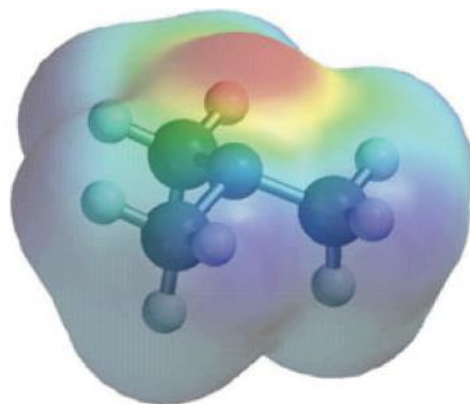


Lecture 3-1

Amines – Structures and Properties



Instructor: Dr. Tanatorn Khotavivattana

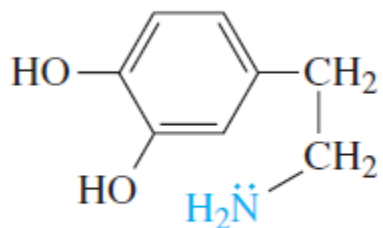
E-mail: tanatorn.k@chula.ac.th

Recommended Textbook:

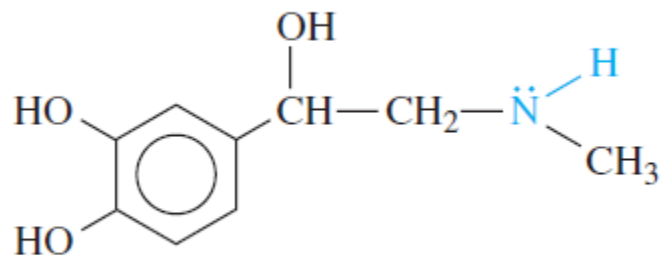
Chapter 19 in *Organic Chemistry*, 8th Edition, L. G. Wade, Jr., **2010**,
Prentice Hall (Pearson Education)

What is amine?

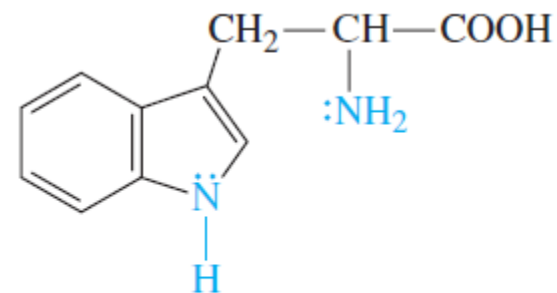
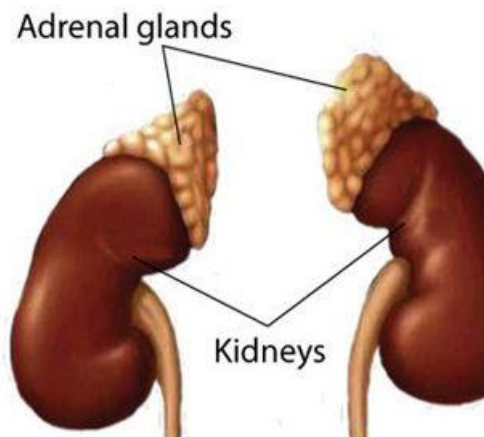
Amine = organic **derivatives of ammonia** with one or more alkyl or aryl groups bonded to the nitrogen atom



dopamine
a neurotransmitter



epinephrine
an adrenal hormone



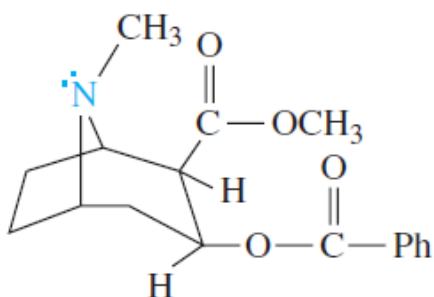
L-tryptophan
an amino acid



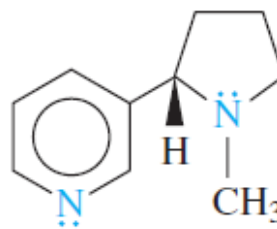
- Because of their high degree of **biological activity**, many amines are used as **drugs** and **medicines**

Amines in Nature

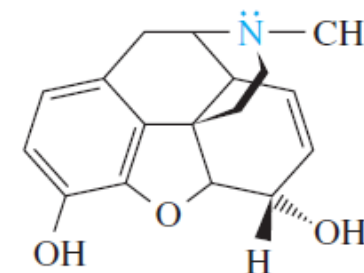
Alkaloids are an important group of **biologically active amines**, mostly synthesised by plants to protect them from being eaten by insects and other animals



cocaine
in coca leaves



nicotine
in tobacco



morphine
in opium poppies

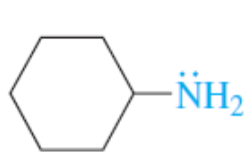


- All alkaloids are **toxic** and cause death if taken in large quantities

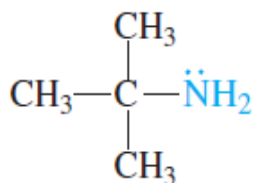
Classification

Amines are classified as **primary (1°)**, **secondary (2°)**, or **tertiary (3°)**, corresponding to one, two, or three alkyl or aryl groups bonded to nitrogen

Primary (1°) amines

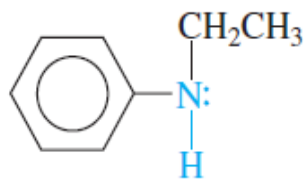


cyclohexylamine (1°)

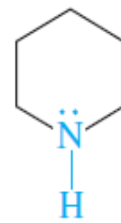


tert-butylamine (1°)

Secondary (2°) amines

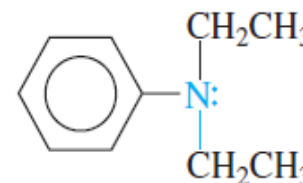


N-ethylaniline (2°)

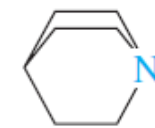


piperidine (2°)

Tertiary (3°) amines

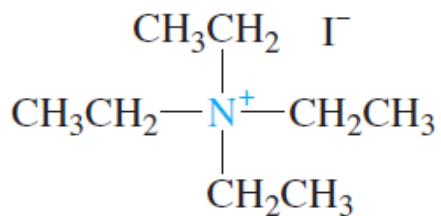


N,N-diethylaniline (3°)

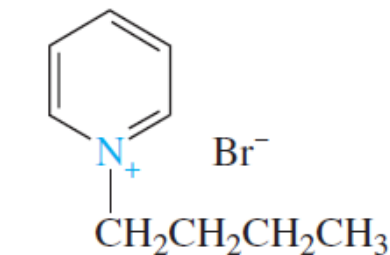


quinuclidine (3°)

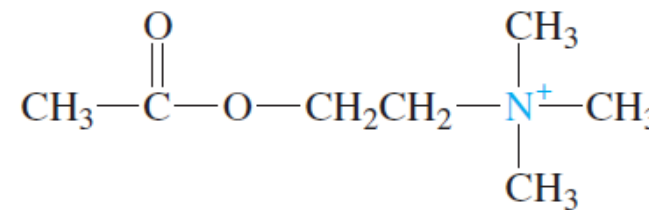
Quaternary ammonium salts have four alkyl or aryl bonds to a nitrogen atom. The nitrogen atom bears a positive charge



tetraethylammonium iodide



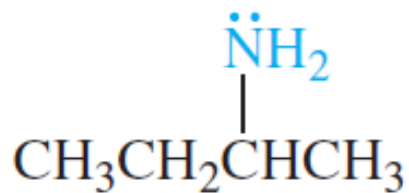
N-butylpyridinium bromide



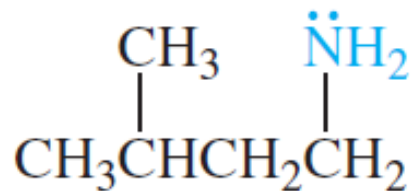
acetylcholine, a neurotransmitter

Nomenclature – IUPAC Names

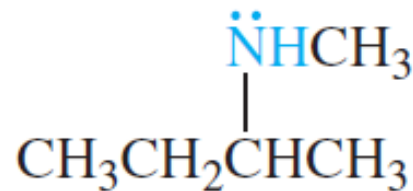
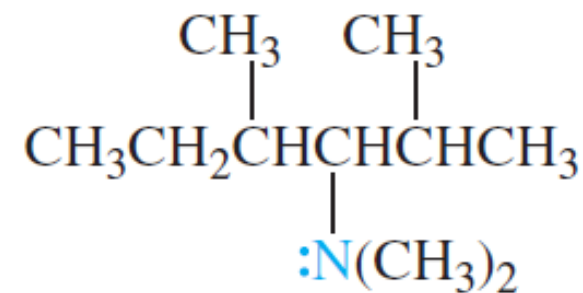
- Suffix = **-amine**
- Other substituents on the carbon chain are given numbers, and the prefix **N-** is used for each substituent on nitrogen



butan-2-amine

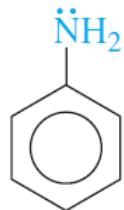


3-methylbutan-1-amine

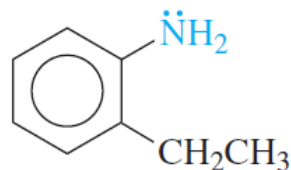
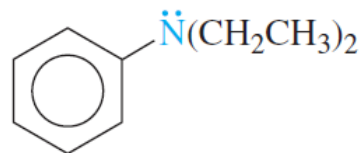
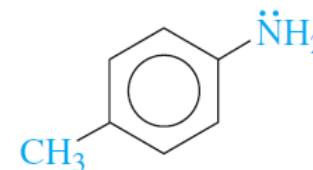
*N*-methylbutan-2-amine2,4,*N,N*-tetramethylhexan-3-amine

Nomenclature – Common Names

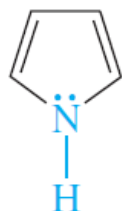
- Aromatic and heterocyclic amines are generally known by **historical names**



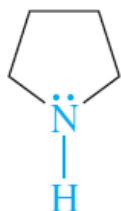
aniline

2-ethylaniline
or *o*-ethylaniline*N,N*-diethylaniline4-methylaniline
or *p*-toluidine

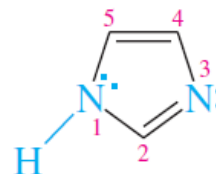
aziridine



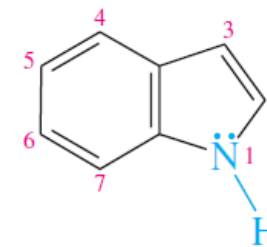
pyrrole



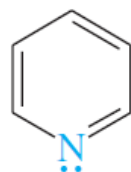
pyrrolidine

1-methylpyrrolidine
(*N*-methylpyrrolidine)

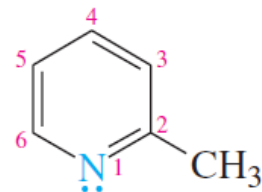
imidazole



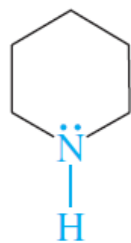
indole



pyridine



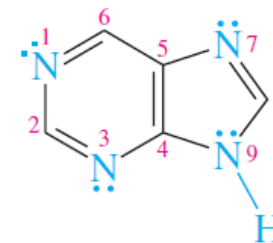
2-methylpyridine



piperidine

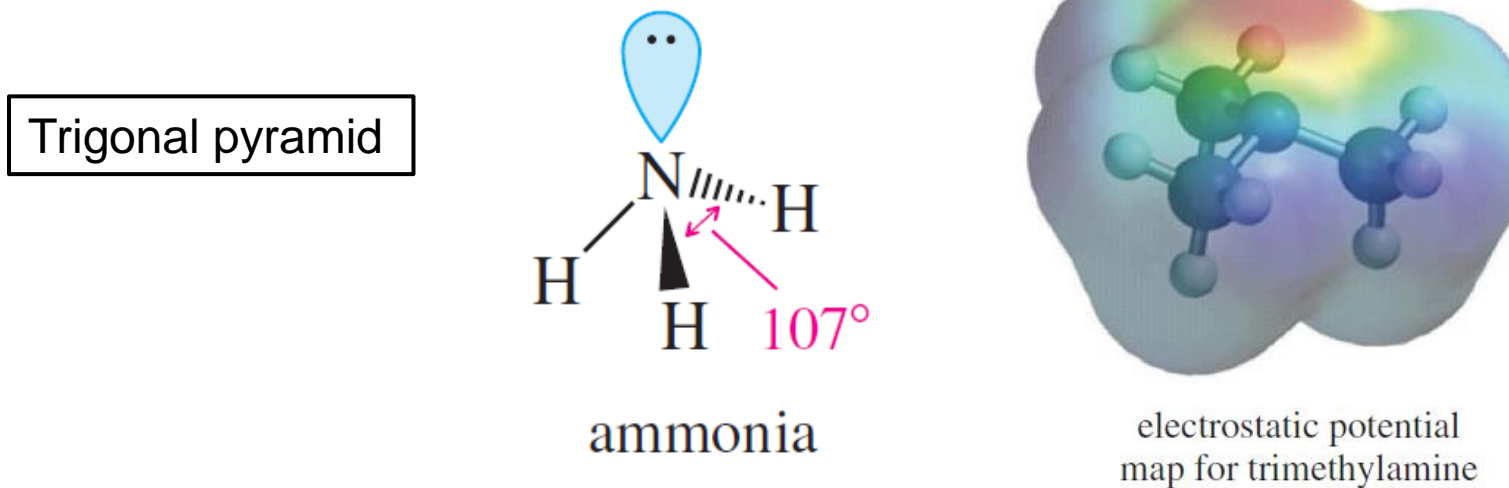


pyrimidine



purine

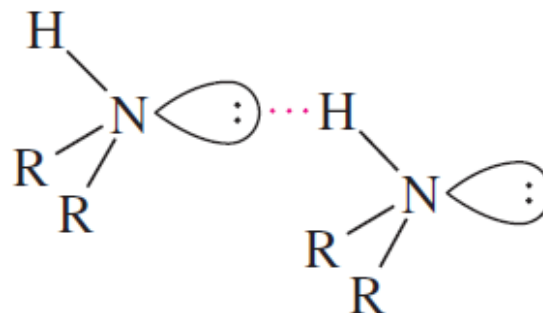
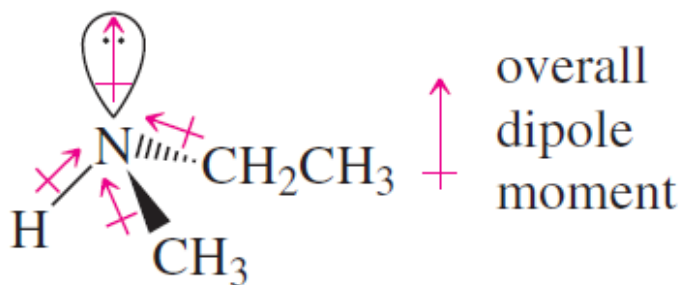
- Both ammonia and amine have a slightly **distorted tetrahedral shape**
- The nitrogen atom is **sp^3 hybridised**



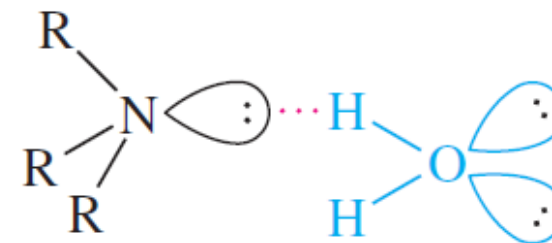
- In ammonia, the **bulky lone pair** compressing the bond angles to 107° from the “ideal” bond angle of 109.5°.

Physical Properties of Amines

- Amines are **strongly polar** because the large dipole moment of the lone pair electrons adds to the dipole moments of the $C \rightarrow N$ and $H \rightarrow N$ bonds



1° or 2° amine:
hydrogen bond donor and acceptor



3° amine:
hydrogen bond acceptor only

Physical Properties of Amines

- **Primary** and **secondary** amines have N—H bonds, allowing them to form **hydrogen bonds = High Boiling Point, High Water Solubility**

- **Tertiary** amines cannot engage in hydrogen bonding because they have no N—H bonds; however, they can accept hydrogen bonds from other molecules

Lower Boiling Point



High Water Solubility

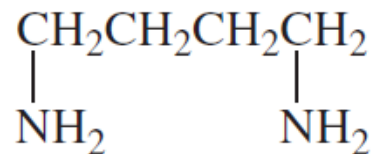


Physical Properties of Amines

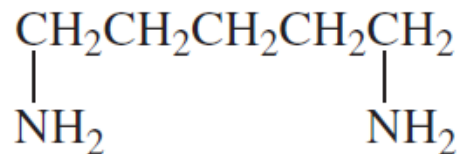
Compound	bp (°C)	Type	Molecular Weight
$(\text{CH}_3)_3\text{N:}$	3	tertiary amine	59
$\text{CH}_3-\text{O}-\text{CH}_2-\text{CH}_3$	8	ether	60
$\text{CH}_3-\text{NH}-\text{CH}_2-\text{CH}_3$	37	secondary amine	59
$\text{CH}_3\text{CH}_2\text{CH}_2-\text{NH}_2$	48	primary amine	59
$\text{CH}_3\text{CH}_2\text{CH}_2-\text{OH}$	97	alcohol	60

- The most obvious property of amines is their characteristic odour of **rotting fish**

putrid
= stinky



putrescine
(butane-1,4-diamine)

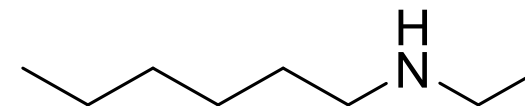
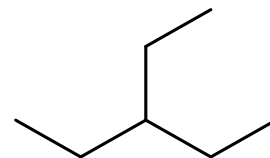
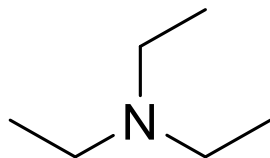
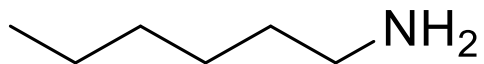


cadaverine
(pentane-1,5-diamine)

cadaver
= corpse

Physical Properties of Amines - Example

Rank the following compounds in order of increasing **boiling point**



Physical Properties of Amines - Example

Rank the following compounds in order of increasing **water solubility**

