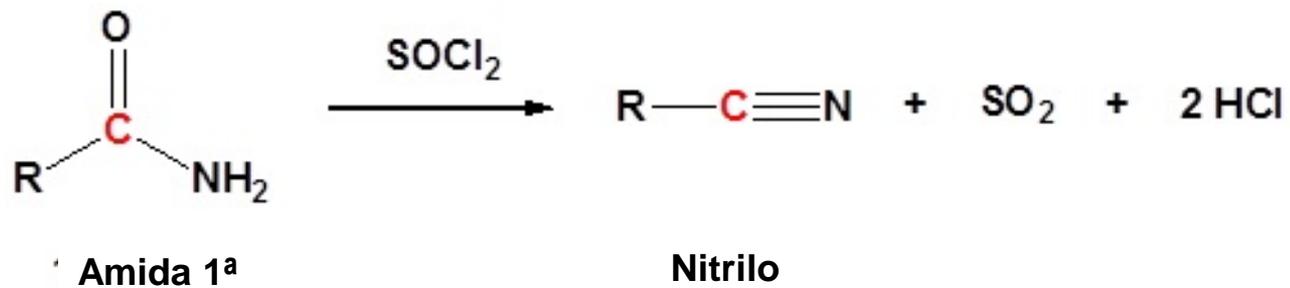


Step 3: 1,2-elimination



<http://www.masterorganicchemistry.com/wp-content/uploads/2012/01/3-mech19.png>

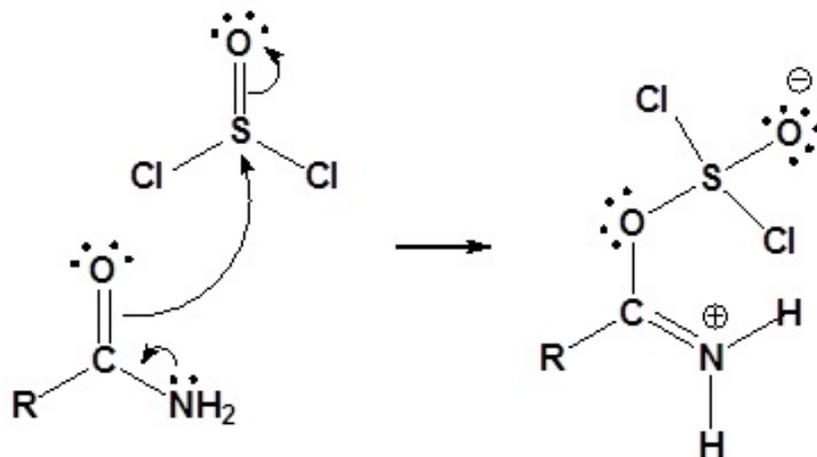




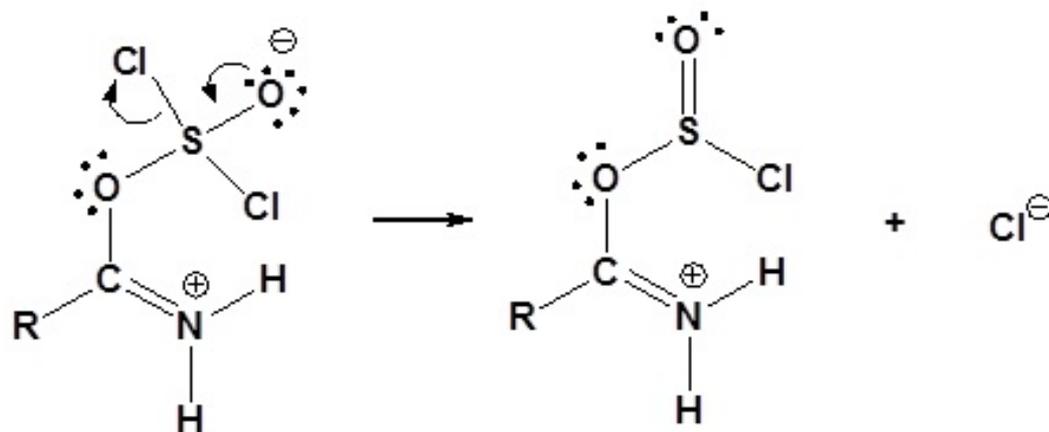
https://chem.libretexts.org/Core/Organic_Chemistry/Amides/Reactivity_of_Amides/1%C2%B0_Amides_can_be_converted_to_Nitriles_with_Thionyl_Chloride



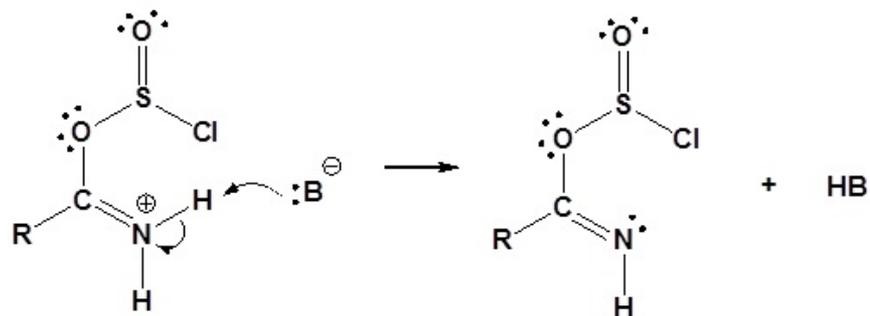
1) Adición del nucleófilo en el cloruro de tionilo



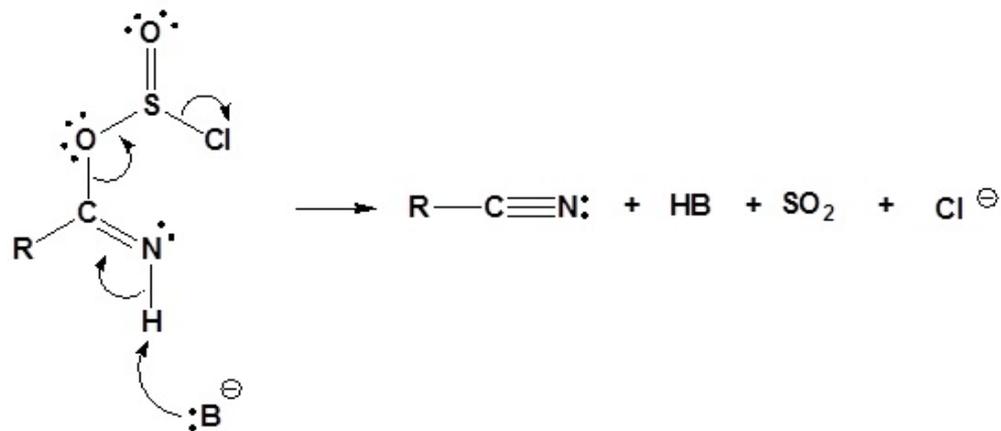
2) Eliminación del grupo saliente

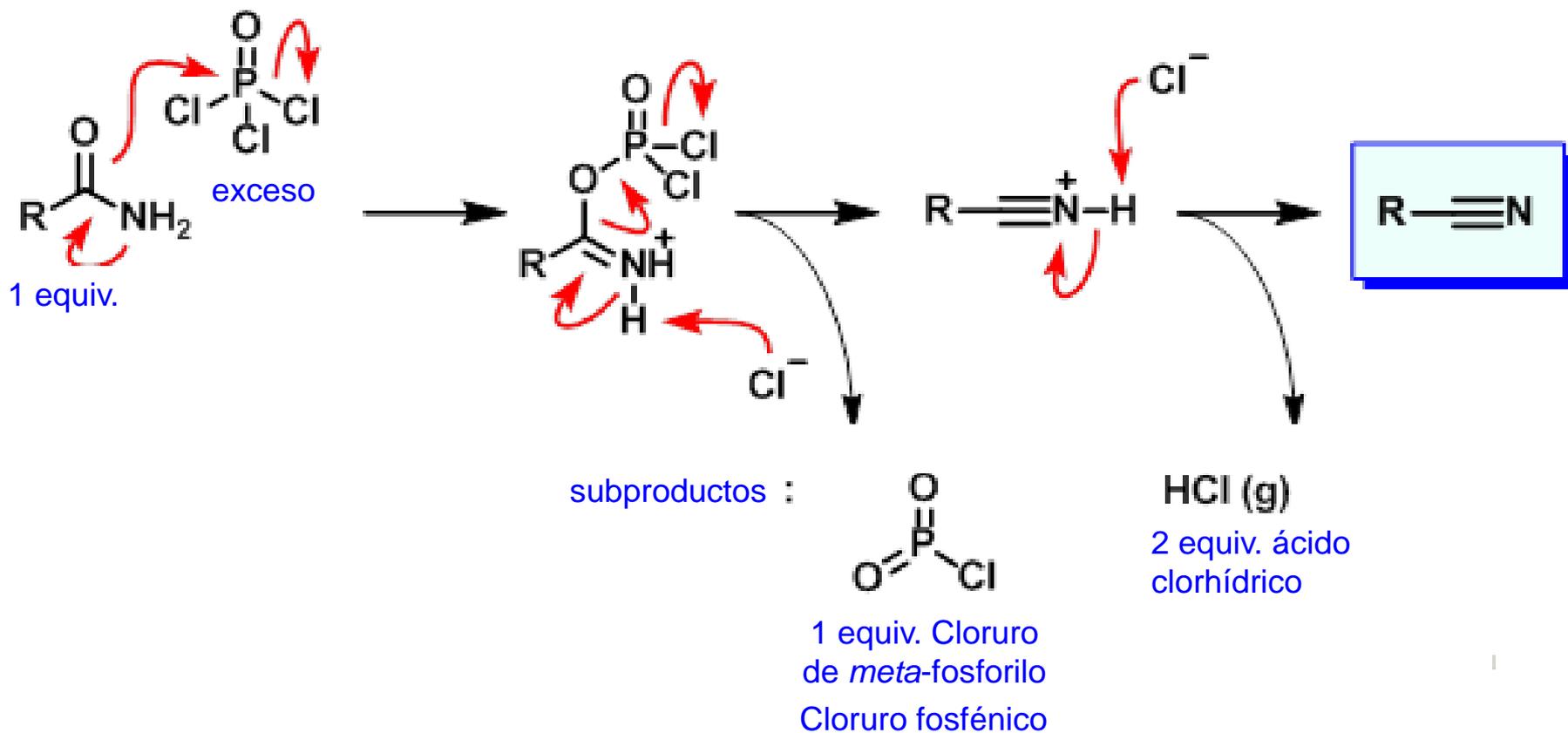


3) Desprotonación



4) Eliminación del grupo saliente

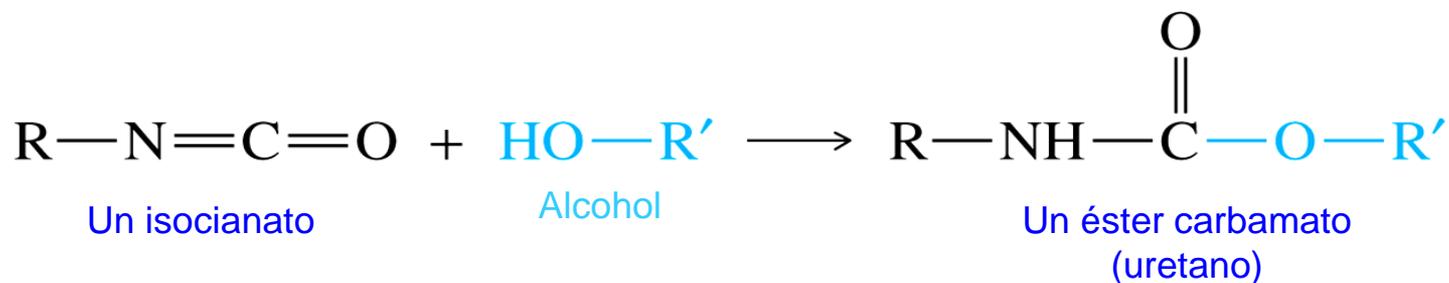




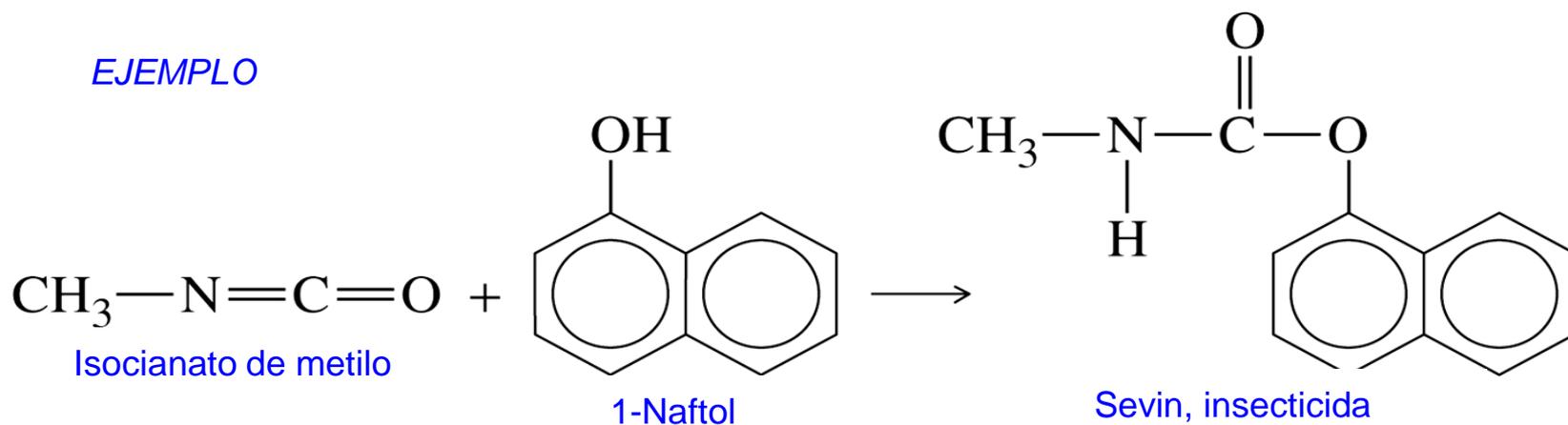
http://www.commonorganicchemistry.com/Rxn_Pages/Amide_to_Nitrile/Amide_to_Nitrile_POCl3_Mech.png



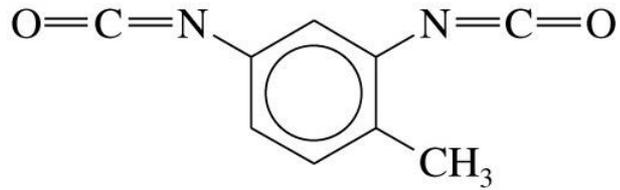
Síntesis de Ésteres Carbamato partir de Isocianatos



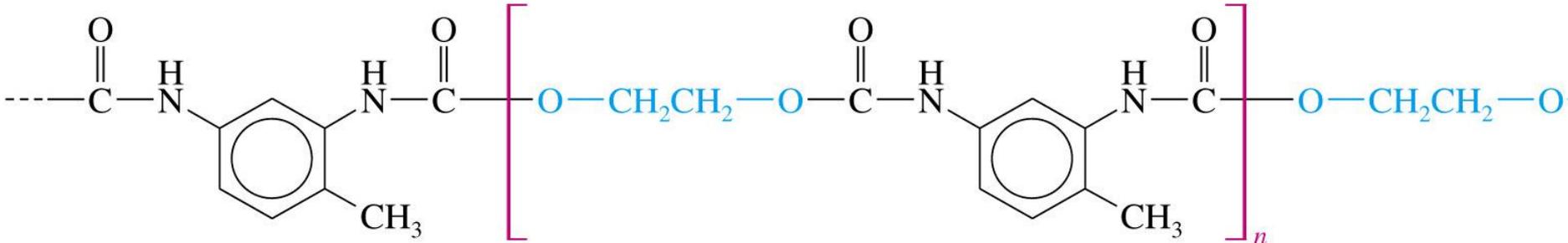
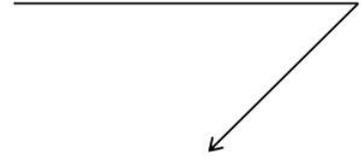
EJEMPLO



Síntesis de Poliuretanos



Diisocianato de tolueno



Un poliuretano

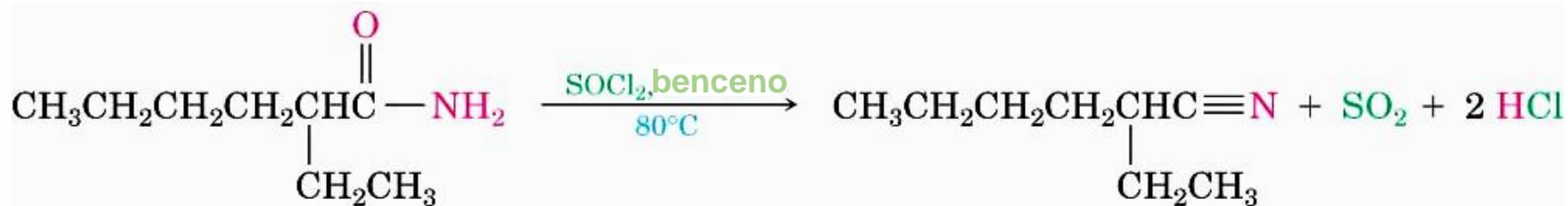


NITRILOS



Preparación de Nitrilos por Deshidratación

- Consiste en la reacción de amidas primarias RCONH_2 con SOCl_2 o POCl_3 (o con otros agentes deshidratantes)
- No esta limitada por el impedimento estérico o a reacciones laterales (e.g. en la reacción de halogenuros de alquilo con NaCN , en donde puede ocurrir una eliminación en lugar de la sustitución)



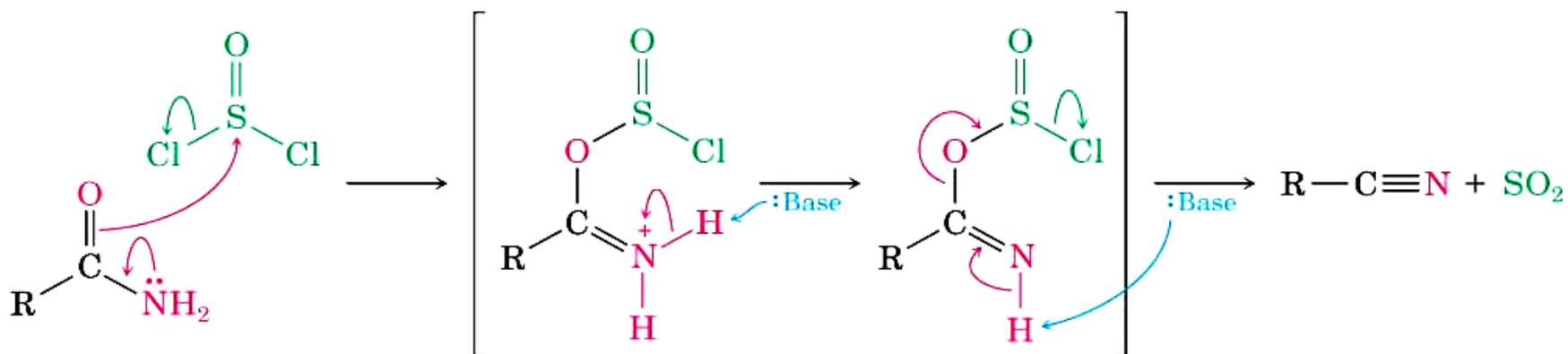
2-Etilhexanamida

2-Etilhexanonitrilo (84%)



Mecanismo de la reacción de Deshidratación de Amidas

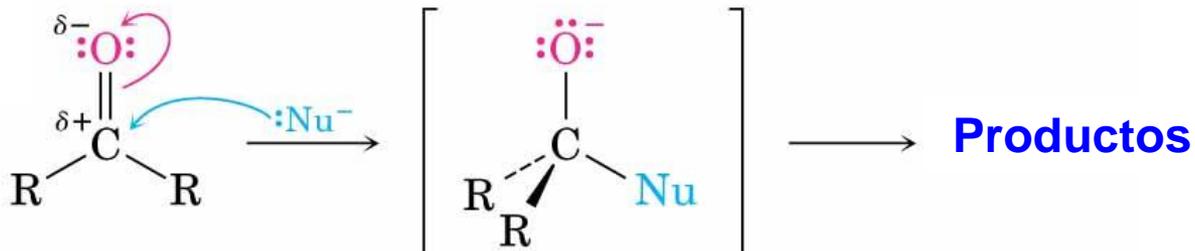
- El átomo nucleofílico de la amida ataca al SOCl_2 y después ocurre un equilibrio ácido-base y posteriormente una eliminación



Reacciones de los Nitrilos

- RC≡N esta fuertemente polarizado con un átomo de carbono electrofílico
- Es atacado por nucleófilos para dar aniones de imina con hibridación sp^2 en forma semejante a los compuestos carbonílicos

Compuesto
carbonílico

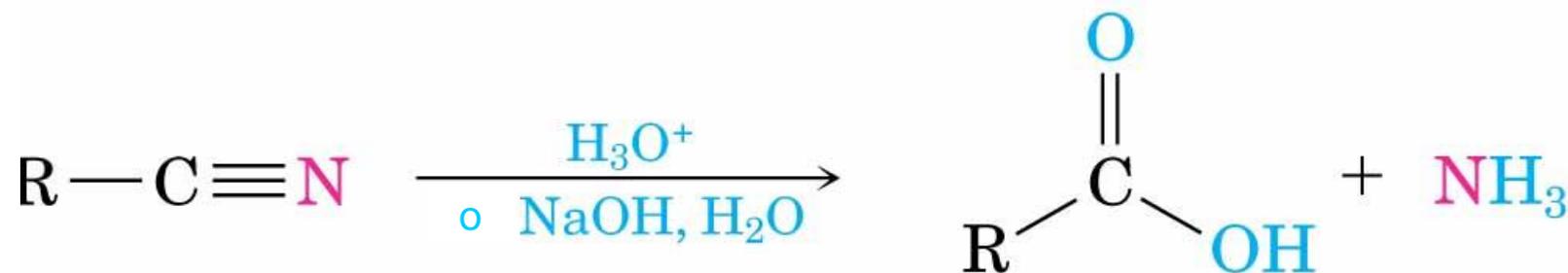


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Hidrolisis: Conversión de los Nitrilos en Ácidos Carboxílicos

- Los Nitrilos son hidrolizados, con catalisis ácida o básica para formar a un ácido carboxílico y amoniaco, o bien a una amida

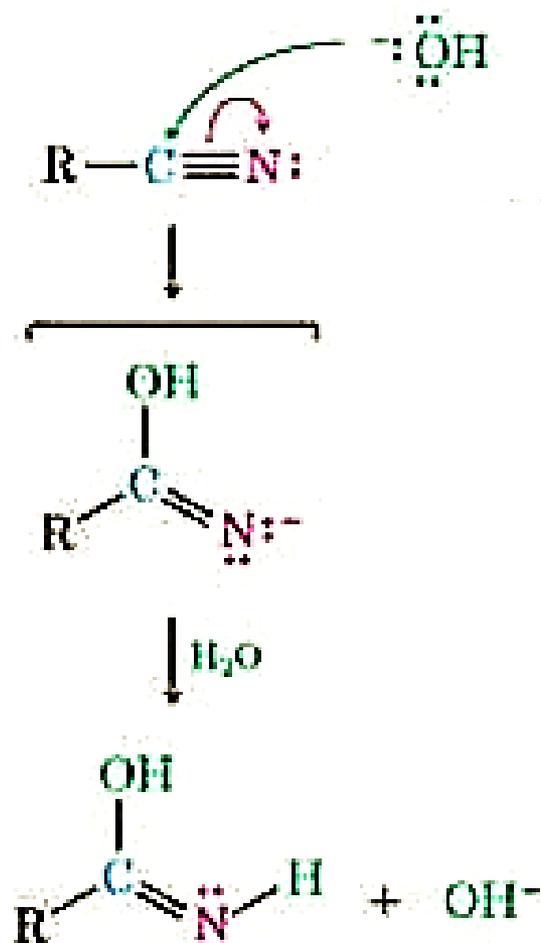


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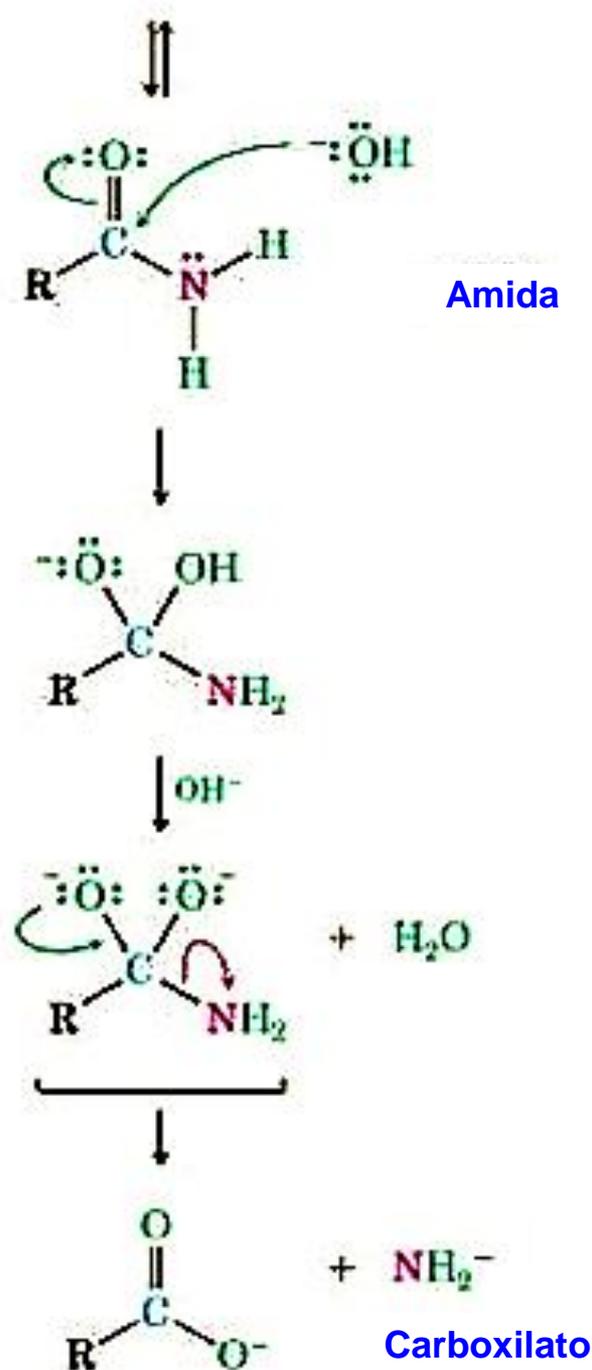


Mecanismo de la Hidrolisis de Nitrilos

- La adición nucleofílica del ion hidróxido al enlace $C\equiv N$
- Una posterior reacción ácido-base da lugar a una hidroximiina (tautomero enol), la cual se tautomeriza a una amida (tautómero ceto).

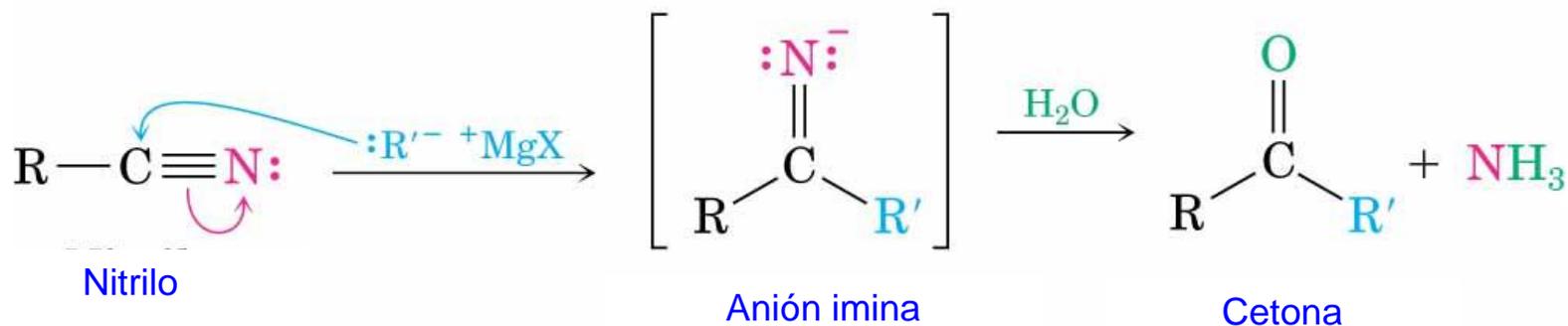


- Una segunda molécula de hidróxido se adiciona al grupo carbonilo de la amida y la pérdida de un protón da un dianión
- La eliminación del anion amiduro (NH_2^-) da lugar al carboxilato



Reacción de los Nitrilos con Reactivos Organometálicos

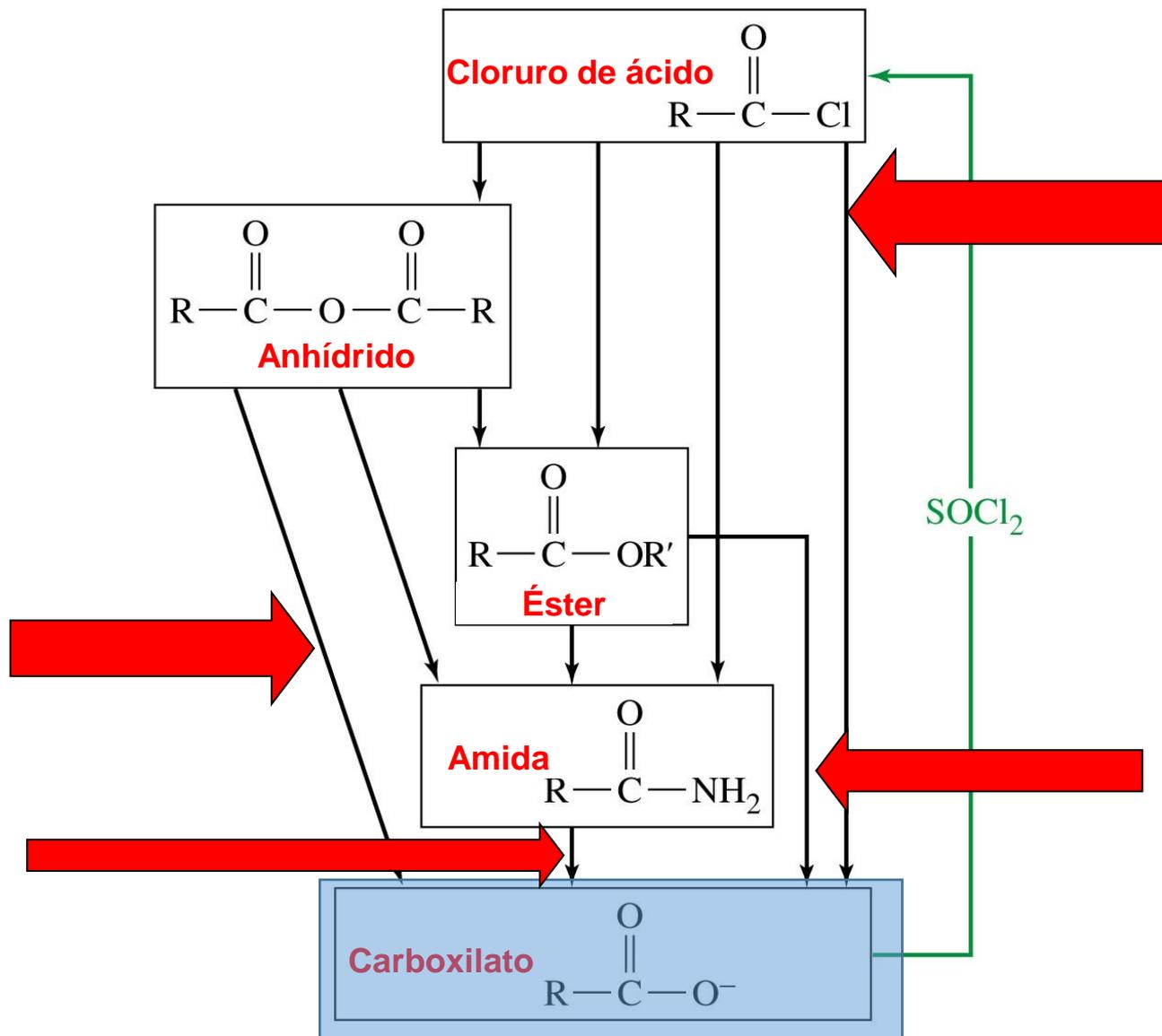
- Los reactivos de Grignard se adicionan a un nitrilo para dar como intermediario un **anión de imina**, el cual es hidrolizado por la adición de agua para dar una **cetona**



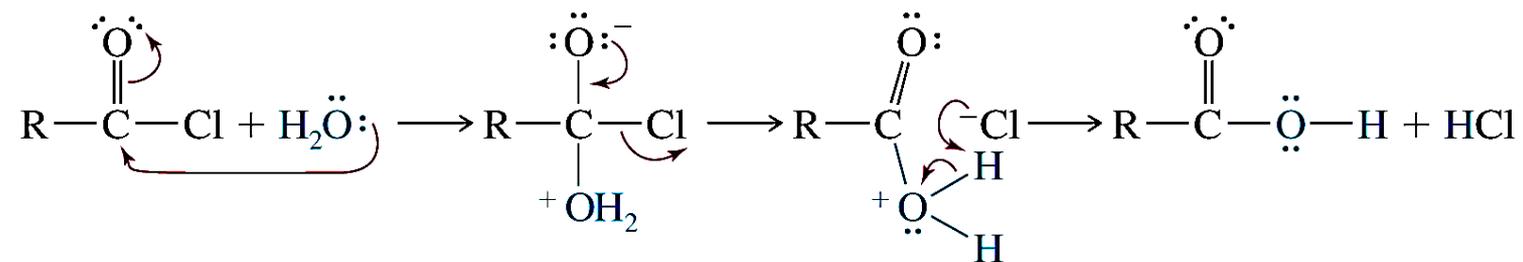
© 2004 Thomson/Brooks Cole



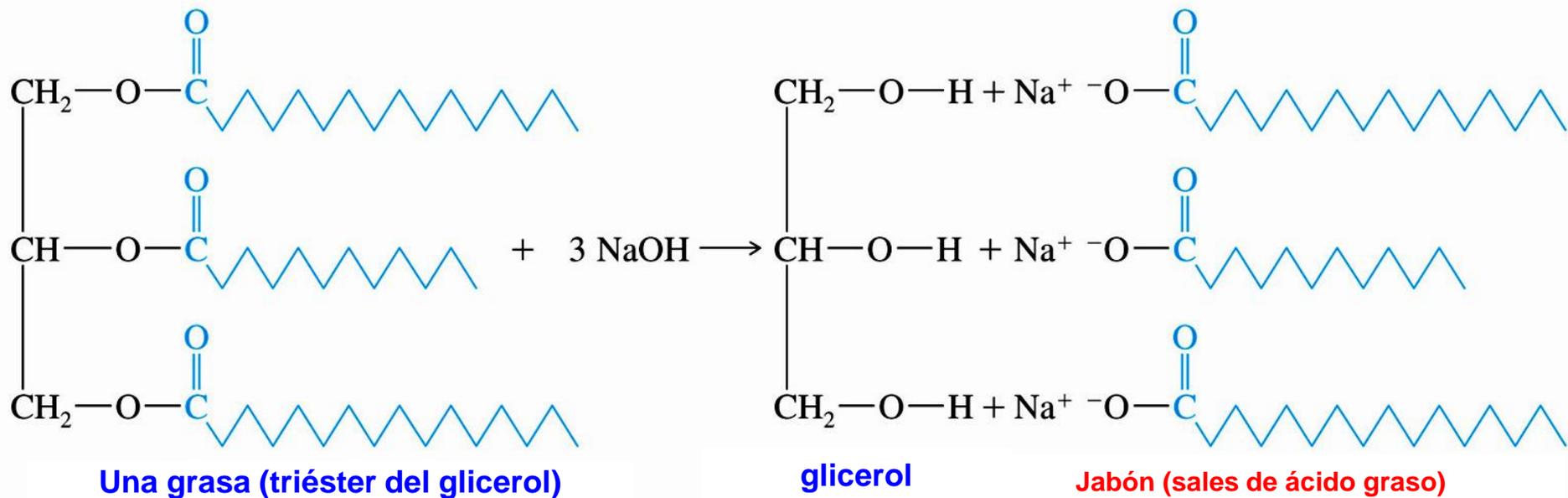
Interconversión de los derivados de ácido



Hidrólisis de Cloruros de ácido

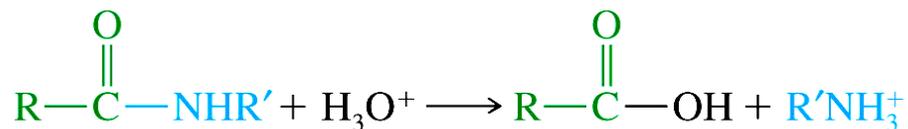


Hidrólisis de ésteres. Saponificación

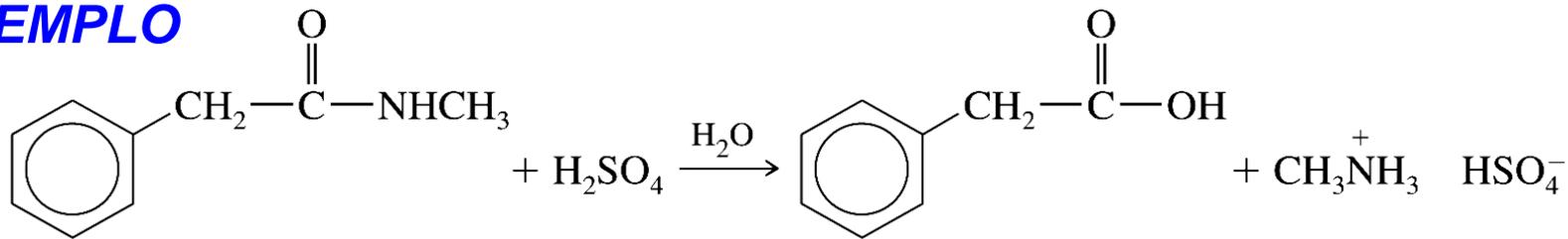


Hidrólisis ácida de amidas

HIDRÓLISIS ÁCIDA



EJEMPLO



N-metil-2-fenilacetamida

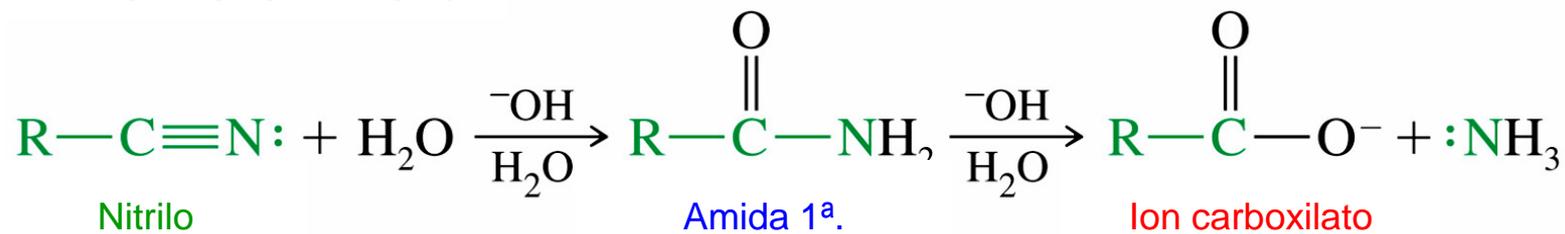
Ácido fenilacético

Bisulfato de
metilamonio

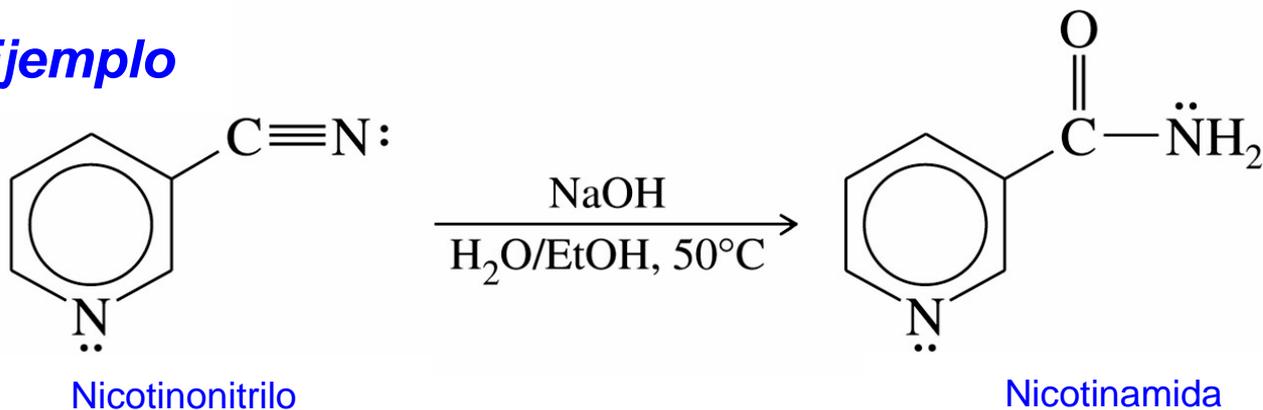


Hidrólisis básica nitrilos

HIDRÓLISIS BÁSICA

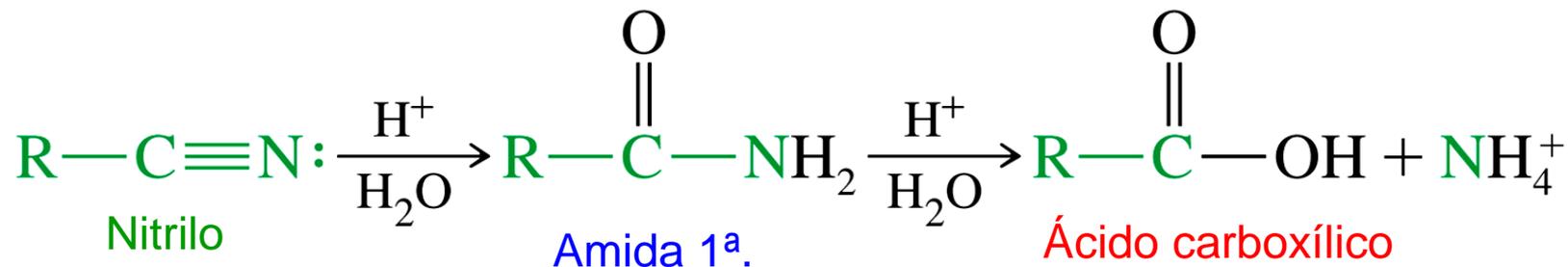


Ejemplo

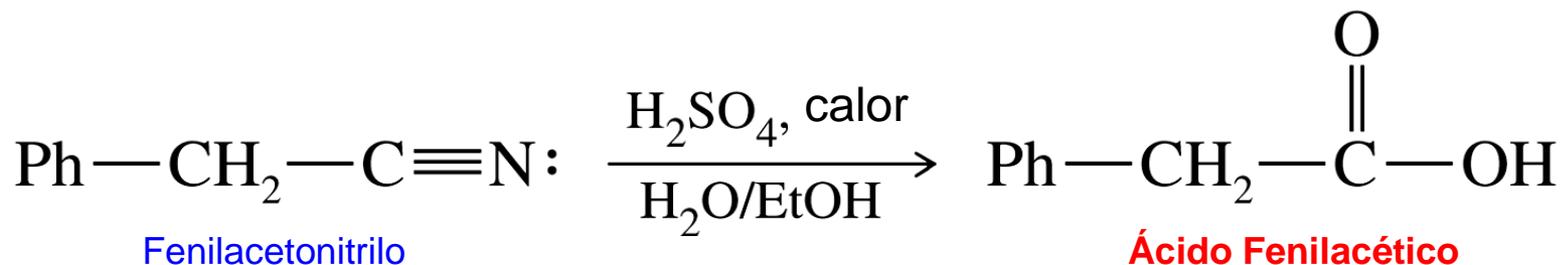


Hidrólisis ácida de nitrilos

HIDRÓLISIS ÁCIDA



Ejemplo



REDUCCIONES DE DERIVADOS DE ÁCIDOS CARBOXÍLICOS



Tabla periódica vista por un químico orgánico



Tabla periódica de los elementos

grupo 1																	18		
1	1.00794 1.012 1.008 H Hidrogeno [1s ¹]																	4.002602 3.972 4.0026 He Helio [1s ²]	
2	6.941 6.94 6.941 Li Litio [1s ² 2s ¹]	9.012182 9.012 9.012 Be Berilio [1s ² 2s ²]																	20.1797 20.18 20.18 Ne Neon [1s ² 2s ² 2p ⁶]
3	22.98976 22.99 22.99 Na Sodio [1s ² 2s ² 2p ⁶ 3s ¹]	24.3050 24.305 24.305 Mg Magnesio [1s ² 2s ² 2p ⁶ 3s ²]																	39.948 39.95 39.95 Ar Argon [1s ² 2s ² 2p ⁶ 3s ² 3p ⁶]
4	39.0983 39.1 39.1 K Potasio [1s ² 4s ¹]	40.078 40.08 40.08 Ca Calcio [1s ² 4s ²]	44.95591 44.96 44.96 Sc Escandio [1s ² 4s ² 3d ¹]	47.867 47.87 47.87 Ti Titanio [1s ² 4s ² 3d ²]	50.9415 50.94 50.94 V Vanadio [1s ² 4s ² 3d ³]	51.9962 51.996 51.996 Cr Cromo [1s ² 4s ¹ 3d ⁵]	54.93804 54.94 54.94 Mn Manganeso [1s ² 4s ² 3d ⁵]	55.845 55.85 55.85 Fe Hierro [1s ² 4s ² 3d ⁶]	58.93319 58.93 58.93 Co Cobalto [1s ² 4s ² 3d ⁷]	58.6934 58.69 58.69 Ni Niquel [1s ² 4s ² 3d ⁸]	63.546 63.55 63.55 Cu Cobre [1s ² 4s ¹ 3d ¹⁰]	65.38 65.38 65.38 Zn Zinc [1s ² 4s ² 3d ¹⁰]	69.723 69.72 69.72 Ga Galio [1s ² 4s ² 4p ¹]	72.64 72.64 72.64 Ge Germanio [1s ² 4s ² 4p ²]	74.92160 74.92 74.92 As Arsenico [1s ² 4s ² 4p ³]	78.96 78.96 78.96 Se Selenio [1s ² 4s ² 4p ⁴]	79.904 79.90 79.90 Br Bromo [1s ² 4s ² 4p ⁵]	83.798 83.80 83.80 Kr Kripton [1s ² 4s ² 4p ⁶]	
5	85.4678 85.47 85.47 Rb Rubidio [1s ² 5s ¹]	87.62 87.62 87.62 Sr Estroncio [1s ² 5s ²]	88.90585 88.91 88.91 Y Itrio [1s ² 5s ² 4d ¹]	91.224 91.22 91.22 Zr Zirconio [1s ² 5s ² 4d ²]	92.90638 92.91 92.91 Nb Niobio [1s ² 5s ¹ 4d ⁴]	95.96 95.96 95.96 Mo Molibdeno [1s ² 5s ¹ 4d ⁵]	(98) 98 98 Tc Tecnecio [1s ² 5s ¹ 4d ⁶]	101.07 101.07 101.07 Ru Rutenio [1s ² 5s ¹ 4d ⁷]	102.9055 102.91 102.91 Rh Rodio [1s ² 5s ¹ 4d ⁸]	106.42 106.42 106.42 Pd Paladio [1s ² 5s ¹ 4d ¹⁰]	107.8682 107.87 107.87 Ag Plata [1s ² 5s ¹ 4d ¹⁰]	112.41 112.41 112.41 Cd Cadmio [1s ² 5s ² 4d ¹⁰]	114.818 114.82 114.82 In Indio [1s ² 5s ² 5p ¹]	118.710 118.71 118.71 Sn Estaño [1s ² 5s ² 5p ²]	121.760 121.76 121.76 Sb Antimonio [1s ² 5s ² 5p ³]	127.60 127.60 127.60 Te Telurio [1s ² 5s ² 5p ⁴]	126.9044 126.90 126.90 I Yodo [1s ² 5s ² 5p ⁵]	131.293 131.29 131.29 Xe Xenon [1s ² 5s ² 5p ⁶]	
6	132.9054 132.91 132.91 Cs Cesio [1s ² 6s ¹]	137.327 137.33 137.33 Ba Bario [1s ² 6s ²]	174.9668 174.97 174.97 Lu Lutecio [1s ² 6s ² 4f ¹⁴]	178.49 178.49 178.49 Hf Hafnio [1s ² 6s ² 4f ¹⁴]	180.9478 180.95 180.95 Ta Tantalio [1s ² 6s ² 4f ¹⁴]	183.84 183.84 183.84 W Wolframio [1s ² 6s ² 4f ¹⁴]	186.207 186.21 186.21 Re Renio [1s ² 6s ¹ 4f ¹⁴]	190.23 190.23 190.23 Os Osmio [1s ² 6s ¹ 4f ¹⁴]	192.217 192.22 192.22 Ir Iridio [1s ² 6s ¹ 4f ¹⁴]	195.084 195.08 195.08 Pt Platino [1s ² 6s ¹ 4f ¹⁴]	196.9665 196.97 196.97 Au Oro [1s ² 6s ¹ 4f ¹⁴]	200.59 200.59 200.59 Hg Mercurio [1s ² 6s ² 4f ¹⁴]	204.3833 204.38 204.38 Tl Talio [1s ² 6s ² 6p ¹]	207.2 207.2 207.2 Pb Plomo [1s ² 6s ² 6p ²]	208.9804 208.98 208.98 Bi Bismuto [1s ² 6s ² 6p ³]	(210) 210 210 Po Polonio [1s ² 6s ² 6p ⁴]	(210) 210 210 At Astatido [1s ² 6s ² 6p ⁵]	(220) 220 220 Rn Radon [1s ² 6s ² 6p ⁶]	
7	(223) 223 223 Fr Francio [1s ² 7s ¹]	(226) 226 226 Ra Radio [1s ² 7s ²]	(262) 262 262 Lr Lawrencio [1s ² 7s ² 5f ¹⁴]	(261) 261 261 Rf Rutherfordio [1s ² 7s ² 5f ¹⁴]	(262) 262 262 Db Dubnio [1s ² 7s ² 5f ¹⁴]	(266) 266 266 Sg Seaborgio [1s ² 7s ² 5f ¹⁴]	(264) 264 264 Bh Bohrio [1s ² 7s ² 5f ¹⁴]	(277) 277 277 Hs Hassio [1s ² 7s ² 5f ¹⁴]	(268) 268 268 Mt Meitnerio [1s ² 7s ² 5f ¹⁴]	(271) 271 271 Ds Darmstadtio [1s ² 7s ² 5f ¹⁴]	(272) 272 272 Rg Roentgenio [1s ² 7s ² 5f ¹⁴]	(285) 285 285 Cn Copernicio [1s ² 7s ² 5f ¹⁴]	(284) 284 284 Uut Ununtrio [1s ² 7s ² 7p ¹]	(289) 289 289 Fl Flerovio [1s ² 7s ² 7p ²]	(288) 288 288 Uup Ununpentio [1s ² 7s ² 7p ³]	(292) 292 292 Lv Livermorio [1s ² 7s ² 7p ⁴]	(294) 294 294 Uus Ununseptio [1s ² 7s ² 7p ⁵]	(294) 294 294 Uuo Ununoctio [1s ² 7s ² 7p ⁶]	

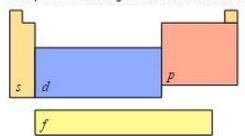
masa atómica o número másico del isótopo más estable
 1.ª energía de ionización en kJ/mol
 símbolo químico
 nombre
 configuración electrónica

55.845
 762.5
Fe
 Hierro
 [Ar] 3d⁶ 4s²

26
 número atómico
 electronegatividad
 estados de oxidación más comunes están en negra

- metales alcalinos
- alcalinotérreos
- otros metales
- metales de transición
- lantánidos
- actínidos
- metaloideos
- no metales
- halógenos
- gases nobles
- elementos desconocidos
- masas de elementos radiactivos entre paréntesis

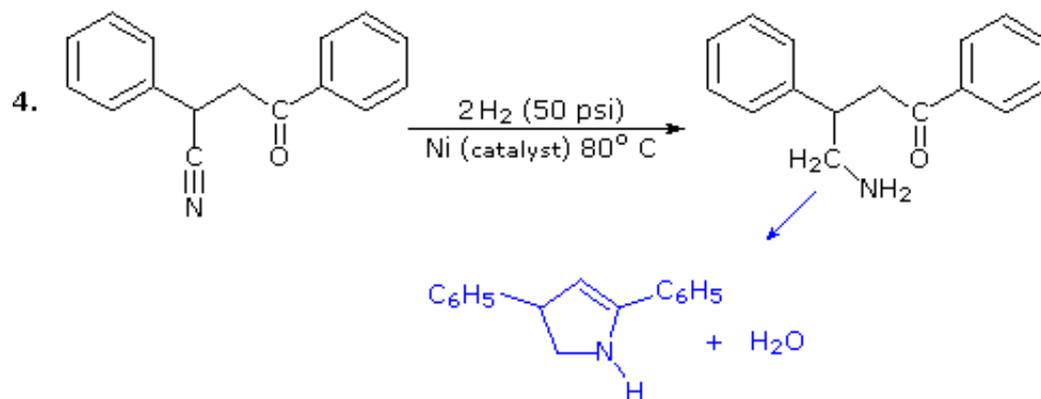
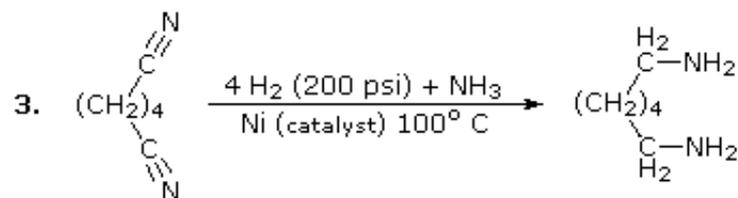
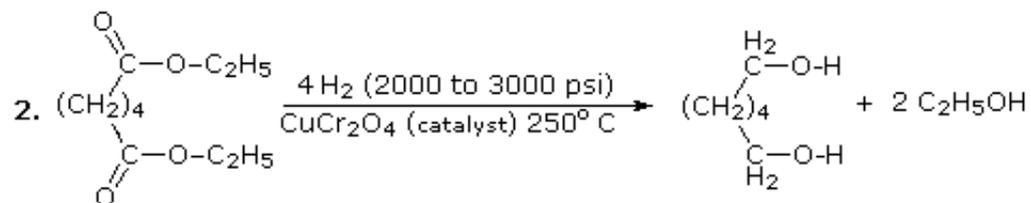
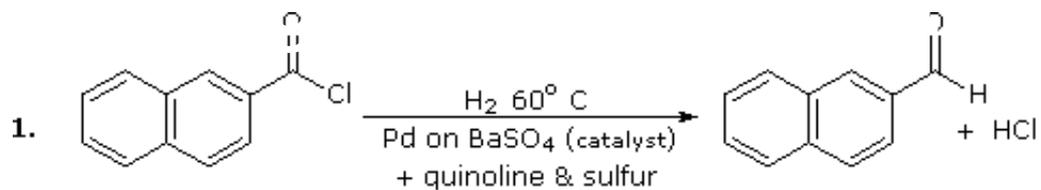
bloques de configuración electrónica

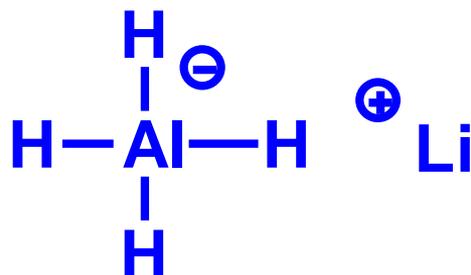


- notas
- por ahora, los elementos 113, 115, 117 y 118 no tienen nombre oficial designado por la IUPAC.
 - 1 kJ/mol ≈ 96.485 eV.
 - todos los elementos tienen un estado de oxidación

138.9054 138.91 138.91 La Lantano [1s ² 5d ¹]	140.116 140.12 140.12 Ce Cerio [1s ² 5d ¹]	140.9076 140.91 140.91 Pr Prasodimio [1s ² 5d ¹]	144.242 144.24 144.24 Nd Neodimio [1s ² 5d ¹]	(145) 145 145 Pm Prometio [1s ² 5d ¹]	150.36 150.36 150.36 Sm Samario [1s ² 5d ¹]	151.964 151.96 151.96 Eu Europio [1s ² 5d ¹]	157.25 157.25 157.25 Gd Gadolinio [1s ² 5d ¹]	158.9253 158.93 158.93 Tb Terbio [1s ² 5d ¹]	162.500 162.50 162.50 Dy Disprósio [1s ² 5d ¹]	164.9303 164.93 164.93 Ho Holmio [1s ² 5d ¹]	167.259 167.26 167.26 Er Erbio [1s ² 5d ¹]	168.9342 168.93 168.93 Tm Tulio [1s ² 5d ¹]	173.054 173.05 173.05 Yb Iterbio [1s ² 5d ¹]
(227) 227 227 Ac Actinio [1s ² 6d ¹]	232.0380 232.04 232.04 Th Torio [1s ² 6d ¹]	231.0358 231.04 231.04 Pa Protactinio [1s ² 6d ¹]	238.0289 238.03 238.03 U Uranio [1s ² 6d ¹]	(237) 237 237 Np Neptunio [1s ² 6d ¹]	(244) 244 244 Pu Plutonio [1s ² 6d ¹]	(243) 243 243 Am Americio [1s ² 6d ¹]	(247) 247 247 Cm Curio [1s ² 6d ¹]	(247) 247 247 Bk Berkelio [1s ² 6d ¹]	(251) 251 251 Cf Californio [1s ² 6d ¹]	(252) 252 252 Es Einstenio [1s ² 6d ¹]	(257) 257 257 Fm Fermio [1s ² 6d ¹]	(258) 258 258 Md Mendelevio [1s ² 6d ¹]	(259) 259 259 No Nobelio [1s ² 6d ¹]





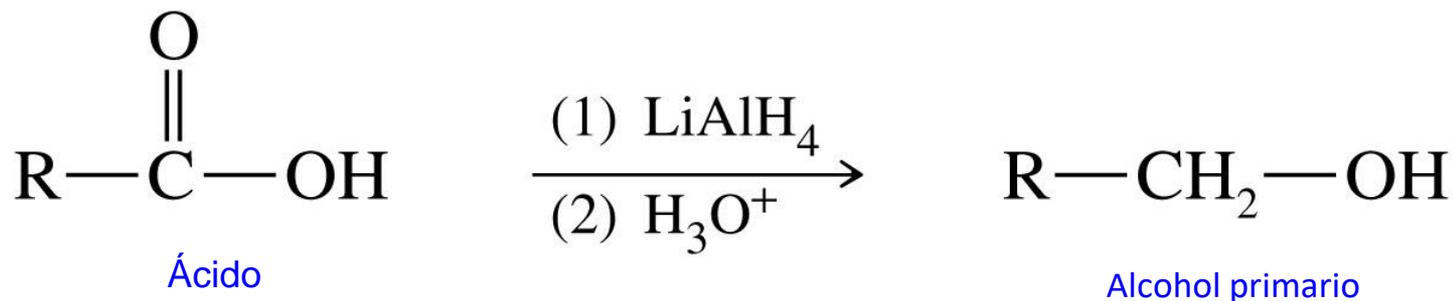


HIDRURO DOBLE DE LITIO Y ALUMINIO

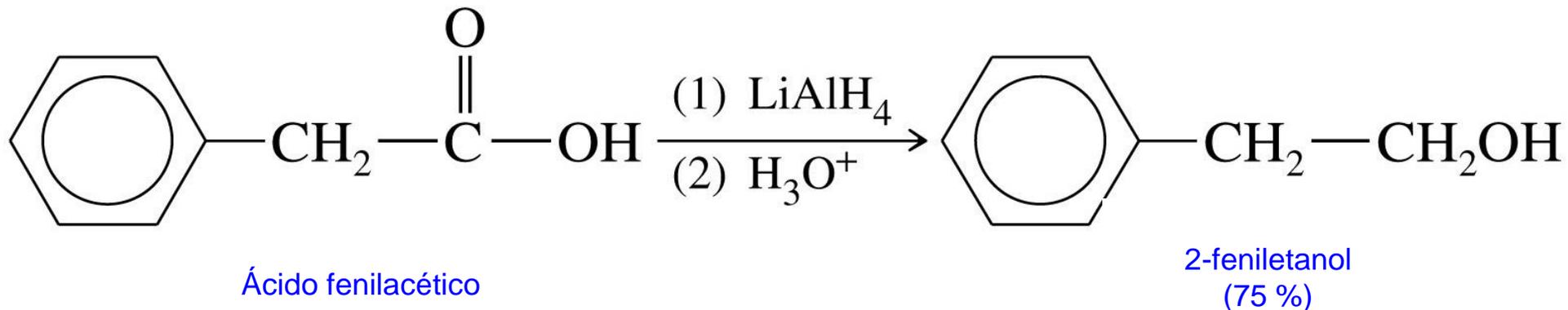


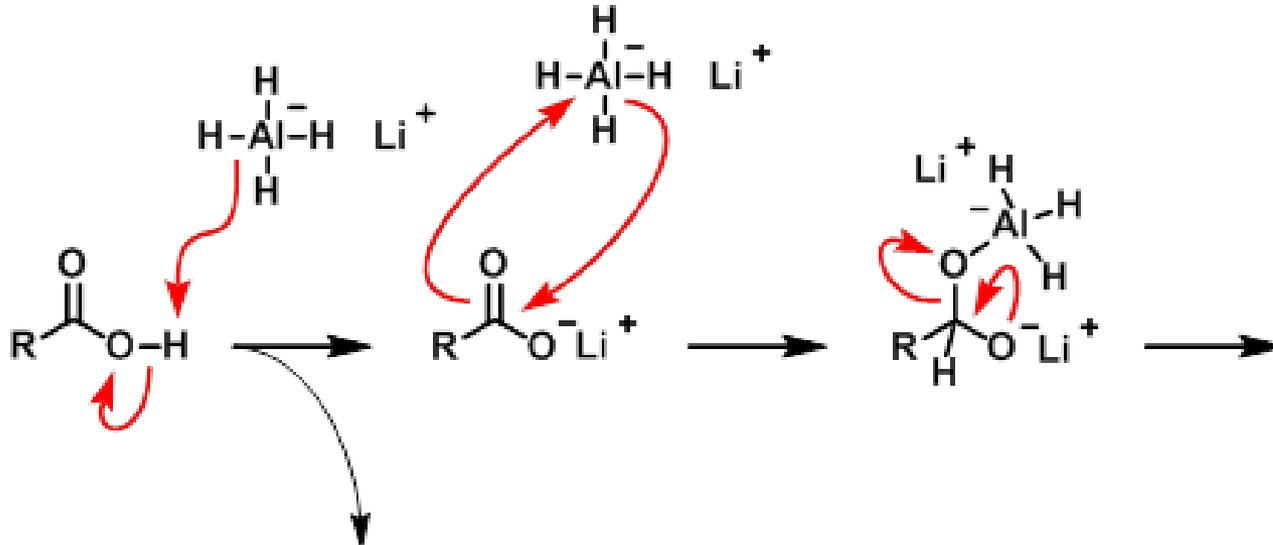
Reducción de Ácidos Carboxílicos con Hidruro de litio y aluminio

Este reactivo es el agente reductor más **democrático**, reduce por igual a grupos funcionales oxidados)

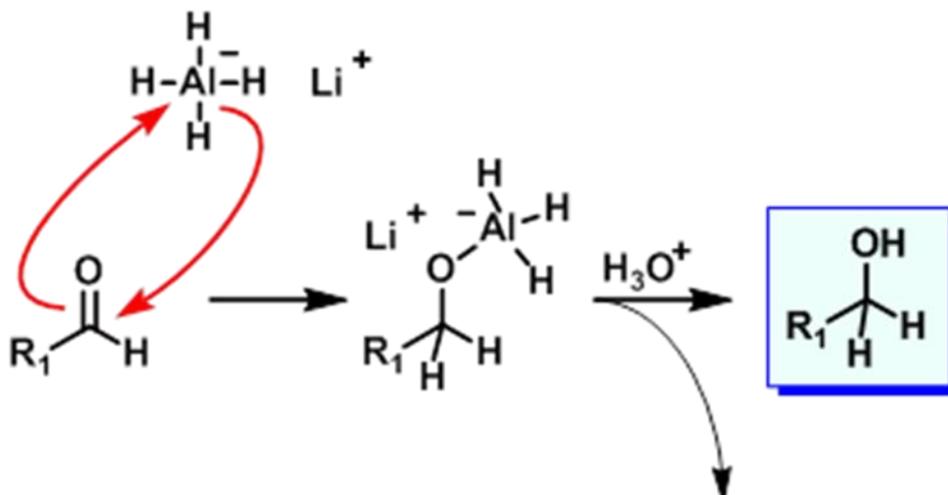


Ejemplo





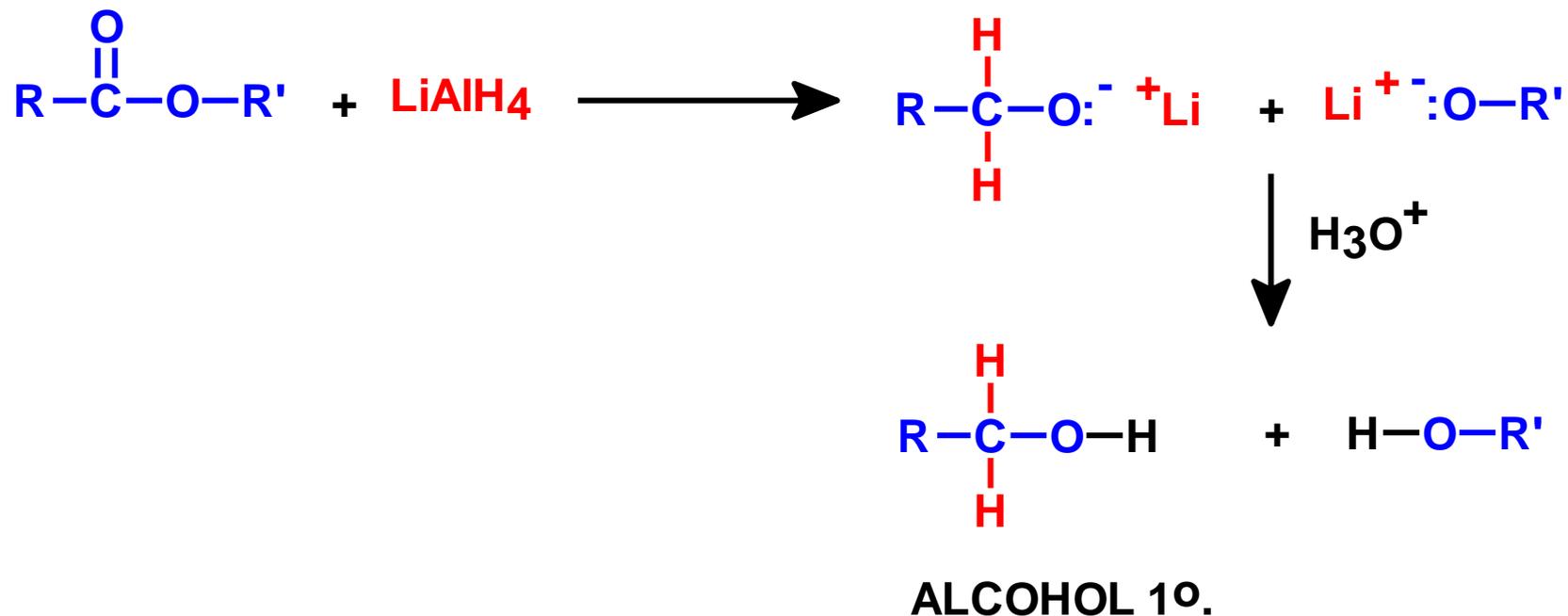
Subproducto:
H₂ (1 equivalente)



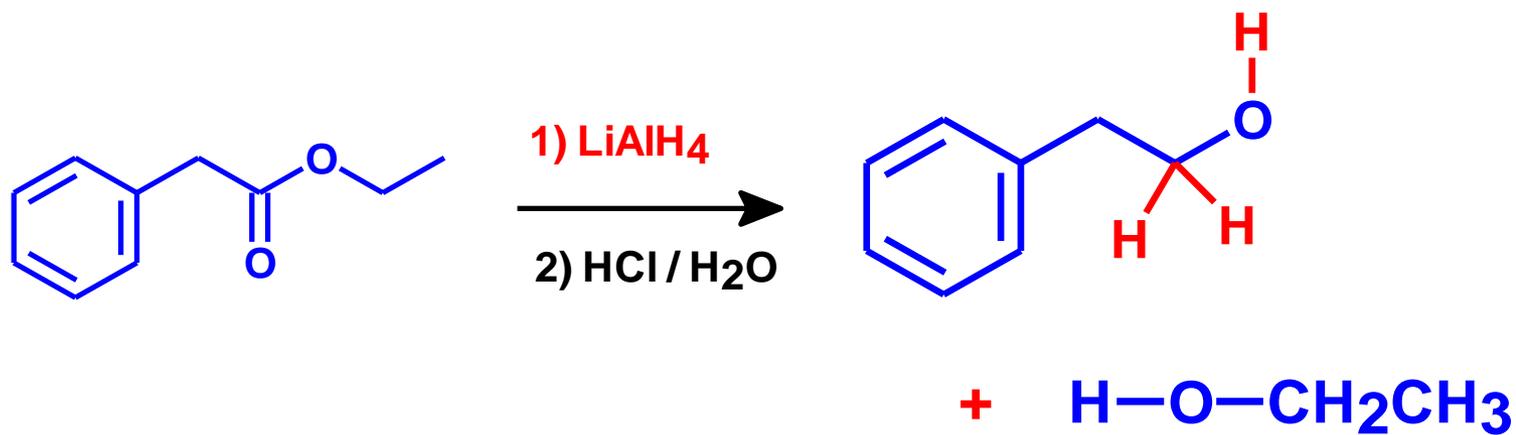
Subproducto: Al(OH)₃
1 equivalente, sales de aluminio



Reducción de Ésteres a Alcoholes primarios

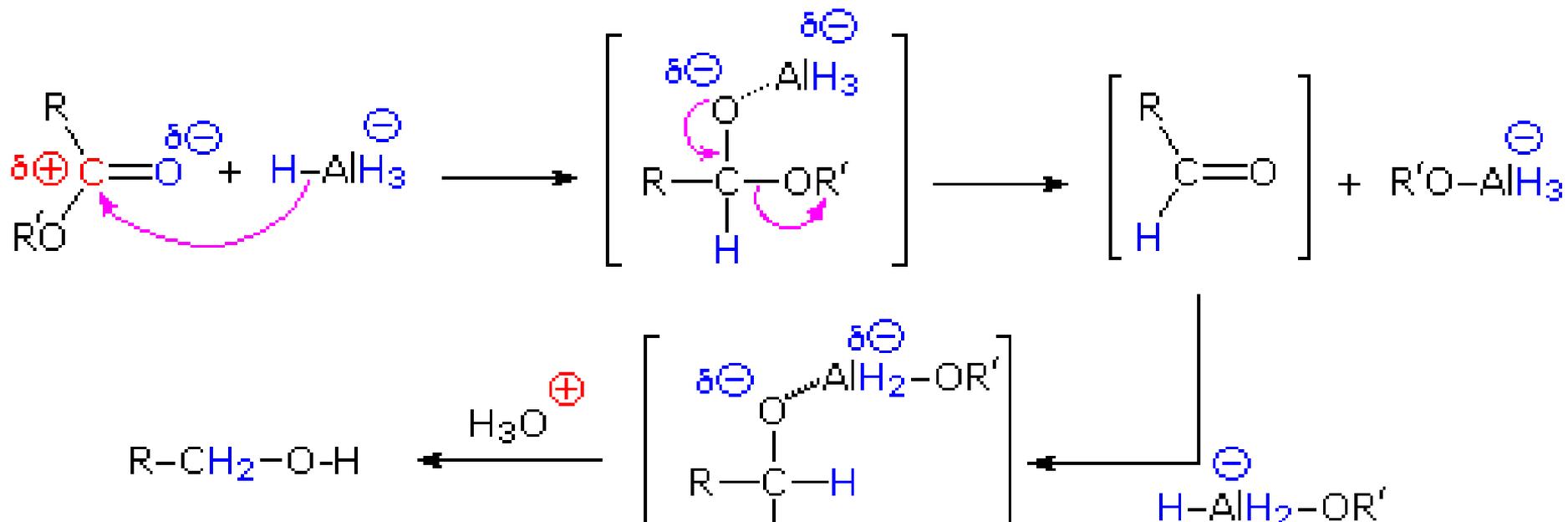


Reducción de Ésteres



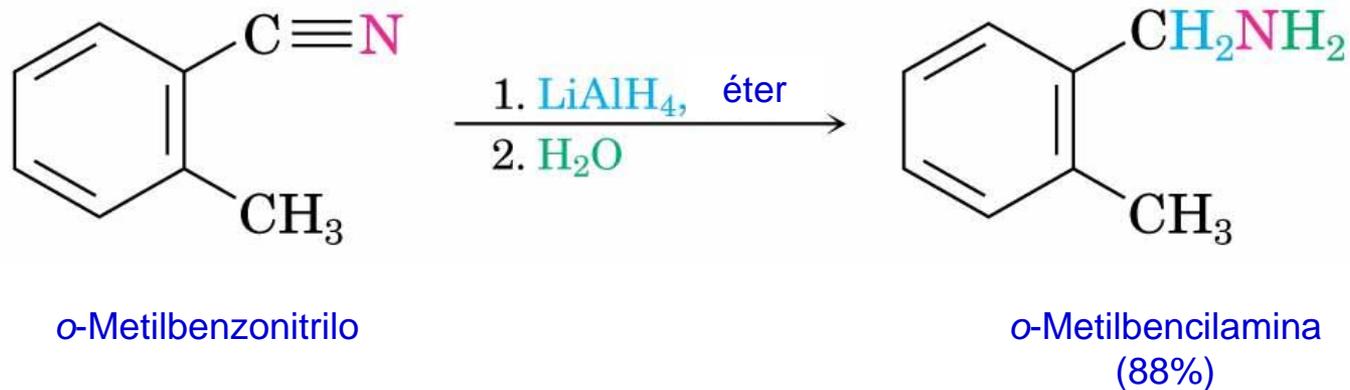
Mecanismo de la reducción con LiAlH_4

Reducción de Ésteres ó Ácidos



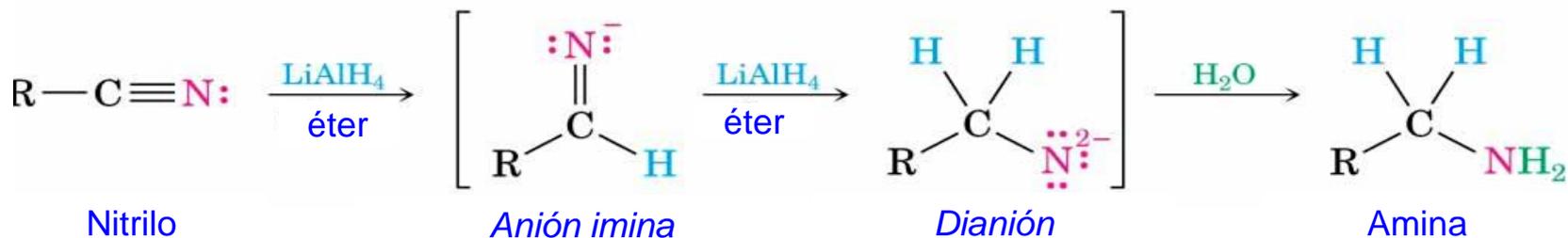
Reducción de Nitrilos

- La reducción de un nitrilo con LiAlH_4 da lugar a una amina primaria

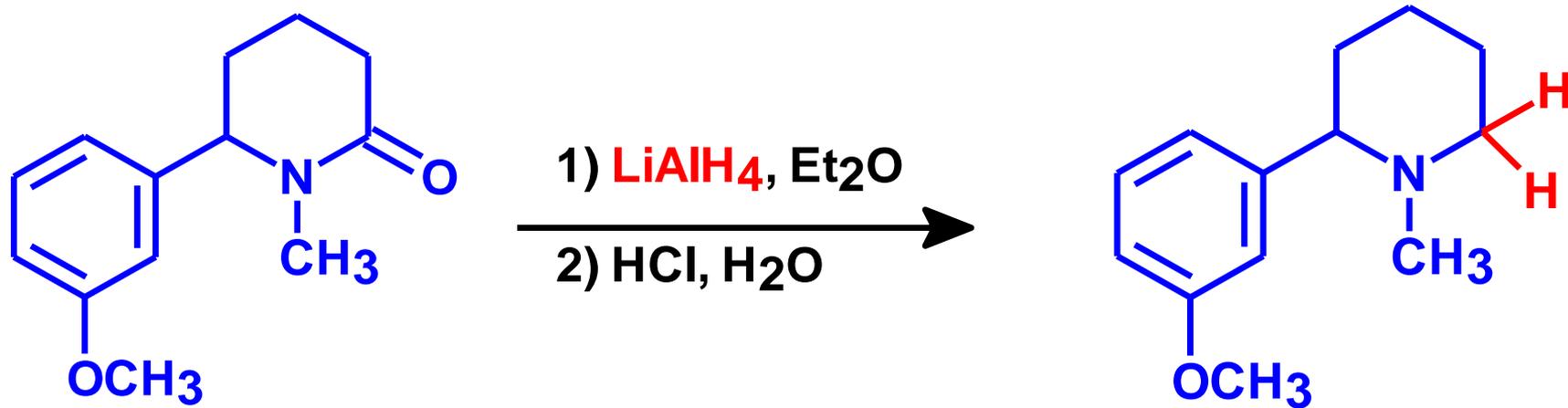


Mecanismo de la Reducción de R-C≡N

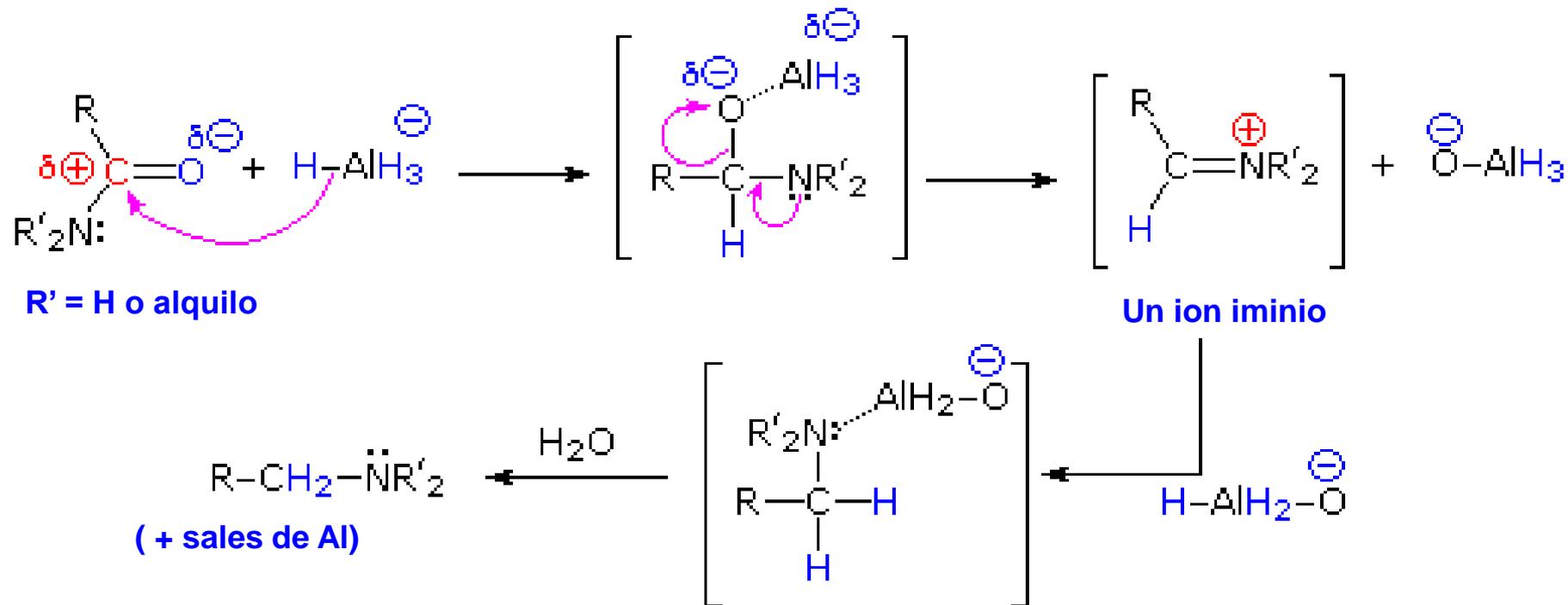
- La adición Nucleofílica del ion hidruro al enlace polar C≡N, da lugar a un anión *imina*
- El enlace C=N del anión *imina* sufre una segunda adición nucleofílica del ion hidruro para dar lugar a un *dianión*, el cual es protonado por el agua:



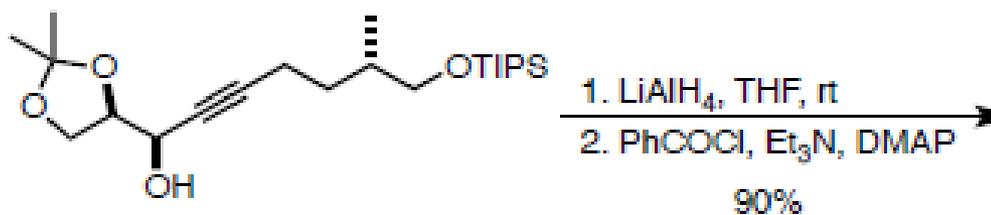
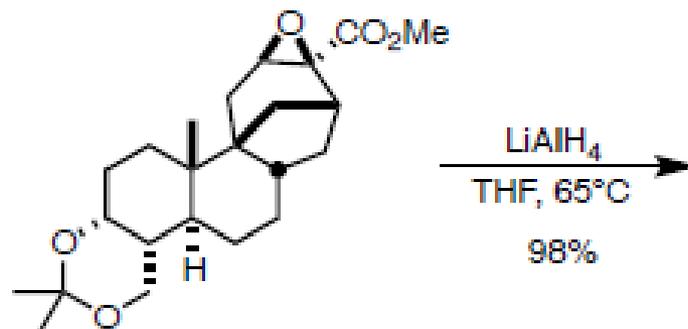
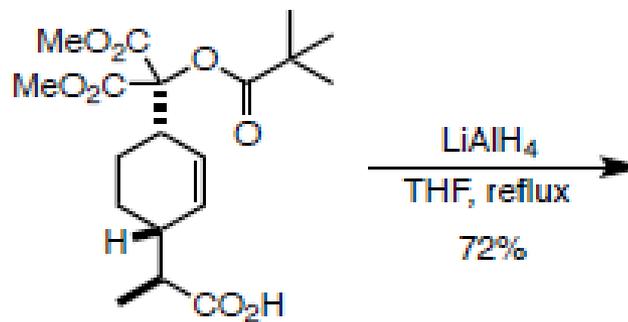
Reducción de Amidas



Reducción de Amidas



Ejemplos



Substrates, Reduction Products

	<u>Iminium Ion</u>	<u>Acid Halide</u>	<u>Aldehyde</u>	<u>Ester</u>	<u>Amide</u>	<u>Carboxylate Salt</u>
Hydride Donors						
LiAlH ₄	Amine	Alcohol	Alcohol	Alcohol	Amine	Alcohol
DIBAL	-	Alcohol	Alcohol	Alcohol or Aldehyde	Amine or Aldehyde	Alcohol
NaAlH(O-t-Bu) ₃	-	Aldehyde	Alcohol	Alcohol (slow)	Amine (slow)	-
AlH ₃	-	Alcohol	Alcohol	Alcohol	Amine	Alcohol
NaBH ₄	Amine	-	Alcohol	-	-	-
NaCNBH ₃	Amine	-	Alcohol (slow)	- **	-	-
Na(AcO) ₃ BH	Amine	-	Alcohol (slow)	Alcohol (slow)	Amine (slow)	-
B ₂ H ₆	-	-	Alcohol	Alcohol (slow)	Amine (slow)	Alcohol
Li(Et) ₃ BH	-	Alcohol	Alcohol	Alcohol	Alcohol (tertiary amide)	-
H ₂ (catalyst)	Amine	Alcohol	Alcohol	Alcohol	Amine	-
LAB	-	-	Alcohol	Alcohol	Alcohol	-

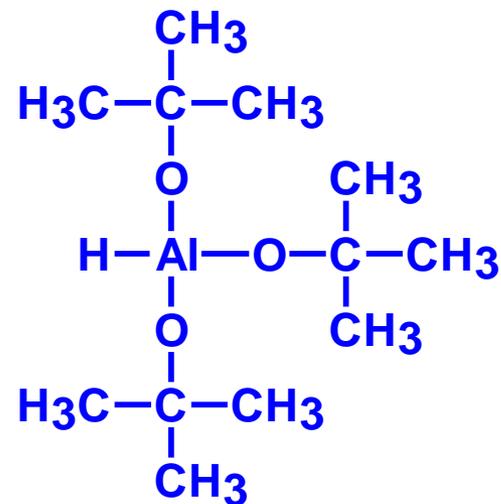
** α-alkoxy esters are reduced to the corresponding alcohols.

- indicates no reaction or no productive reaction (alcohols are deprotonated in many instances,

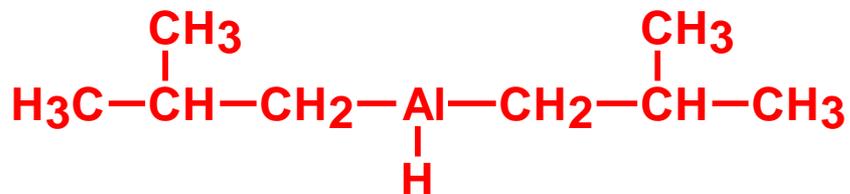


REDUCCIONES SELECTIVAS FORMACIÓN DE ALDEHÍDOS





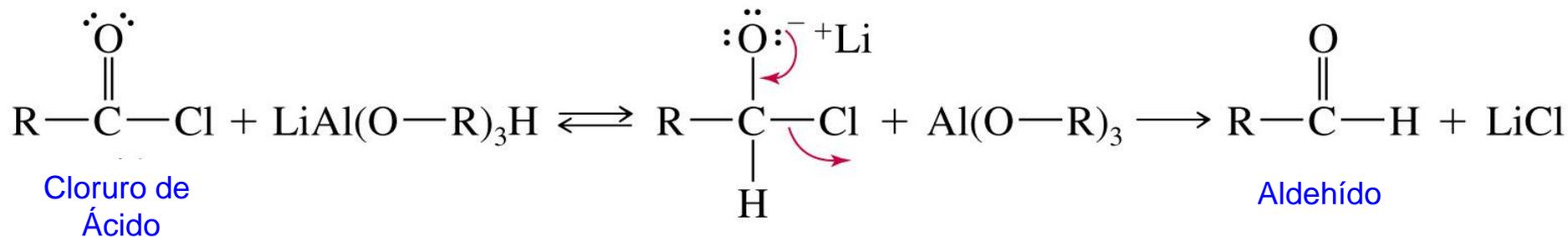
TRITERBUTOXIHDRURO DE LITIO Y ALUMINIO:



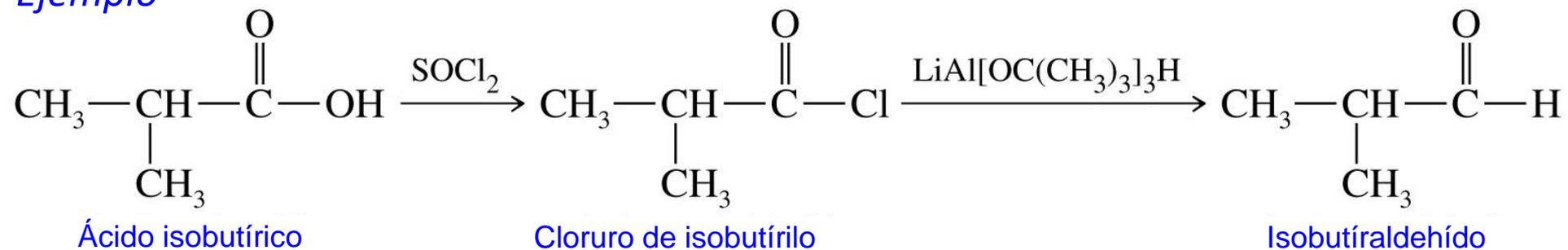
HIDRURO DE DIISOBUTILALUMINIO



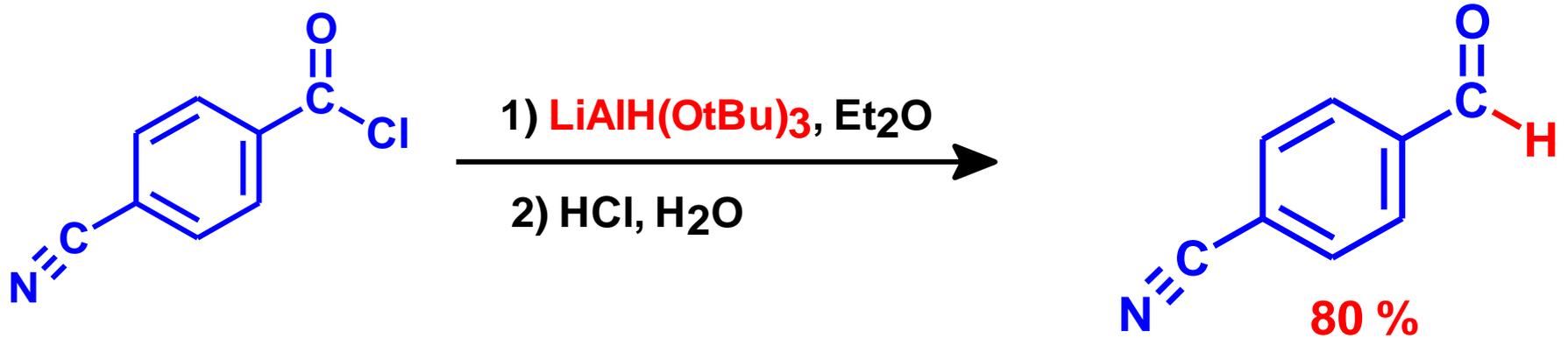
Reducción de Cloruros de Ácido a Aldehídos



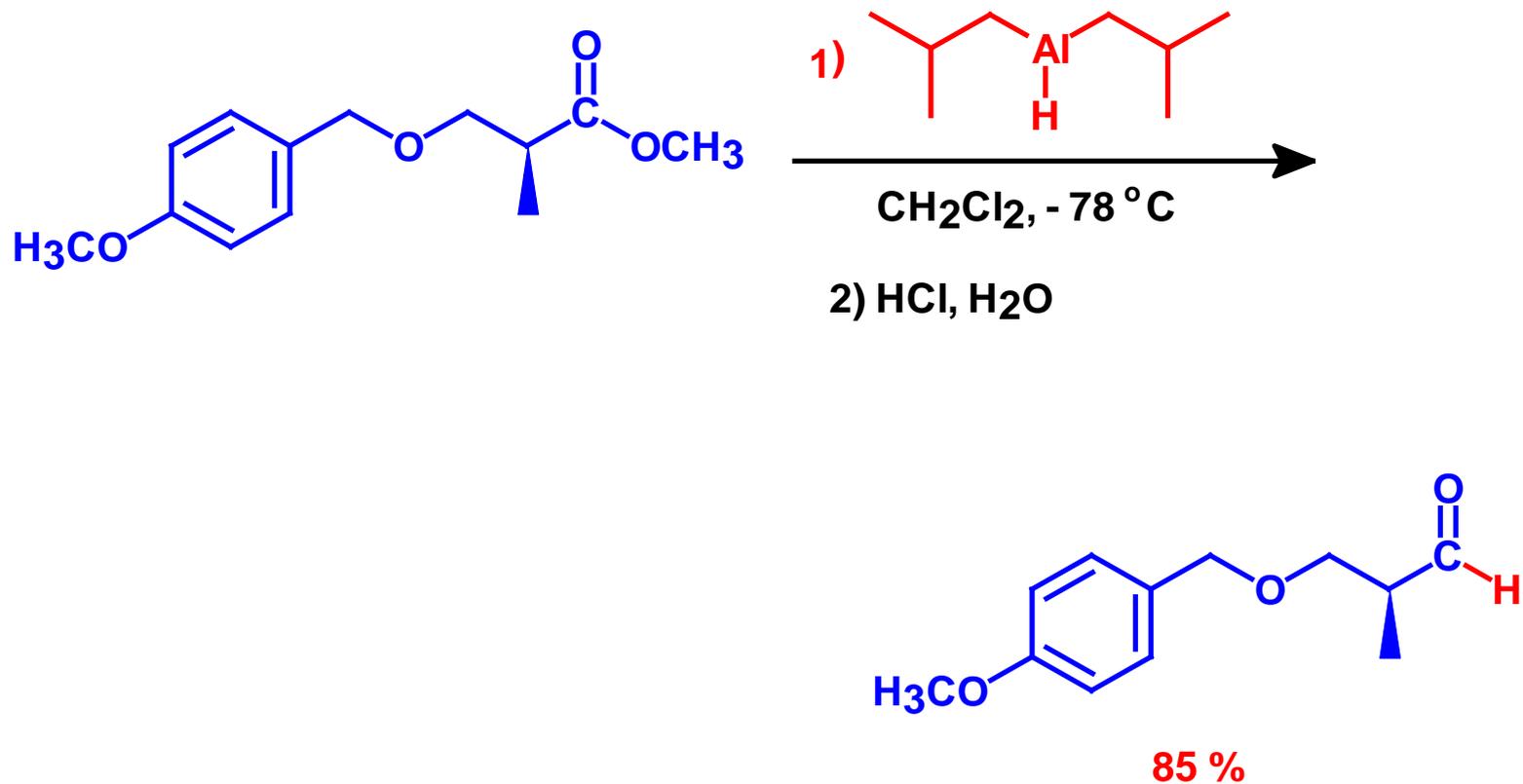
Ejemplo



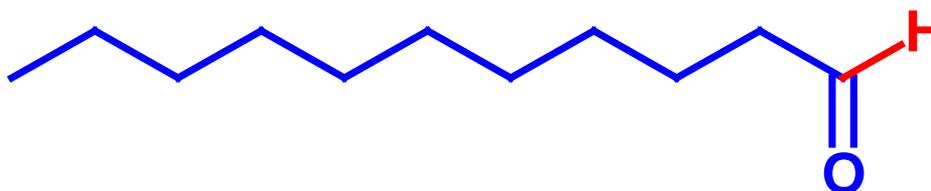
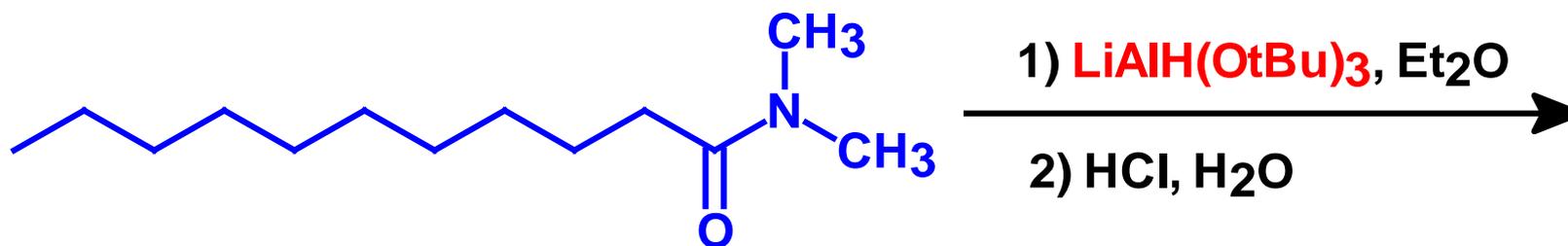
Reducción de Cloruros de Ácido



Reducción de Ésteres a Aldehídos



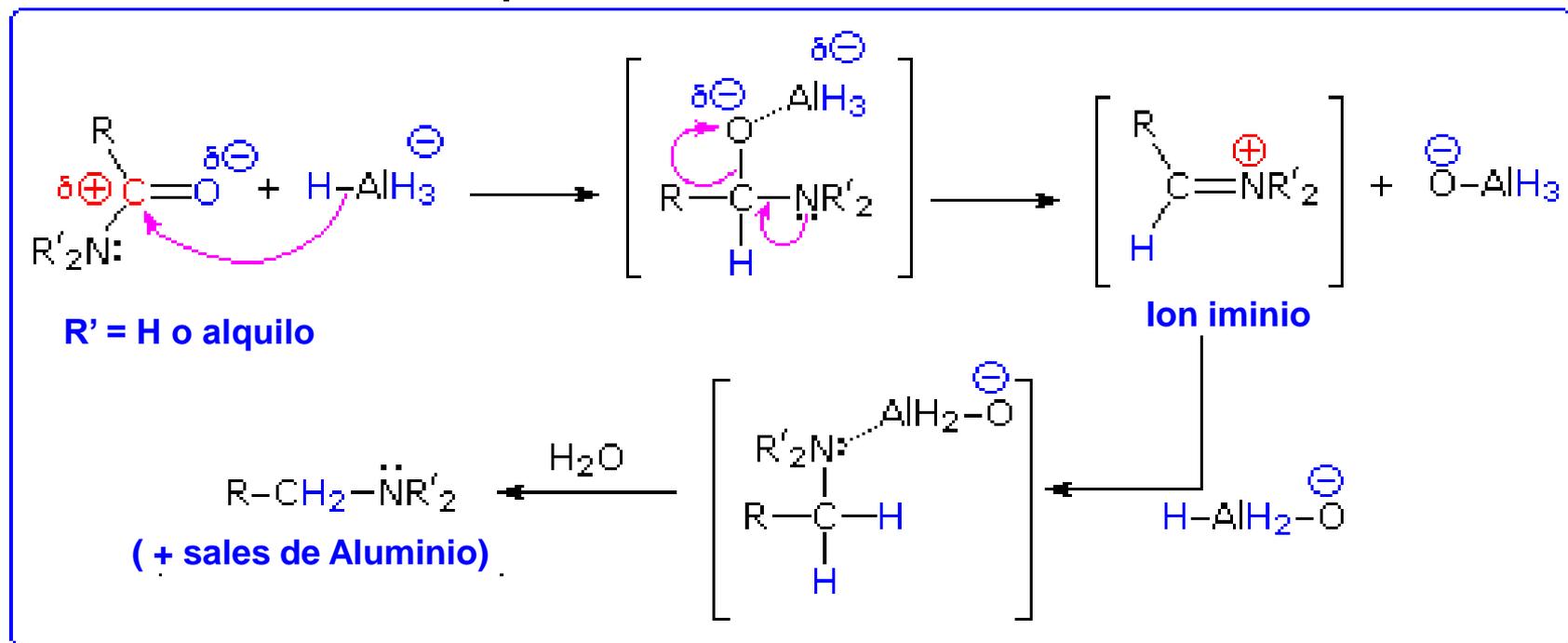
Reducción de Amidas a Aldehídos



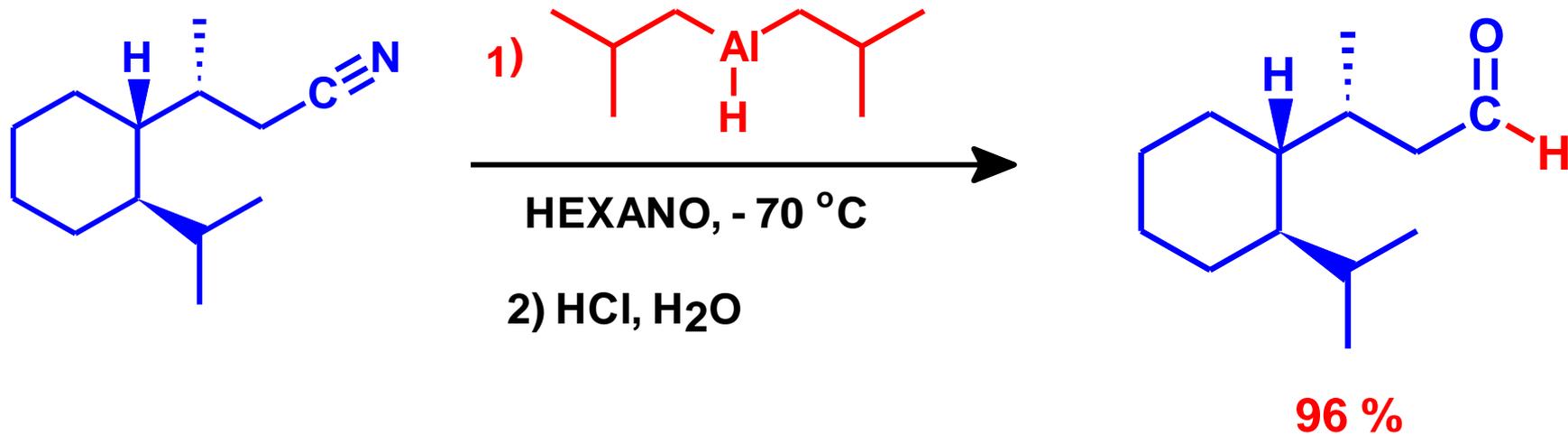
85 %

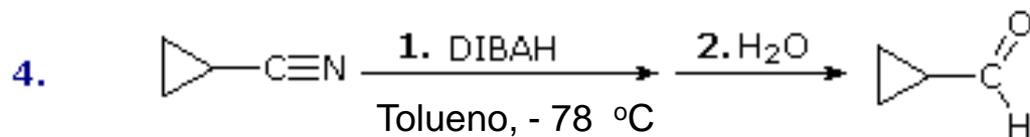
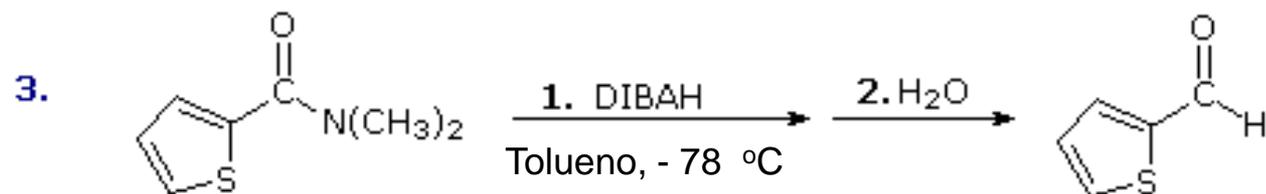
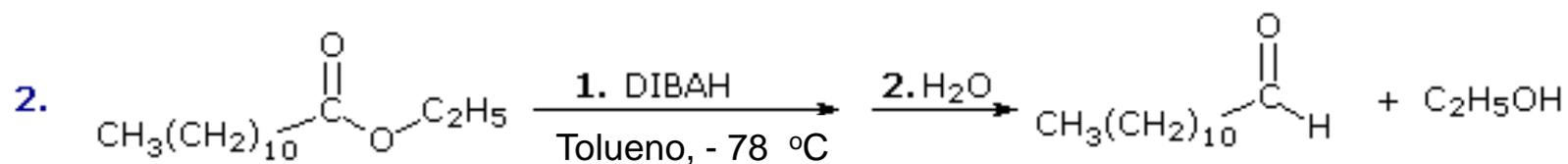
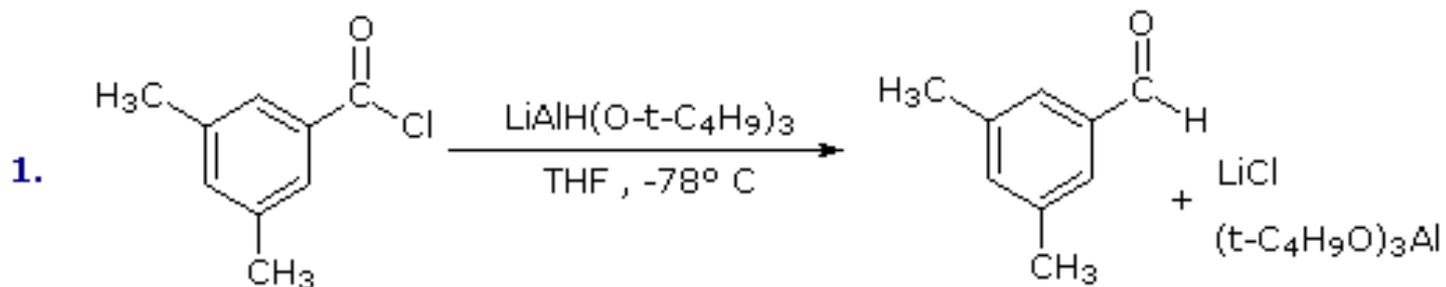


Reducción de una Amida con LiAlH_4



Reducción de Nitrilos a Aldehídos





Reactivo	Grupo funcional					
	Aldehídos y Cetonas	Ácidos Carboxílicos	Ésteres Carboxílicos	Cloruros de acilo	Amidas	Nitrilos
H₂ y catalizador	Alcoholes (lenta, Pt, Pd)	(muy lenta)	(muy lenta)	Aldehídos (Pd/BaSO ₄)	(muy lenta)	Aminas (Ni cat.)
NaBH₄ disolvente polar	Alcoholes	N.R.	Alcoholes (lenta)	Mezcla compleja	N.R.	N.R.
LiAlH₄ éter o THF	Alcoholes	Alcohol 1°	Alcoholes	Alcohol 1°	Aminas	Amina 1a
LiAlH(Ot-Bu)₃ 1 eq. in THF	Alcoholes (lenta a 0°)	N.R.	(muy lenta)	Aldehído (-78 ° C)	Aldehído (-78 ° C)	Aldehído (0 ° C)
(iso-Bu)₂AlH 1 eq. in tolueno	Alcoholes	Alcohol 1°	Aldehído (-78° C)	1°-alcohol	Aldehído (-78 ° C)	Aldehído (-78 ° C)
B₂H₆ THF	Alcoholes (lenta)	Alcohol 1°	(muy lenta)	Mezcla compleja	Amina 1a	Amina 1a

Código de color

La reducción ocurre con facilidad bajo condiciones normales de T y P

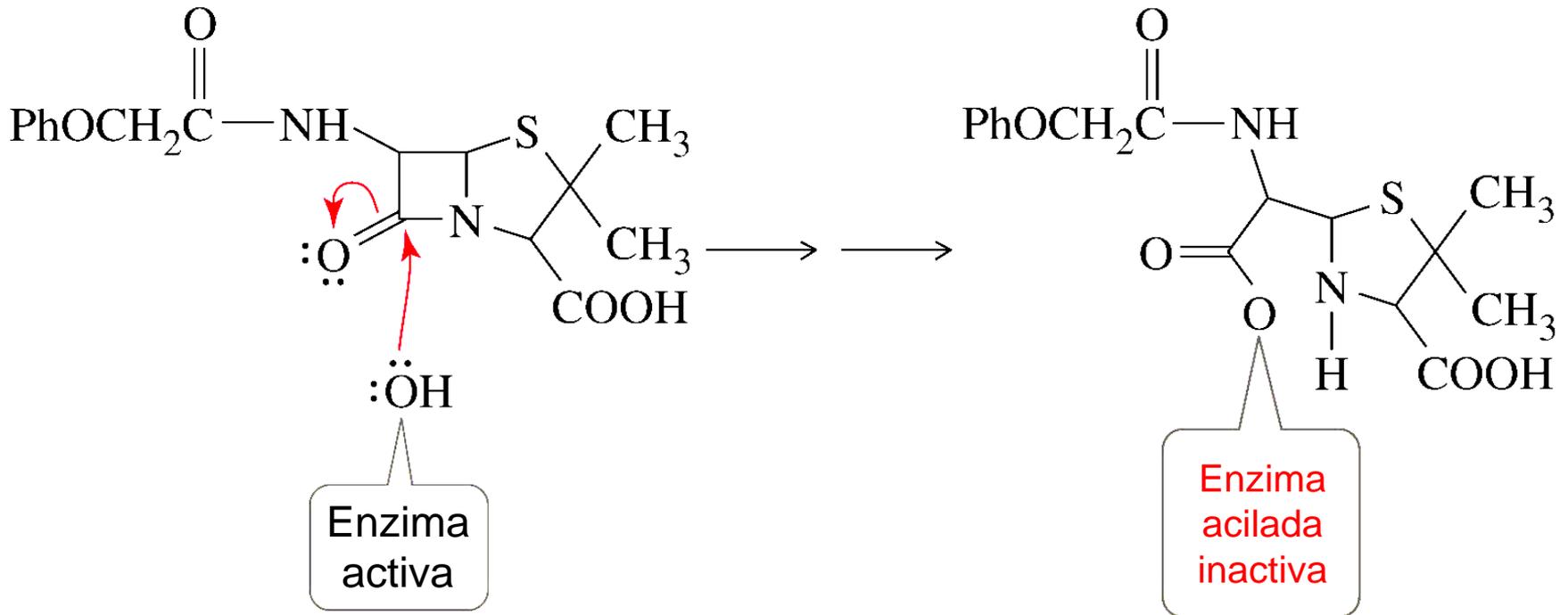
La reducción ocurre con facilidad, pero la selectividad requiere T bajas

La reducción ocurre lentamente. Se necesita de calentamiento y/o altas presiones de H₂ p un uso efectivo

La reducción ocurre muy lentamente o bien no hay reacción (N.R.).

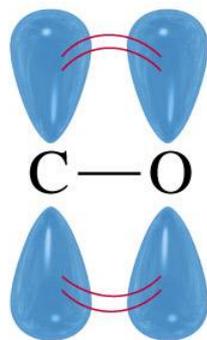


Función de las β -lactamas



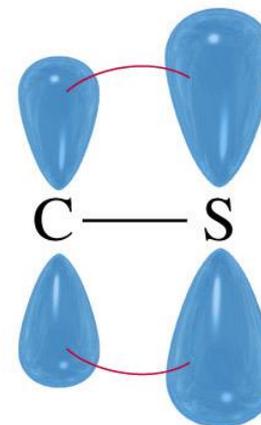
Traslapo por resonancia en ésteres y tioésteres

Éster

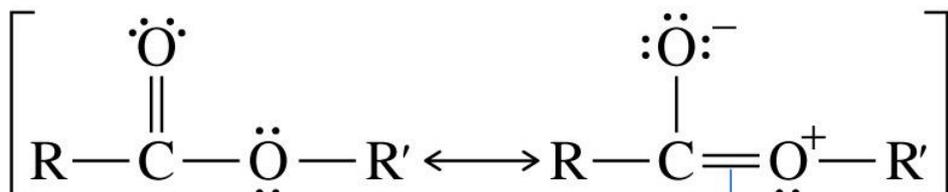


Buen traslazo π
C-O

Tioéster



Pobre traslazo
 π
C-O



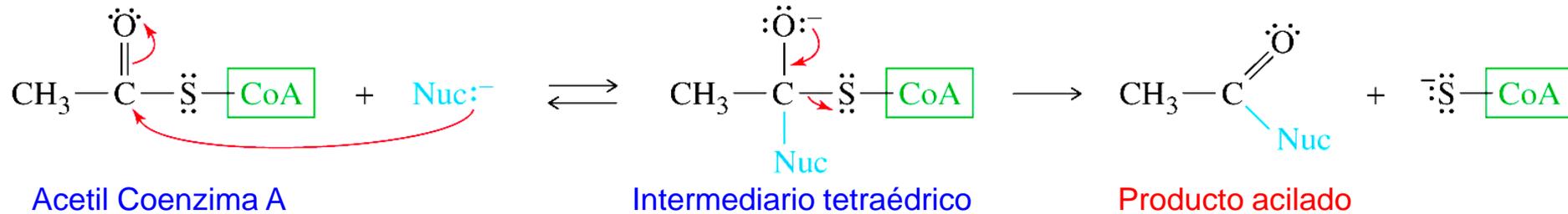
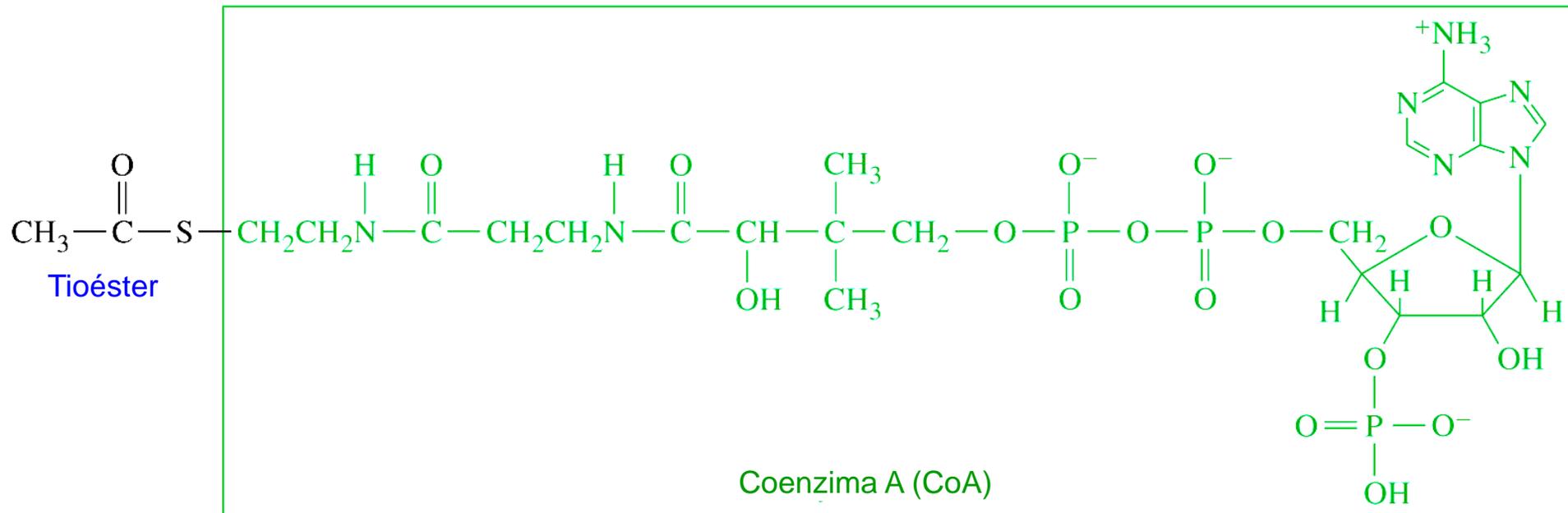
Fuerte traslazo π



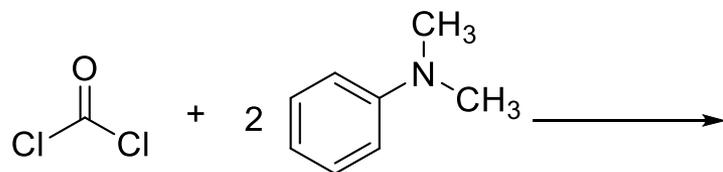
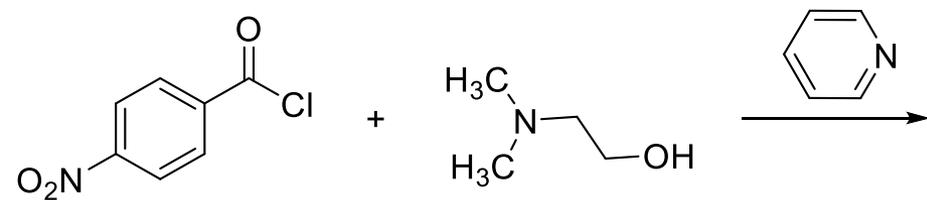
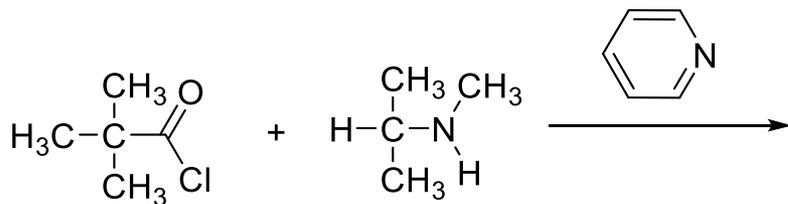
Débil traslazo π



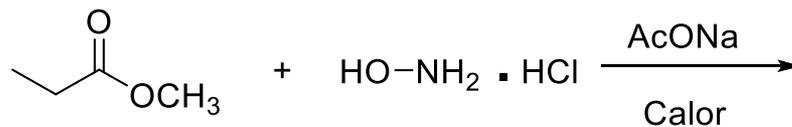
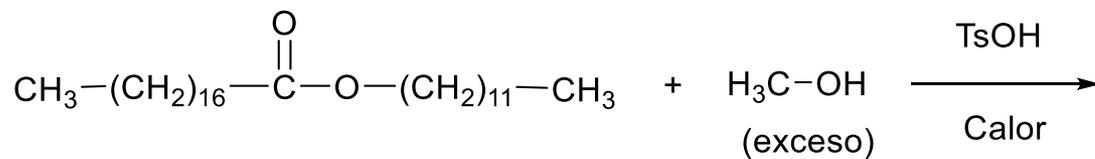
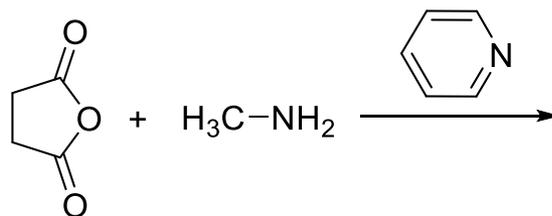
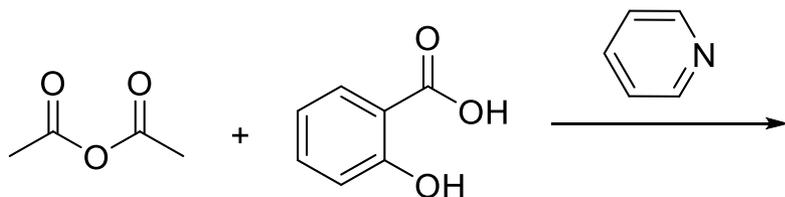
Estructura de la Coenzima A



PROBLEMAS

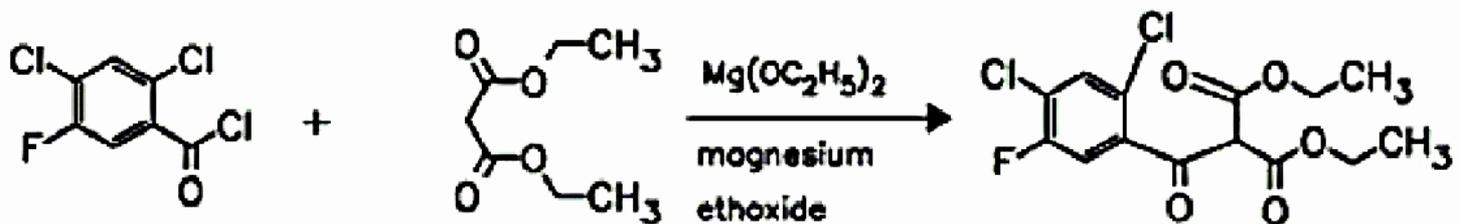


PROBLEMAS



Síntesis de la Ciprofloxacina, antibactericida

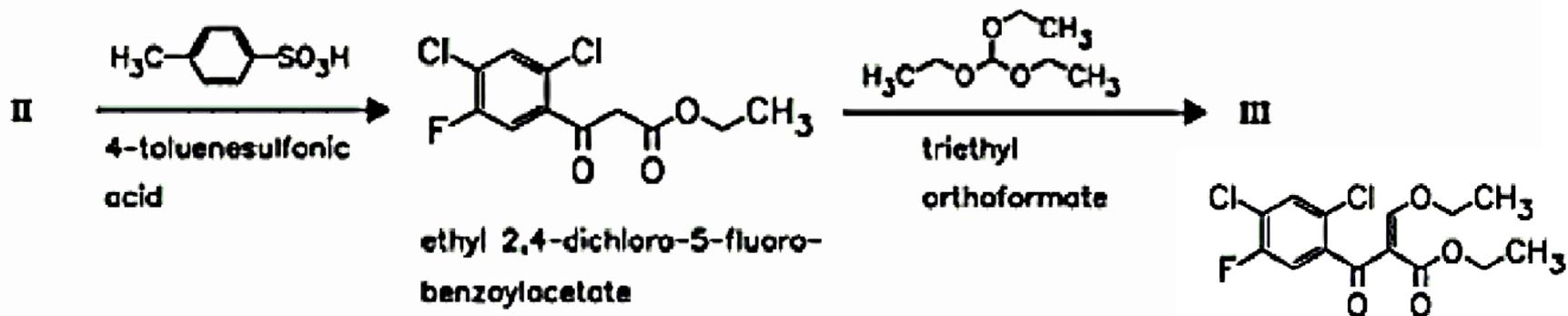
(a)



2,4-dichloro-5-fluoro-
benzoyl chloride (I)

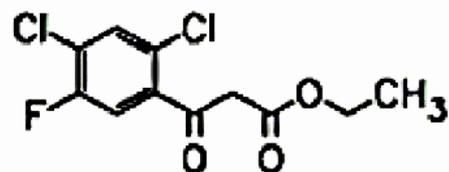
diethyl
malonate

diethyl (2,4-dichloro-5-
fluorobenzoyl)malonate (II)



II

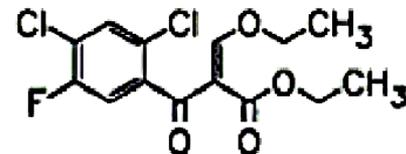
$H_3C-C_6H_4-SO_3H$
4-toluenesulfonic
acid



ethyl 2-(2,4-dichloro-5-fluoro-
benzoyl)acetate

$H_3C-O-C(OCH_3)_2$
triethyl
orthoformate

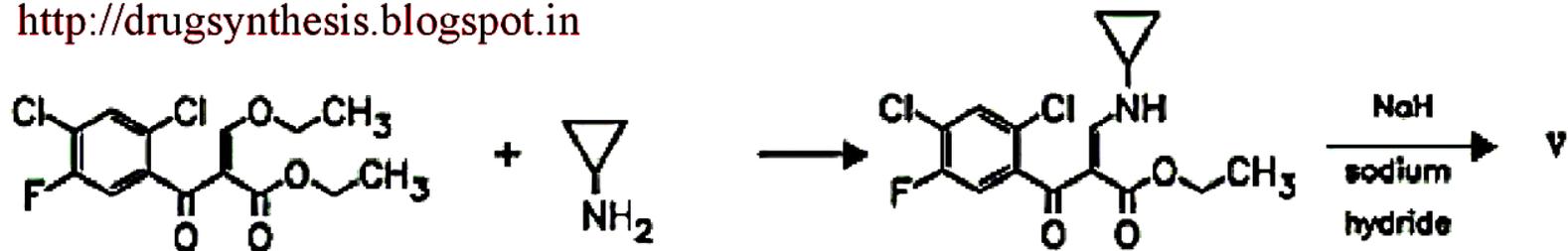
III



ethyl 2-(2,4-dichloro-
5-fluorobenzoyl)-3-
ethoxyacrylate (III)



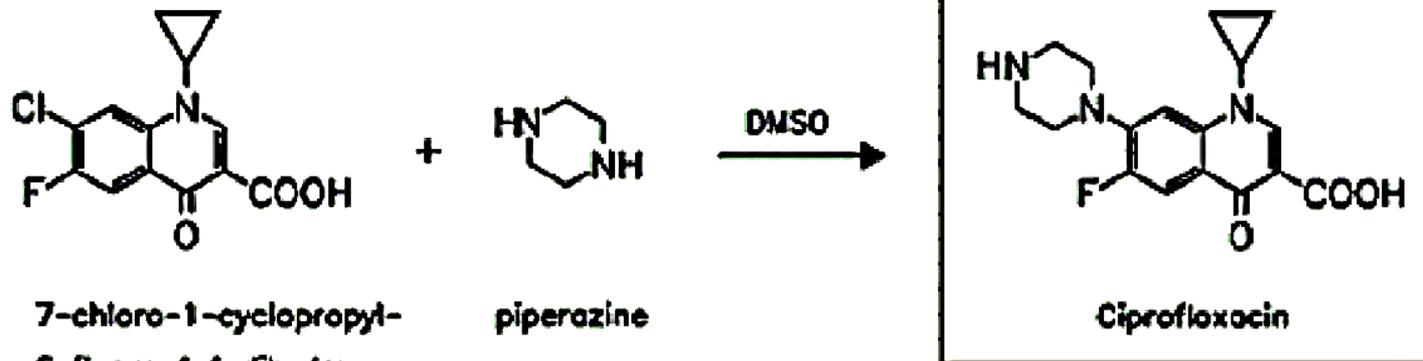
<http://drugssynthesis.blogspot.in>



ethyl 2-(2,4-dichloro-5-fluorobenzoyl)-3-ethoxyacrylate (III)

cyclopropylamine (IV)

ethyl 3-cyclopropylamino-2-(2,4-dichloro-5-fluorobenzoyl)acrylate



7-chloro-1-cyclopropyl-6-fluoro-1,4-dihydro-4-oxoquinoline-3-carboxylic acid (V)

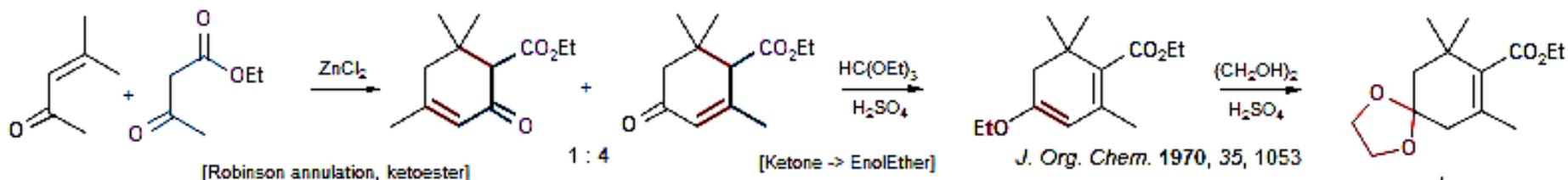
piperazine

Ciprofloxacin



Abscisic Acid

Constantino, M. G.; Losco, P.; Castellano, E. E. *J. Org. Chem.* 1989, 54, 681.



1. LiAlH₄
2. MnO₂

