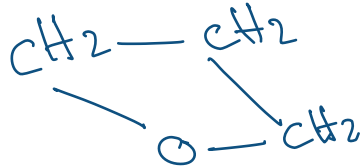
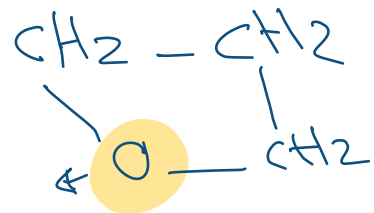
THE SCOPE OF THE FIELD OF HETEROCYCLIC CHEMISTRY

cycle → example



Hetero (غريبة / مختلفة / C, N, O, S) → example



⇒ heterocyclic compound.

- ليش مهم أدرس ال heterocyclic compounds ؟؟

غرضه أغلب الأدوية تكون من heterocyclic compound.

cycle

Isocycle

Hetrocycle

كل الذرات المكونة للحلقة بنفس الشي

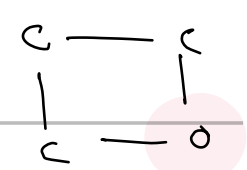
كل الذرات المكونة للحلقة كربون

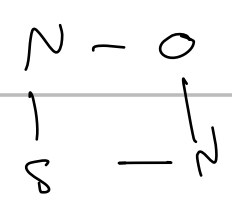
هي ما فيها c

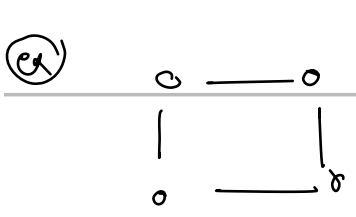
هي فيها c

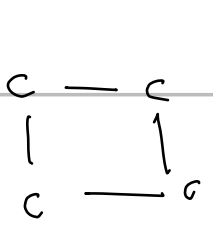
Iso cyclic

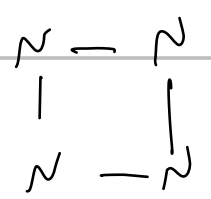
Carbocyclic









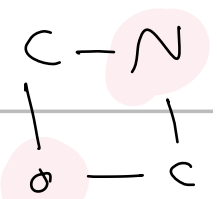


بغض النظر عن التفرعات شو فيها ذرات المهم ذرات الحلقة نفسها

بغض النظر عن التفرعات شو فيها ذرات المهم ذرات الحلقة نسبيا.

مجال دراستنا

مجال دراستنا



organic compound

organic compound

هو فيه c

هو فيه c

خارج المجال دراستنا

خارج المجال دراستنا

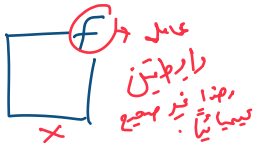
Heterocylic compounds:

بدلت ذرة متغيرة. هي مركبات carbocyclic أو أكثر من الكربون
بذرات مختلفة heterocyclic ما نعرف (N/S/O) heteroatom

- Heterosubstituted rings are those in which one or more carbon atoms in a purely carbon-containing ring (known as a carbocyclic ring) is replaced by some other atom (referred to as a heteroatom).
- In practice, the most commonly found heteroatom is nitrogen, followed by oxygen and sulfur.

The most common Heteroatoms.

ملاحظة:
عارج نلاقي حلقة فيها هالذرتين
بأي مسألة بيطلبوا رابطة
مباشرة متوقع.



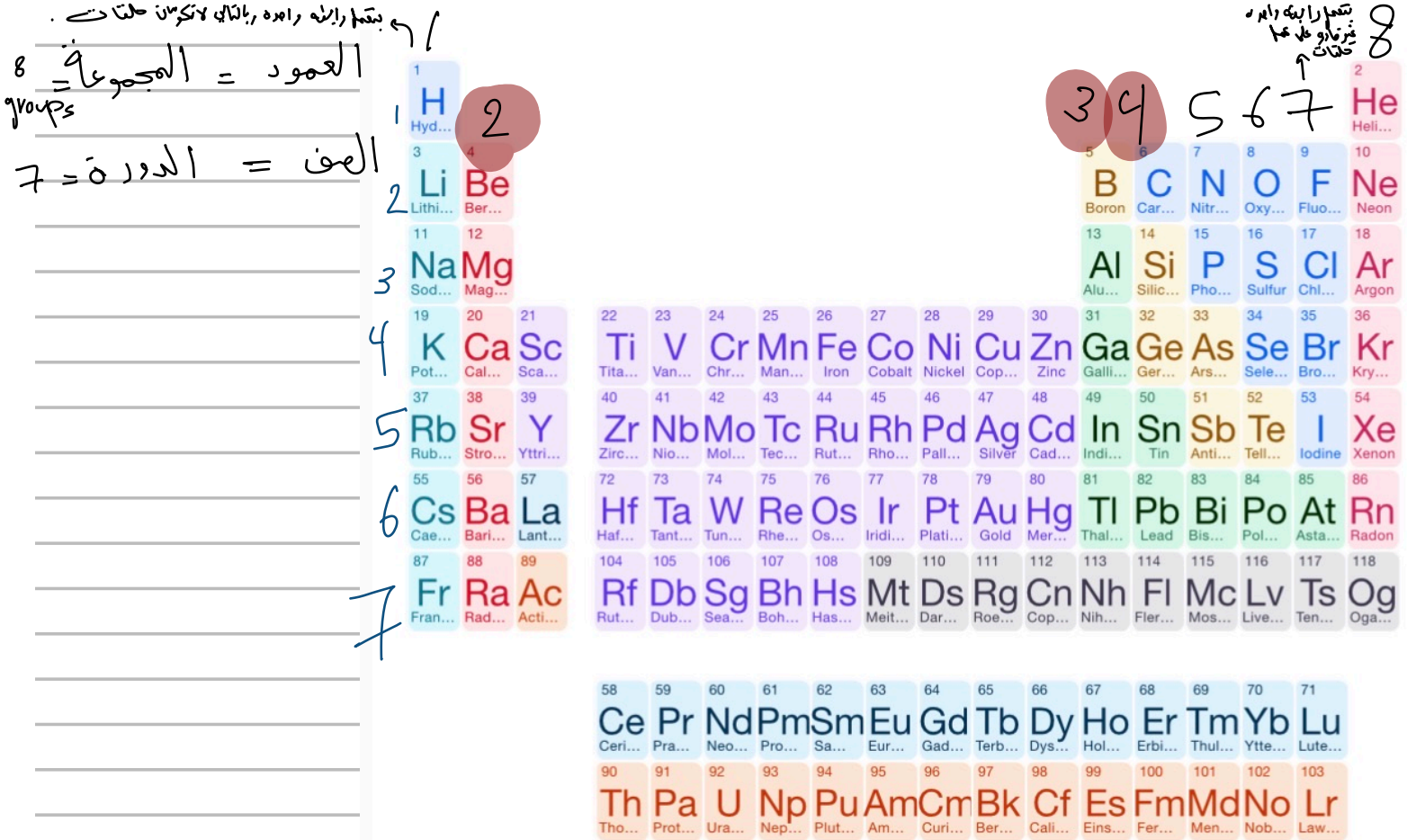
عدد ذرات
رابطتين
وهذا غير صحيح
كيميائياً

- In a 1983 report, the International Union of Pure and Applied Chemistry (IUPAC) recognized 15 elements coming from Groups II to IV of the Periodic System capable of forming cyclic structures with carbon atoms.

IUPAC ⇒ كملوا دراسة (بحث) ⇒ وجدوا فيه 15 elements من (2 → 4) of the periodic system ⇒ قادرين على عمل cyclic structures with C atoms.

العمود = المجموعة = groups

الصف = الدورة = 7



group ⇒ 2 , 3 , 4

تمتاز عناصر هذه المجموعات بقدرتها على تكوين رابطتين أو أكثر وبالتالي بتعمل حلقة.

⇒ قادرين على تكوين cyclic structures with C

ملاحظة: عنصر 5 and 6 برضو قادرات على تكوين حلقات ولكن لم يتم ذكرهم.

عنصر رقم 7 ⇐ 1+7 بتعمل رابطة واحدة وبالتالي لا تكون حلقات.

عنصر 8 بتعمل رابطة واحدة وبالتالي لا تكون حلقات

عنصر 8 فالتعمل روابط لأنها مشبعة.

- Heterocyclic compounds are far from being just the result of some synthetic research effort. Nature abounds in heterocyclic compounds,
- THE SCOPE OF THE FIELD OF HETEROCYCLIC CHEMISTRY many of profound importance in biological processes.
- We find heterocyclic rings in **vitamins**, **coenzymes**, **porphyrins (like hemo□globin)**, **DNA**, **RNA**, and so on.
- The plant kingdom contains thousands of nitrogen heterocyclic compounds, most of which are **weakly basic and called alkaloids** (alkali like).
- Complex heterocyclic compounds are elaborated by **microorganisms** and are useful as antibiotics in medicine.
- **Marine animals and plants** are also a source of complex heterocyclic compounds and are receiving much attention in current research efforts.

Heterocyclic Compounds

موجود بالطبيعة

Human
موجودة بال
- Coenzymes
- Vitamins
- hormones
- aminoacids
- DNA and RNA
- Porphyrins (Hemoglobin)

marine animals and Plants.
- معظم الـ complex heterocyclic compounds

Plants
- وجودها الرئيسي بالـ heterocyclic كبارة alkaloids تسمى (N) وتعتبر weakly basic

microorganisms
- منها بتستخدم في صناعة antibiotics (مضادات حيوية) مثل الـ Penicillin

مصنوع بال labs والمصانع.

cycle

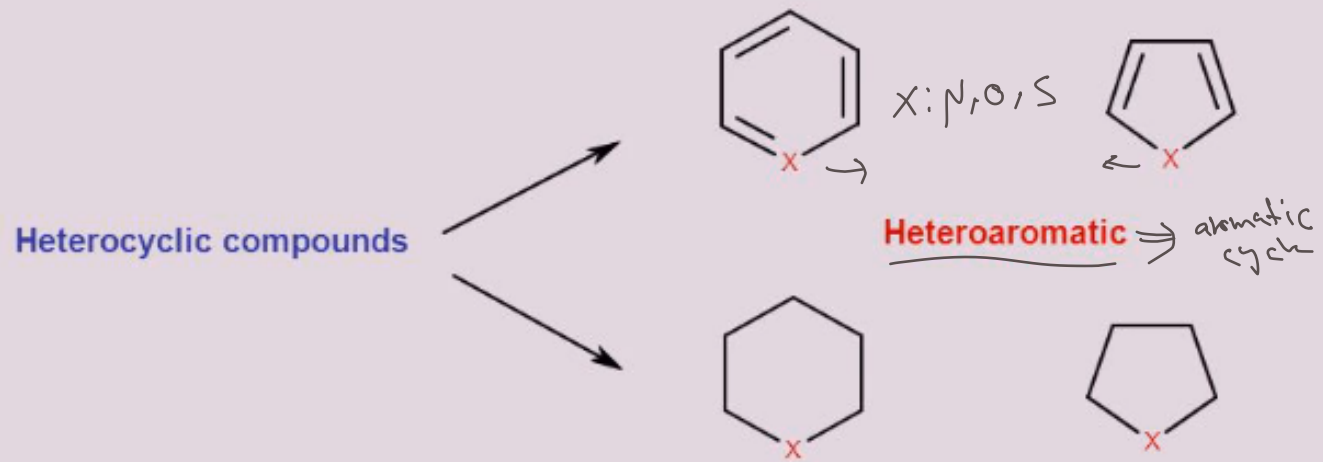
non-cylic compound → non-aromatic (aliphatic)

aromatic → heteroaromatic

non-aromatic (aliphatic) → heteroalicyclic → aliphatic

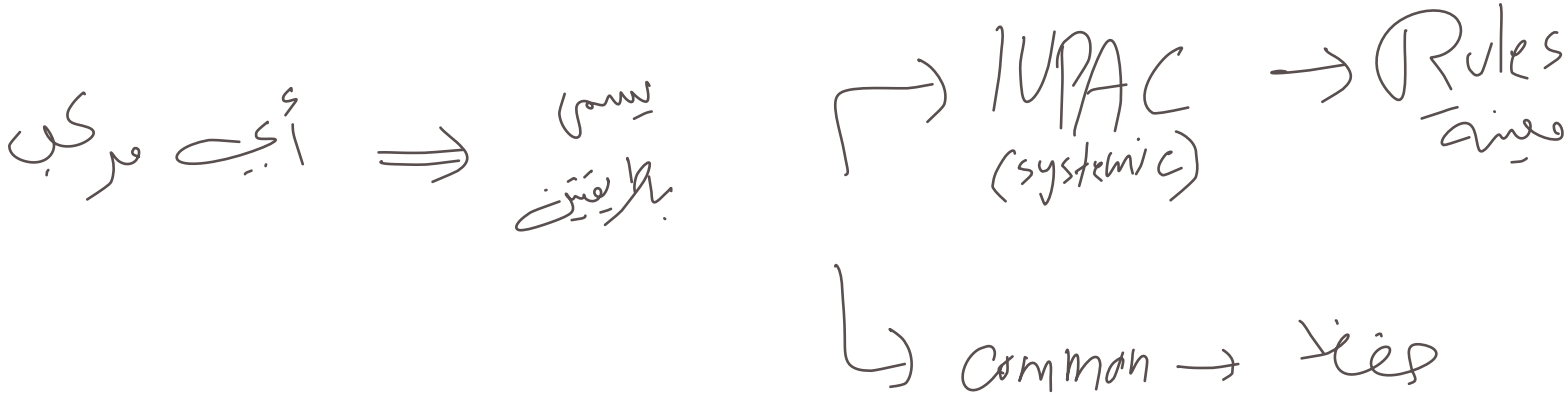
Heterocyclic classification

It can be classified into



ضروري نحفظ تكلم العلم :

The IUPAC rules of nomenclature allow the continued use of well-established common names for some of these fundamental ring systems, but as we will find, there are systematic names also in use for them.



Double bond

Conjugated

من عيّنة
أو ستراكر

- وجود single بين double وهيك.

$C=C-C=C$

Isolated

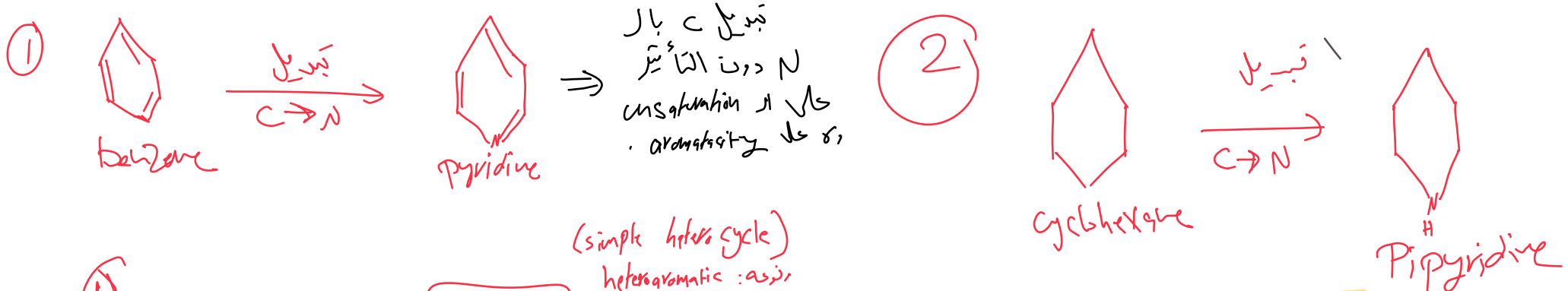
- أكثر من رابطة single بين double bonds.

$C-C-C-C=C$

Cumulated

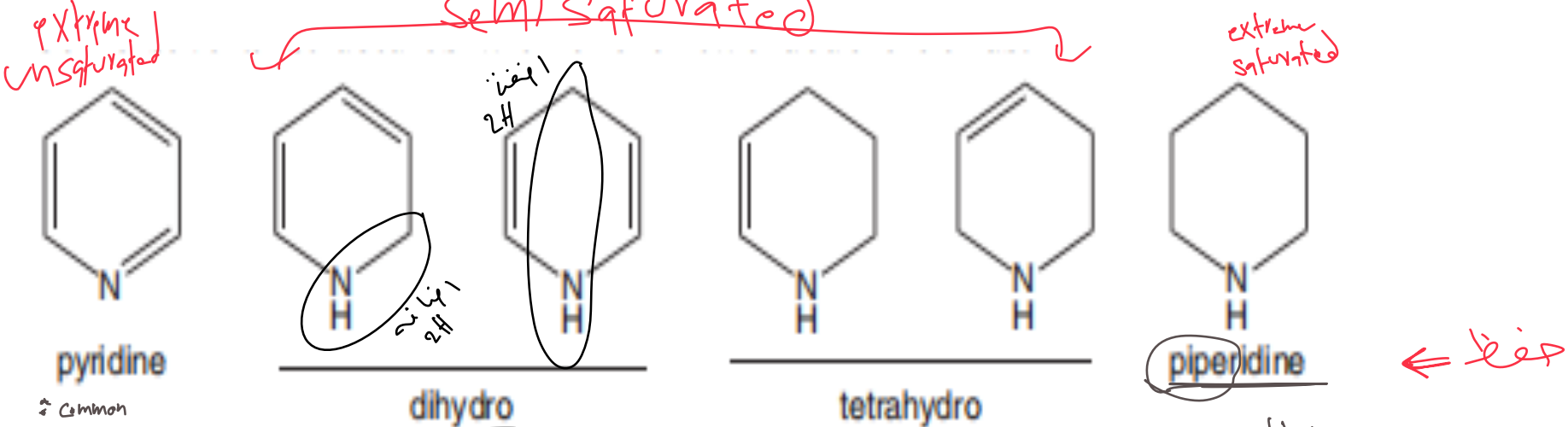
- رابطتين double bonds وراء بعض باستمرار

$C=C=C$



(simple hetero cycle)
heteroaromatic : يزيد

- The compound pyridine is an excellent example of a simple heterocycle. Here, one carbon of benzene is replaced by nitrogen, without interrupting the classic unsaturation and aromaticity of benzene. Similarly, replacement of a carbon in cyclohexane by nitrogen produces the saturated heterocycle piperidine. Between these extremes of saturation come several structures with one or two double bonds.



سؤال: هل هذا المركب heteroalicyclic/ heteroaromatic

مثلها زي حلقة البنزين واستبدلت كربون بذرة N .

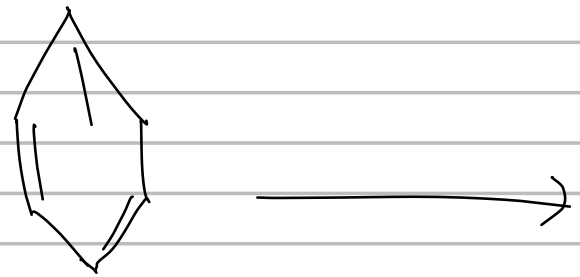
لو شالت زوج من الـ double bonds يصير عنا pyridine و مسماها dihydro كمان زادت واحنا هيدروجينين

لو شالت تنين من الـ double bonds تبع الـ pyridine يصير عنا tetrahydro كمان زادنا 4 هيدروجينات .

هذا المركب heteroalicyclic (non-aromatic) (aliphatic)

أهم أشياء بار
slide
يلي قبل

1



Dehydro

Pyridine ↳ fully unsaturated

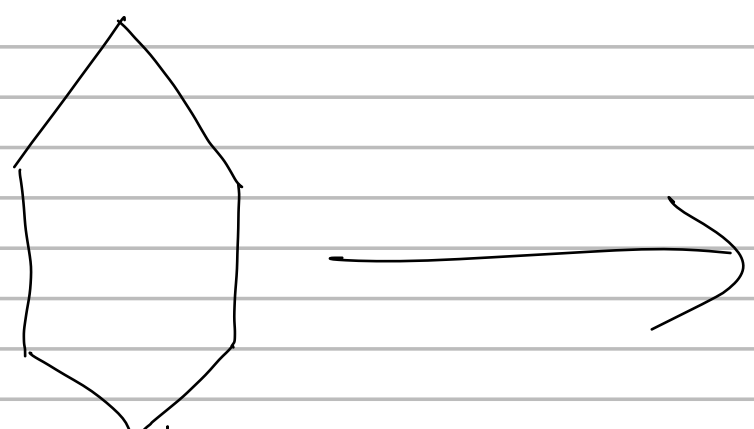
↳ heteroaromatic

↳ aromatic compound

① تم تبديل C بـ N

② لم يتم التغيير بال conjugation و لا بال unsaturation (ما غيرنا اشي بالرابط)

2



cyclohexane

Pipyridine

Pipyridine ↳ fully saturated

↳ aliphatic

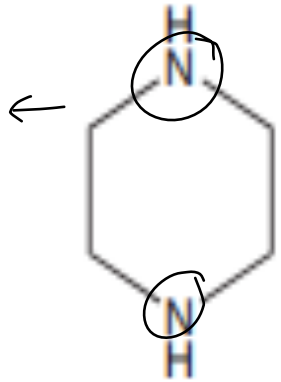
↳ non aromatic

↳ heterocyclic

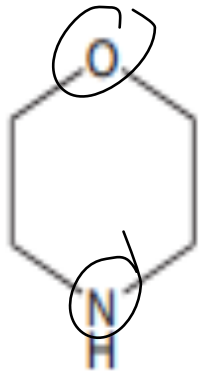
① تم تبديل C بـ N

Rings may have more than one heteroatom, which may be the same or different, as in the examples that follow.

- Two heteroatoms
- identical



piperazine



morpholine

- Two heteroatoms
- different

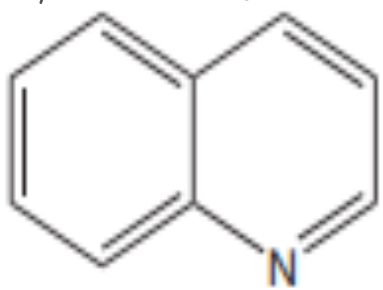
لتوسيع المجال

piper ⇒ لما نشوفها معناتها المركب مشبع

To broaden the field, other rings may be fused onto a parent heterocycle. This gives rise to many new ring systems.

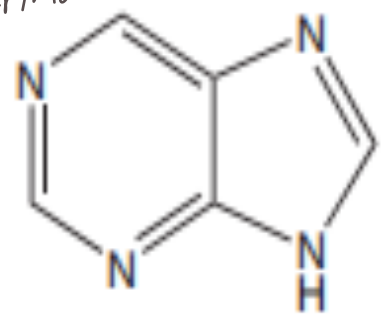
Two rings fused together

benzene + pyridine



quinoline

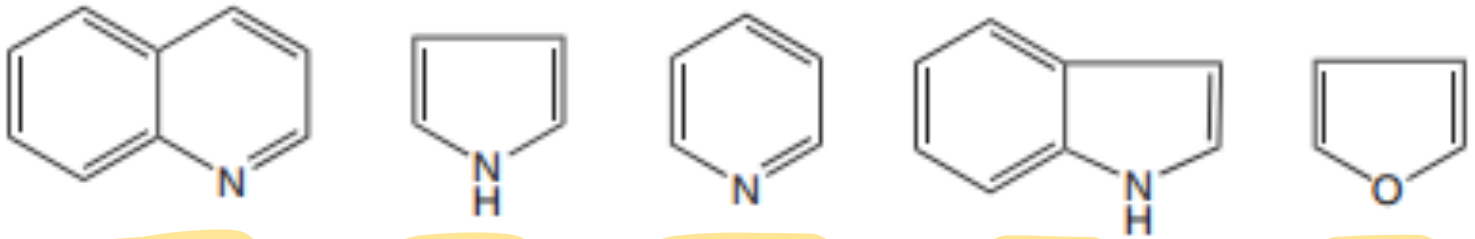
pyrimidine + imidazole



purine

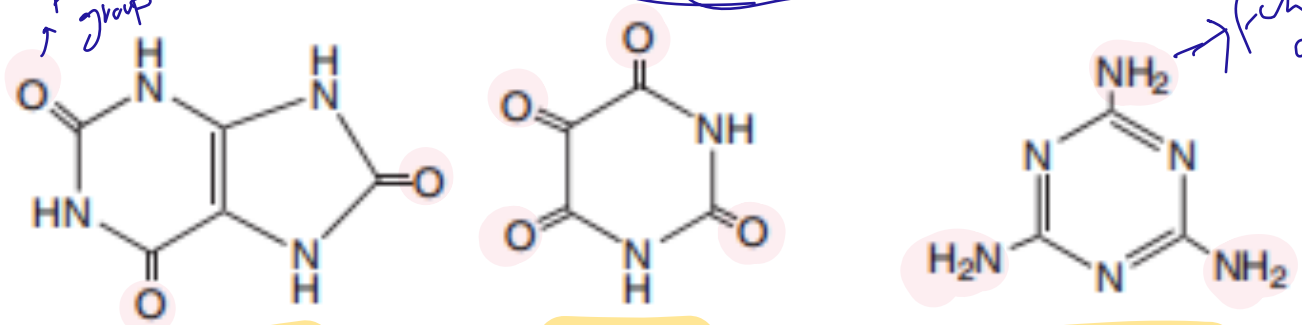
Table 2.1. Some Early Heterocyclic Compounds of Natural Origins

A. Compounds That Are Parent Rings



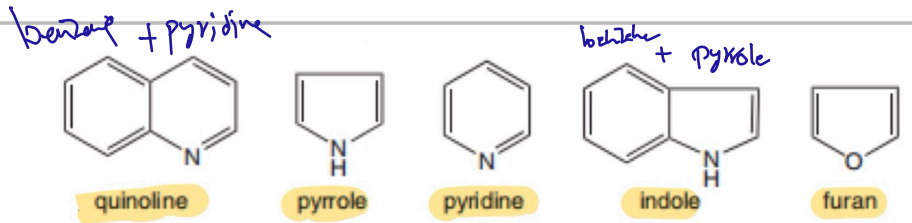
quinoline | pyrrole | pyridine | indole | furan

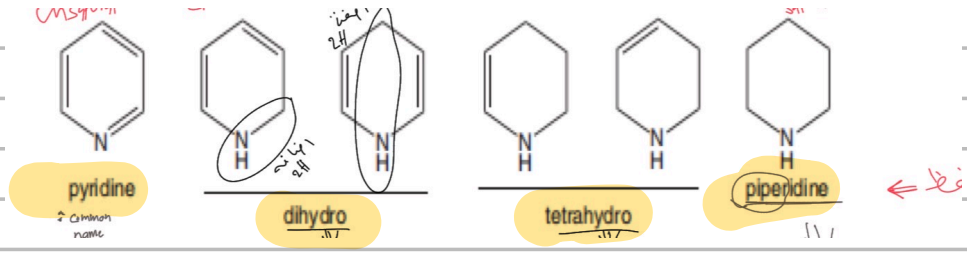
B. Compounds With Functional Groups

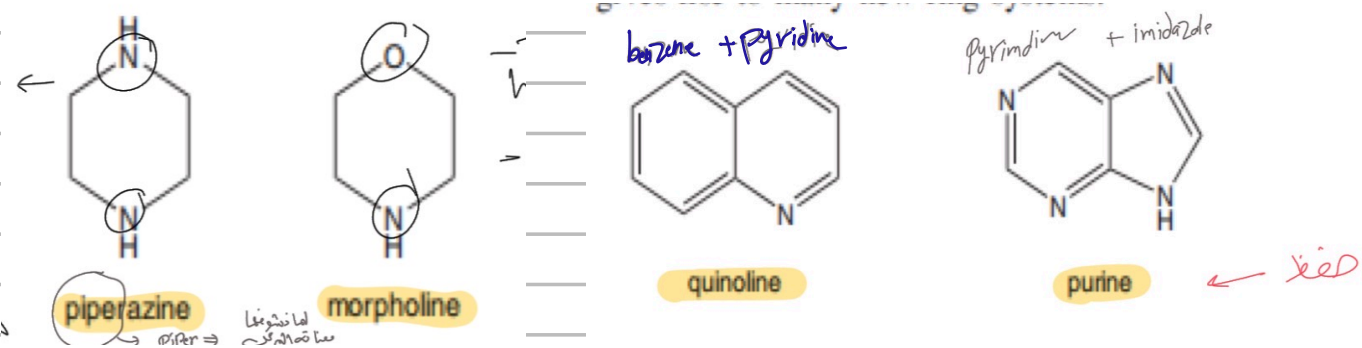


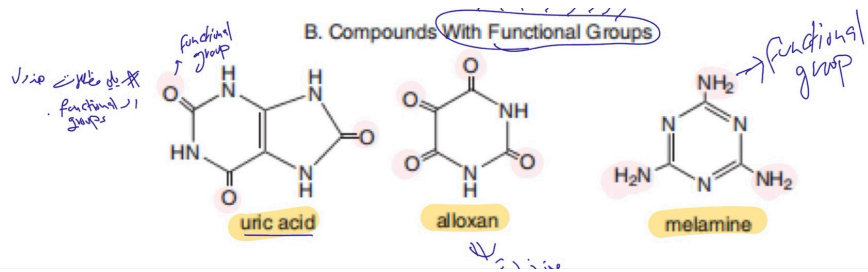
uric acid | alloxan | melamine

٥ تعرف هذه المركبات







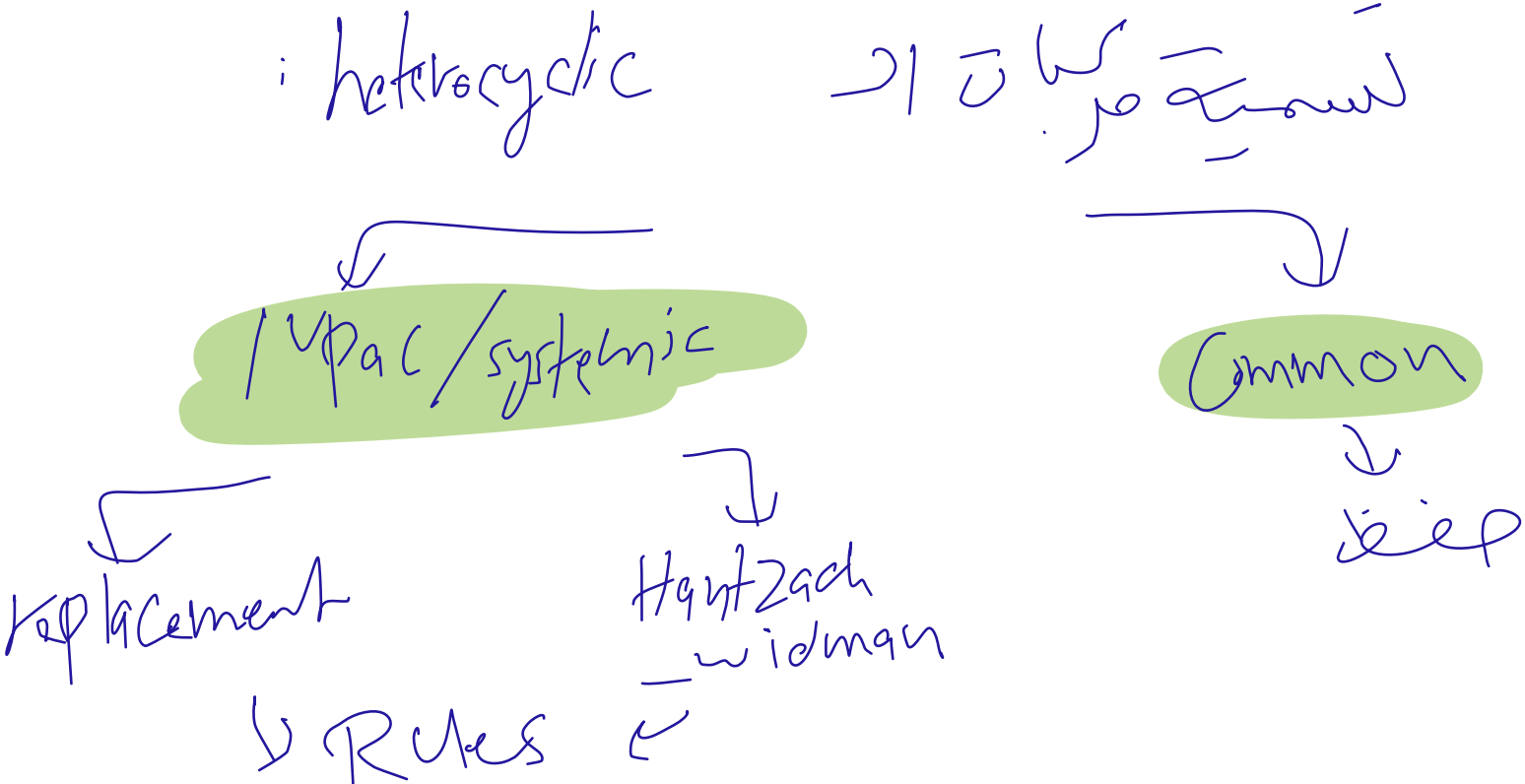


The IUPAC rules allow three nomenclatures.

I. The Hantzsch-Widman Nomenclature.

II. Common Names

III. The Replacement Nomenclature

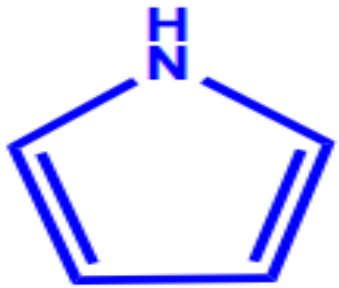


II. Common Names

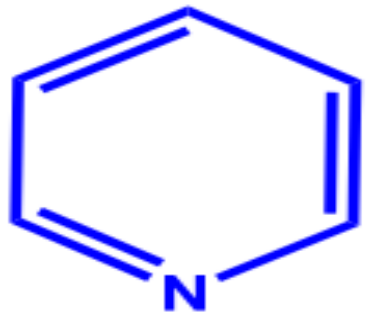
There are a large number of important ring systems which are named widely known with their non-systematic or common names.

Furan

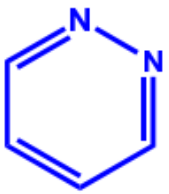
Thiophene



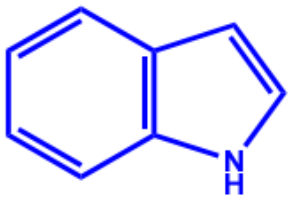
Pyrrole



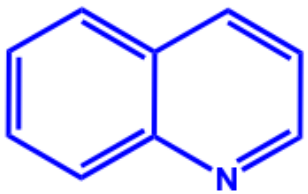
Pyridine



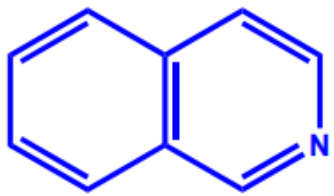
Pyridazine



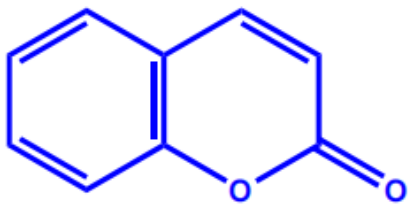
Indole



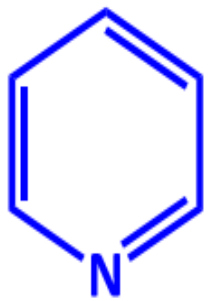
Quinoline



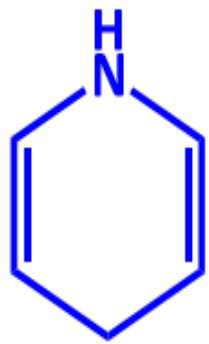
Isoquinoline



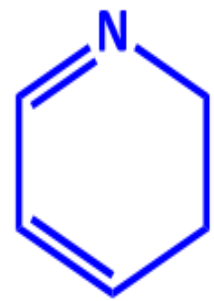
Coumarin



Pyridine



1,4-Dihydropyridine



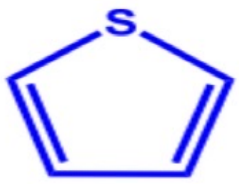
2,3-Dihydropyridine

(Common Names)

1)

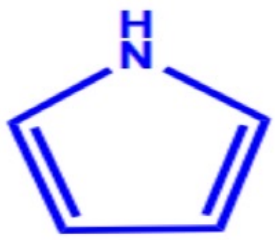
Furan

O + حماسي



Thiophene

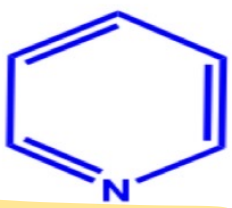
S + حماسي



Pyrrole

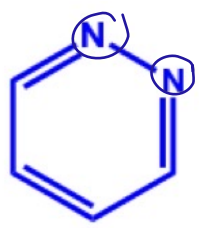
N + حماسي

2)



Pyridine

N + سداسي

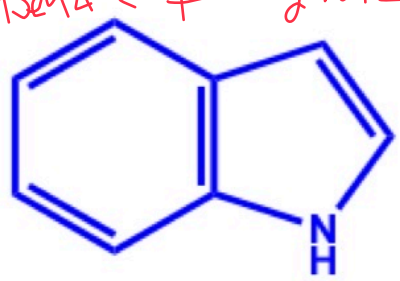


Pyridazine

∴ 2N متجاورين + سداسي

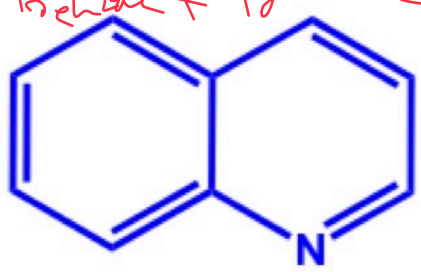
3)

Benzene + Pyrrole

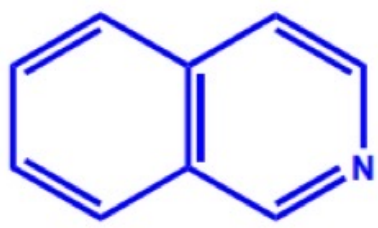


Indole

Benzene + Pyridine

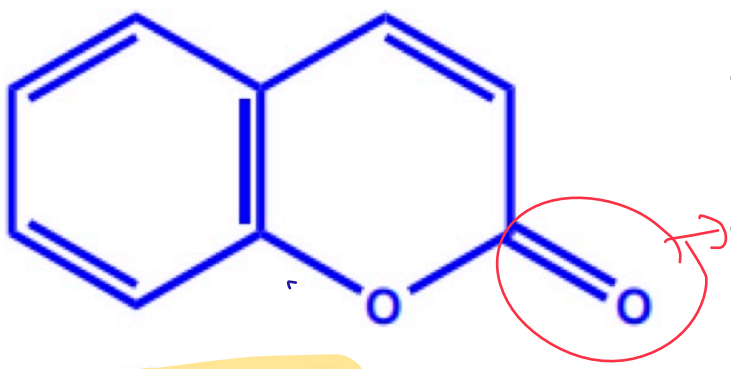


Quinoline



Isoquinoline

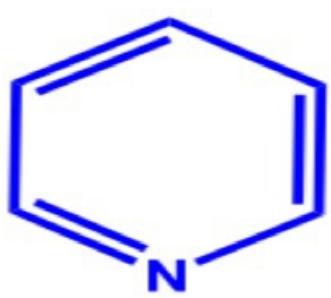
4)



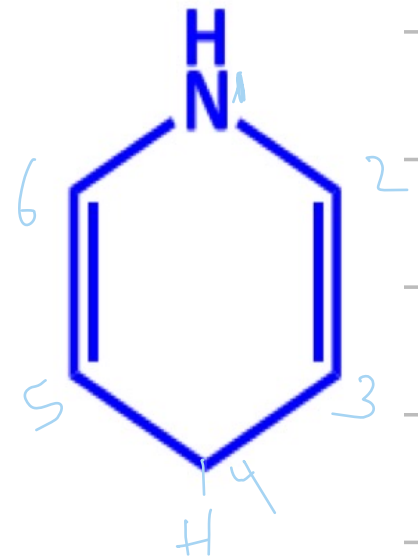
Functional group

Coumarin

5) : Pyridine الأساس

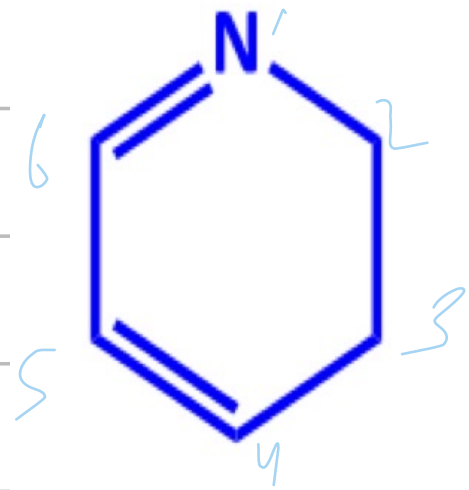


Pyridine



1,4-Dihydropyridine

1,4-DHP



2,3-Dihydropyridine

IUPAC → Hantzsch - widman ⇒ for monocyclic compound only

① نوع الـ heteroatom سنا و كم وحدة منّا.

N O S

② حجم الحلقة (Ring size)

ثلاثية
رباعية
خماسية
سداسية
سباعية
ثمانية
تساعية
عشارية.

③ Saturation (وجود الروابط الثنائية)

no double bond ← fully saturated

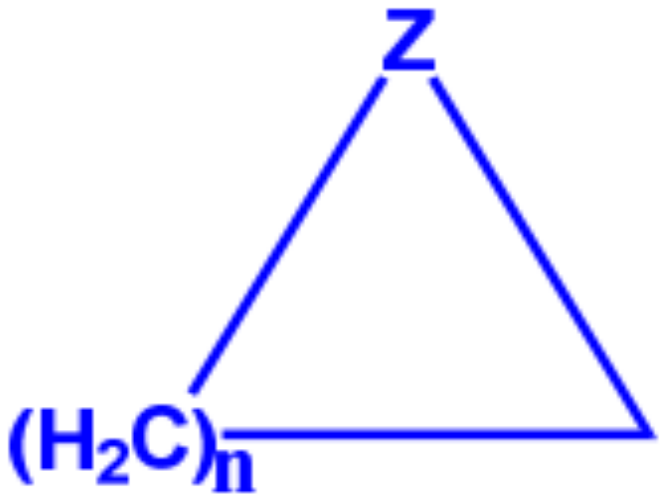
عناصر الكربون ← fully unsaturated ← double bond

double كم ← semi unsaturated

وين مرتفعهم

④ طبيعة وكان التفرع.

I. Hantzsch-Widman Nomenclature



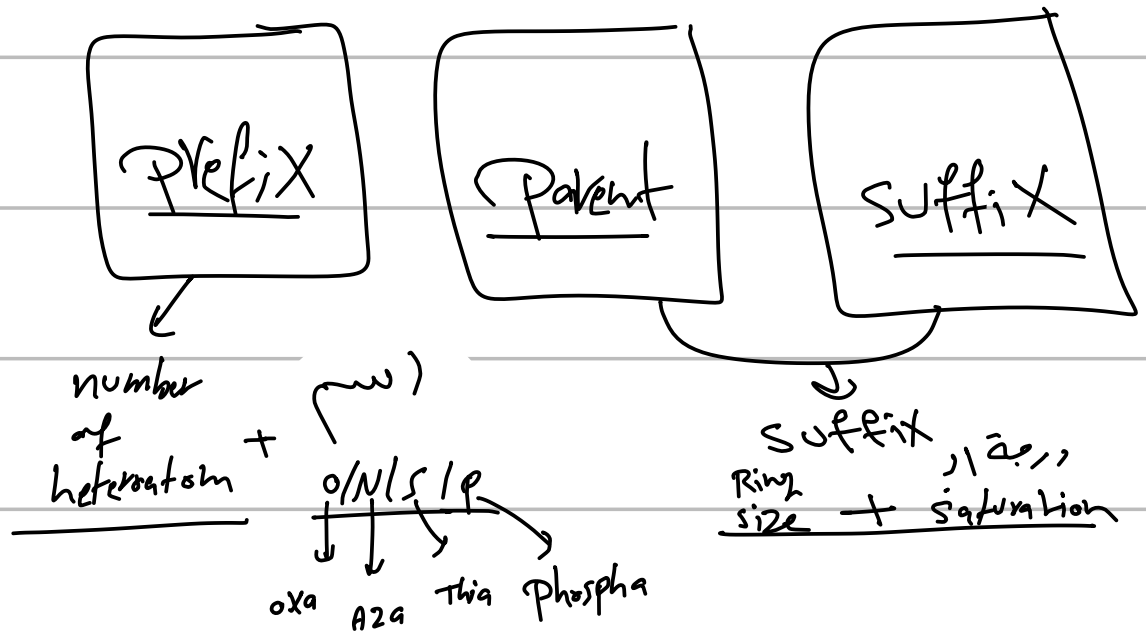
n = 1,2,3, ...

The Hantzsch-Widman nomenclature is based on the type (Z) of the heteroatom; the ring size (n) and nature of the ring, whether it is saturated or unsaturated .

This system of nomenclature applies to monocyclic three-to-ten-membered ring heterocycles.

Hantzsch-widman يتشمل فقط ال الحلقات الغير عادية (تكون من حلقة واحدة فقط) وعدد كربوناتها (3-10) .

اسم المركب الكيميائي



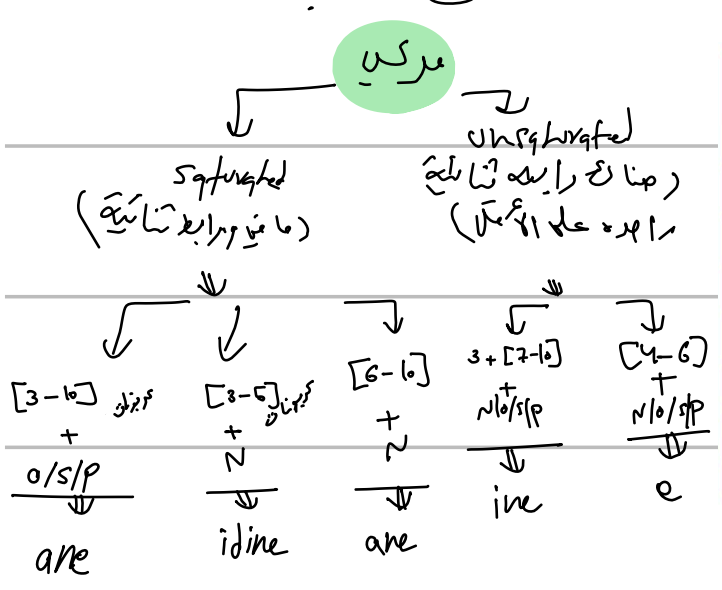
Prefix = number of heteroatom + heteroatom

O → oxa
N → a2a
S → thia
P → phospha

parent + suffix = suffix = Ring size + degree of saturation

Ring size	Suffix	Ring size	Suffix
3	ir	7	ep
4	et	8	oc
5	ol	9	on
6	in	10	ec

ملخص الجدول (Suffix)

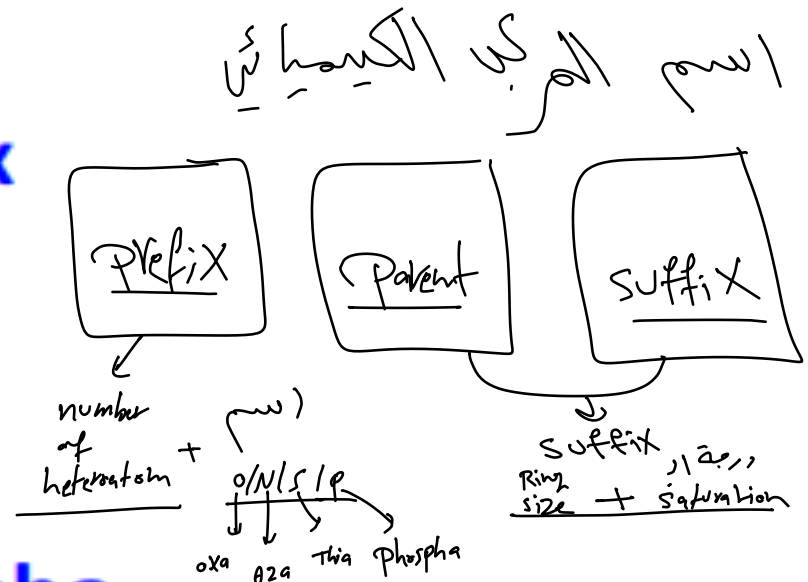


Ring size	Saturated	Unsaturated	Saturated (With Nitrogen)
3	-irane	-irine	-iridine
4	-etane	-ete	-etidine
5	-olane	-ole	-olidine
6	-inane	-ine	
7	-epane	-epine	
8	-ocane	-ocine	
9	-onane	-onine	
10	-ecane	-ecine	

I. Type of the heteroatom

The type of heteroatom is indicated by a prefix as shown below for common hetreroatoms:

Hetreroatom	Prefix
O	Oxa
N	Aza
S	Thia
P	Phospha



Prefix = number of heteroatom + heteroatom (سمي)
o → oxa
N → aza
S → thia
P → phospha

parent + suffix = suffix = Ring size + degree of saturation

II. Ring size (n)

The ring size is indicated by a suffix according to Table I below. Some of the syllables are derived from Latin numerals, namely ir from tri, et from tetra, ep from hepta, oc from octa, on from nona, ec from deca.

Table I: Stems to indicate the ring size of heterocycles

Ring size	Suffix	Ring size	Suffix
3	ir	7	ep
4	et	8	oc
5	ol	9	on
6	in	10	ec

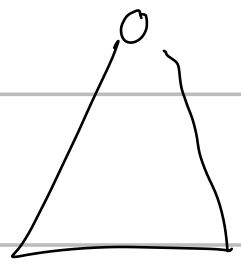
The endings indicate the size and degree of unsaturation of the ring.

(suffix)

Table II: Stems to indicate the ring size and degree of unsaturation of heterocycles

Ring size	Saturated	Unsaturated	Saturated (With Nitrogen)
3	-irane	-irine	-iridine
4	-etane	-ete	-etidine
5	-olane	-ole	-olidine
6	-inane	-ine	
7	-epane	-epine	
8	-ocane	-ocine	
9	-onane	-onine	
10	-ecane	-ecine	

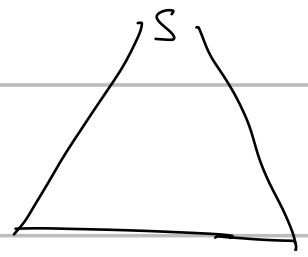
(examPles)



OXa + ir + ane

(O يحذف لأن بعده ذرة)

oxirane



Thia + ir + ane (ن تتبعه)

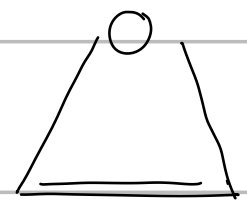
Thiirane

✓ لا يتم عرضها على أنها عادي

ملاحظة:
لو بعد ما حذفت أول ذرة وأصبحت الجملة تبدأ بحرف ساكن جنب بعضه عادي فالحمد لله.

Aza + ir + idine

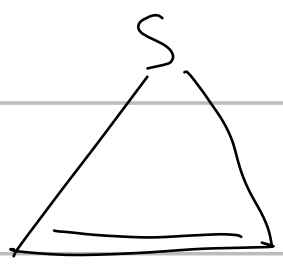
Aziridine



oxa + ir + ine

oxirine / oxirene

حسب العدد / الكتابة بالعدد.



thia + ir + ine

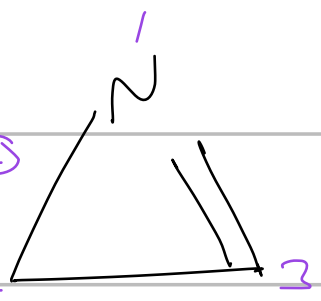
thiirine / thiirene

Aza + ir + ine

1-H

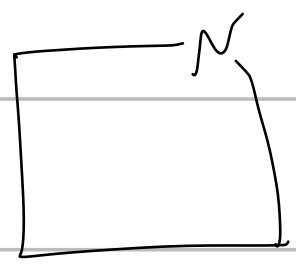
Azirine / Azirene

① بعض الذرة المختلفة رقم واحد
② يمشي على اتجاه الترتيب.

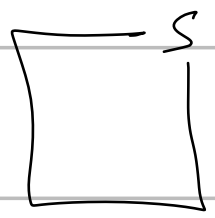


2-H

Aza + ir + ine → Azirine / Azirene

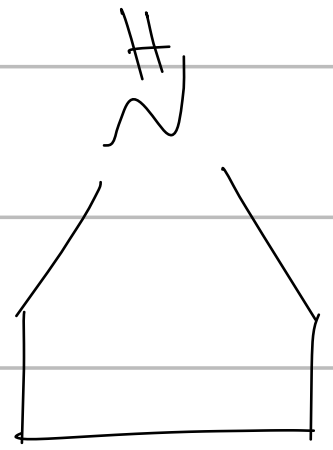


Aza + ti + idine → Azatidine



Thia + ti + ane

Thiatane



Aza + ol + idine

Azolidine

Aza + ol + e

Azole

Aza + in + ane

Azinane

According to this system heterocyles are named by combining appropriate prefix/prefixes with a stem from Table II. The letter "a" in the prefix is omitted where necessary.

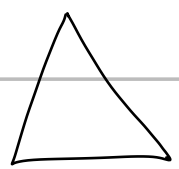
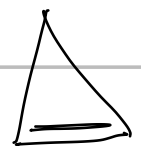
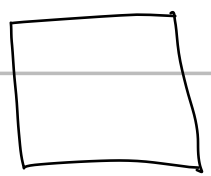
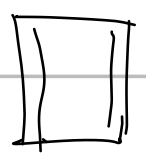
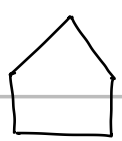
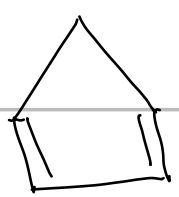
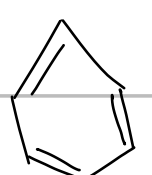
اذا التقى حرفان علة بنحذف الحرف الأول.

Each suffix consists of a ring size root and an ending intended to designate the degree of unsaturation in the ring.

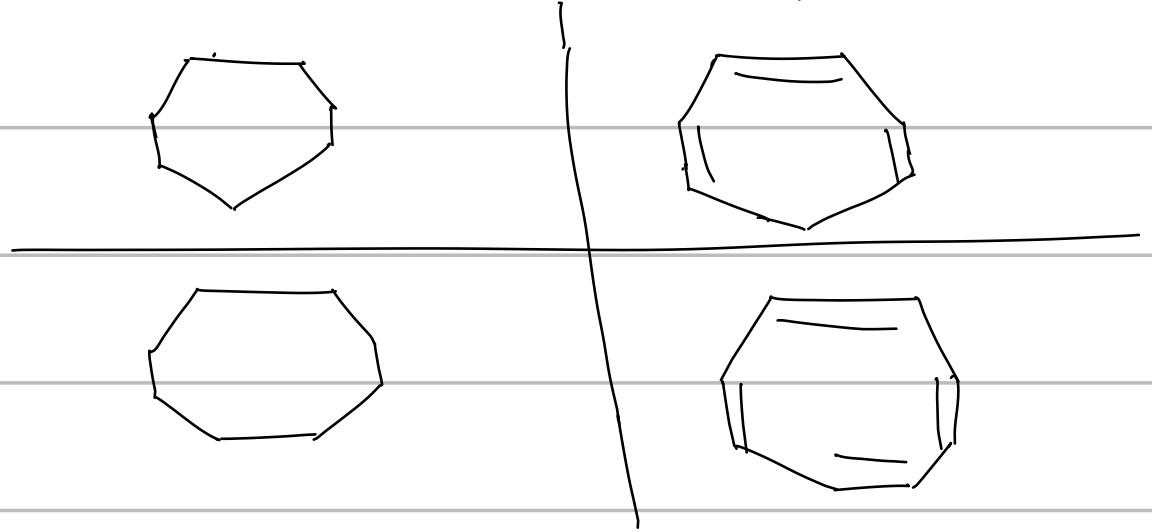
Suffix = ring size + degree of saturation

It is important to recognize that the saturated suffix applies only to completely saturated ring systems, and the unsaturated suffix applies to rings incorporating the maximum number of non-cumulated double bonds.

It is important to recognize that the saturated suffix applies only to completely saturated ring systems, and the unsaturated suffix applies to rings incorporating the maximum number of non-cumulated double bonds.

fully saturated	fully unsaturated
	
	
	
	

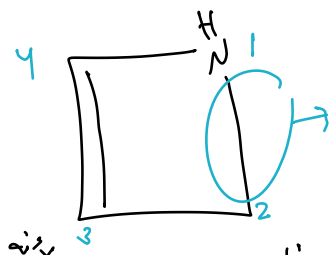
* الجدول يلي كان قبل ما يطبق على المركبات Completely يلي saturated or unsaturated ما فيا ما بين وبين



⇒ lesser degree of unsaturation

⇒ يعني أقل درجة عدم تشبع

Example



Fully unsaturated يعني مفيش ولا رابطة ثنائية H

A2a + ti + idine

+ A2atidine

1,2dihydro يعني أضفنا 2H

يعني مكان الرابطة الثنائية زادت 2H

Systems having a lesser degree of unsaturation require an appropriate prefix, such as "dihydro"or "tetrahydro".

حسب كم رابطة ثنائية شلت أو أضفت كم هيدروجين

Saturated 3, 4 & 5-membered nitrogen heterocycles should use respectively the traditional "iridine", "etidine" & "olidine" suffix.

كيناها

Saturated (With Nitrogen)
-iridine
-etidine
-olidine

Examples

Oxa+irane= Oxirane

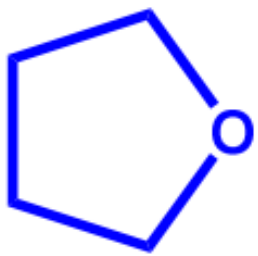
Thia+irane= Thiirane

Aza+iridine= Aziridine

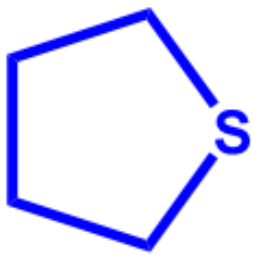
Oxa+etane=Oxetane

Thia+etane=Thietane

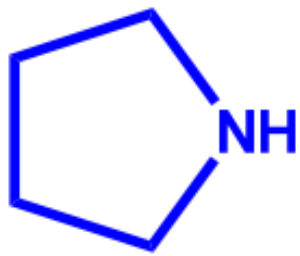
Aza+etidine=Azetidine



Oxa+olane= Oxolane



Thia+olane= Thiolane

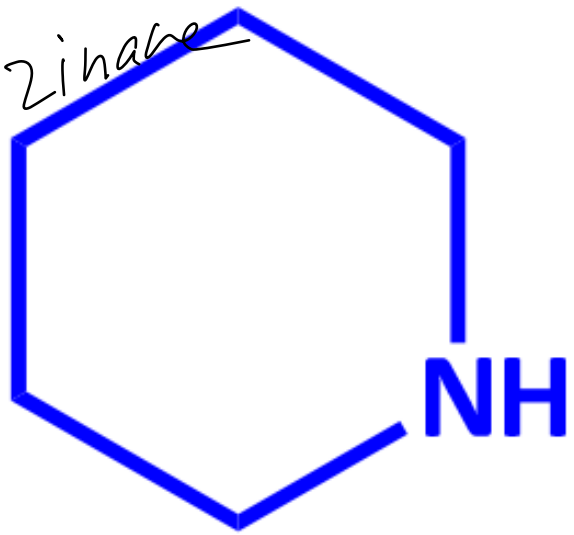


Aza+olidine= Azolidine

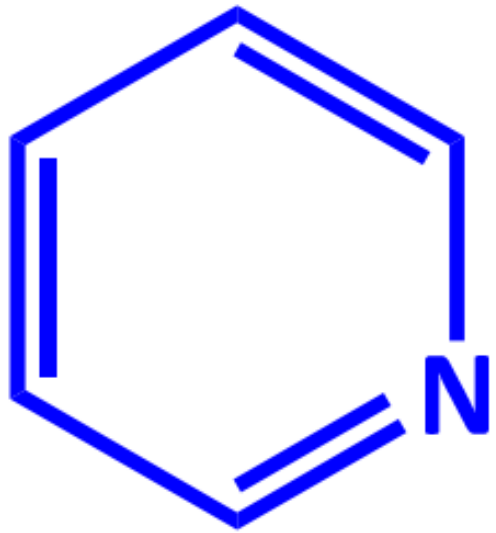
N 6C Saturated (N) (6C)

Aza + in + ane

Azinane



Azinane



Azine

N 6C fully unsaturated

Aza + in + e

Azine

Pyridine

Common Name: Pyridine

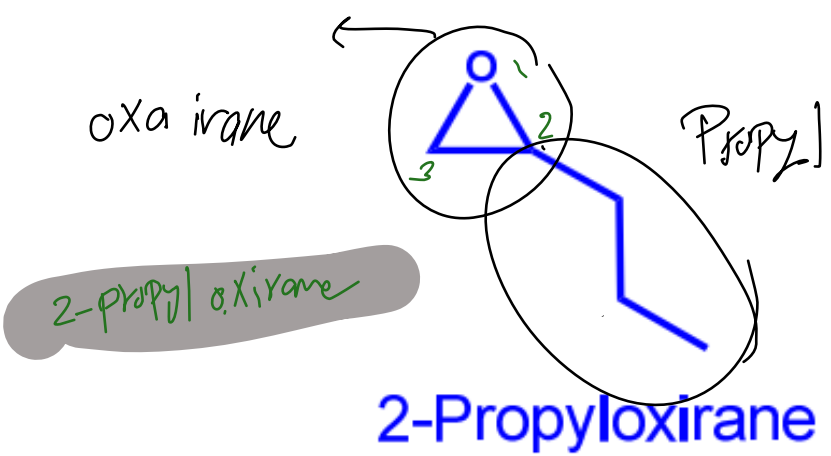
آخر سؤال Perhydro Azine

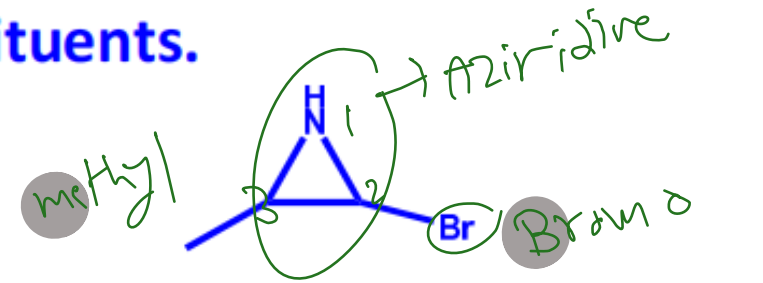
٩) حكينا بنبدأ على التفرع نوعه + موقعه

دايمًا بالترقيم ⇐ ① نعطي الـ heteroatom رقم واحد

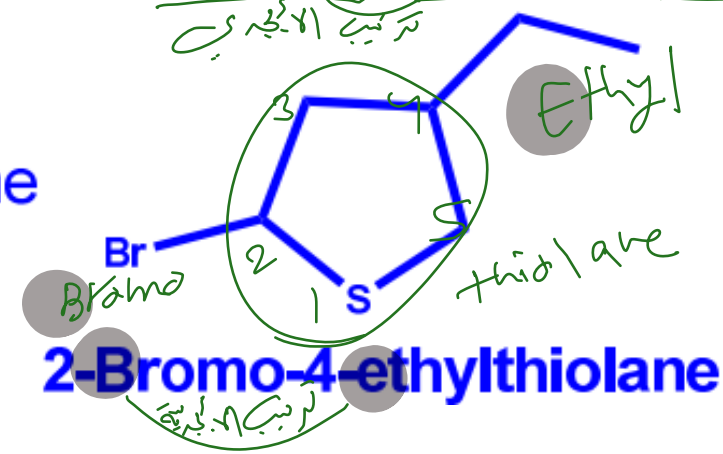
② وبنبدأ منه بالحلقة بحيث نعطي التفرع أقل رقم ممكن.

In case of substituents, the heteroatom is designated number 1, and the substituents around the chain are numbered so as to have the lowest number for the substituents.





ترتيب ابجدي

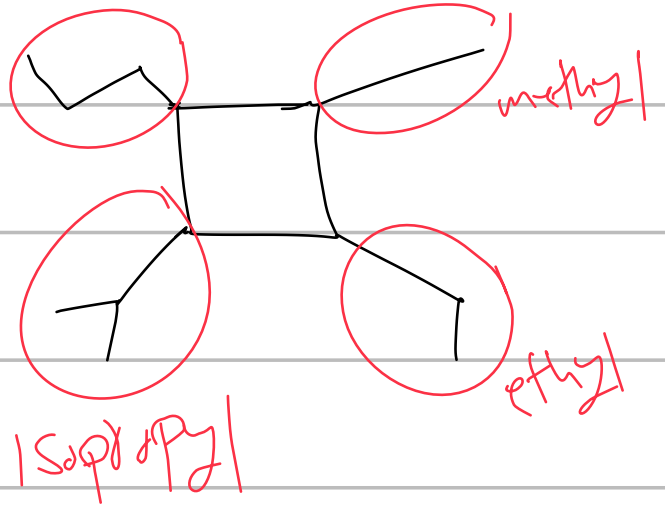


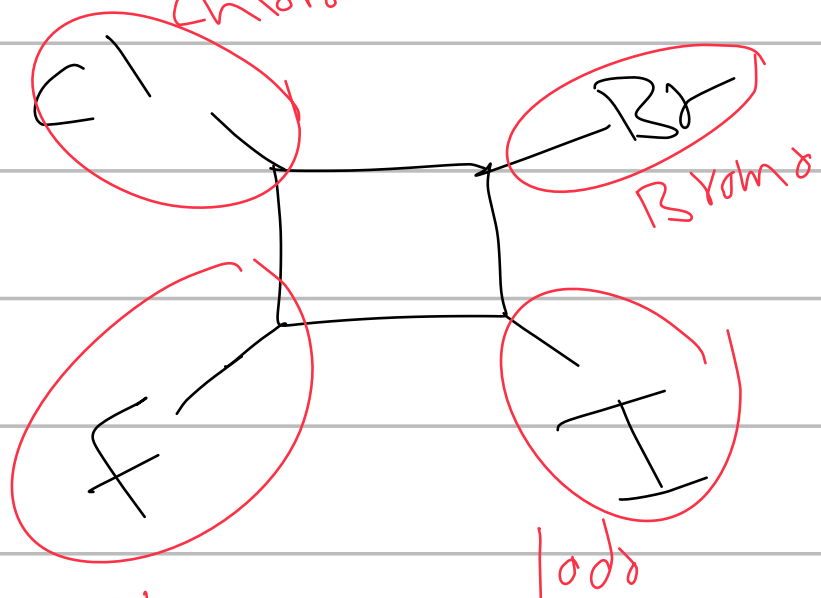
ترتيب ابجدي

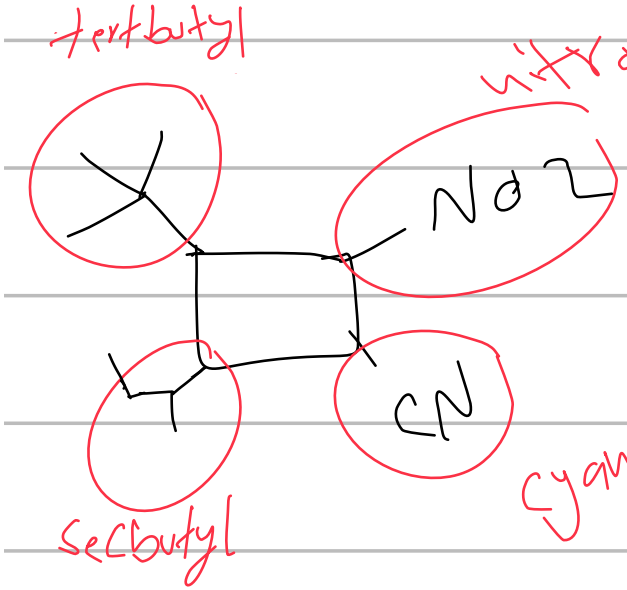
2-Bromo-4-ethylthiolane

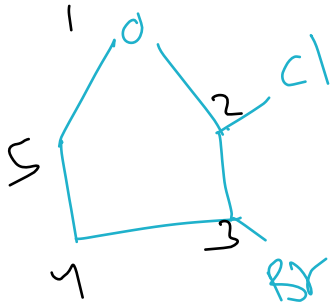
(تذكير بمجموعة التفرعات)

ملاحظة :
sec, ter } نضعها بالترتيب الأبجدي



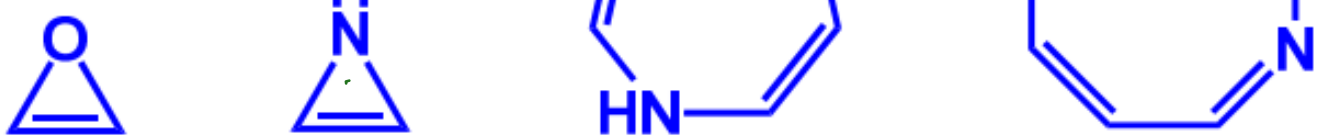






⇒ 3-Bromo-2-chloro oxo|ane

The compound with the maximum number of noncumulative double bonds is regarded as the parent compound of the monocyclic systems of a given ring size.



Oxirine **Azirine** **Azepine** **Azocine**

O 3C
Oxa + ir + ine
oxirine

N 3C
Aza + ir + ine
Azirine

N 7C
Aza + ep + ine
Azepine

N 8C
Aza + oc + ine
Azocine

سلايدات مراجعة

NAMING SIMPLE MONOCYCLIC COMPOUNDS

1. The heteroatom is given a name and is used as a prefix:

- N, aza-;
- O, oxa-;
- S, thia-;
- P, phospha-;
- As, arsa-;
- Si, sila-;
- Se, selena-,
- B,bora
- The “a” ending is dropped if the next syllable starts with a vowel. Thus “aza-irine” is properly written “azirine.”

prefix = name of heteroatom

* في حالة اكثر حرفان حذف الأول اذا بعد الحذف استمر وجود حرفان حلو وراضفا عادي بتخليهم.

- 2. Ring size is designated by stems that follow the prefix:
- 3-atoms,-ir-;
- 4-atoms, -et-;
- 5-atoms, -ol-;
- 6-atoms, -in-;
- 7-atoms, -ep-;
- 8-atoms, -oc-;
- 9-atoms, -on-; and so on.

suffix = Ring size + degree of saturation

Ring size	Suffix	Ring size	Suffix
3	ir	7	ep
4	et	8	oc
5	ol	9	on
6	in	10	ec

- 3. If fully unsaturated, the name is concluded with a suffix for ring
- size: 3-atoms, -ene (except -ine- for N);
- 4-, 5-, and 6-atoms, -e;
- 7-, 8-, and 9- atoms, -ine.

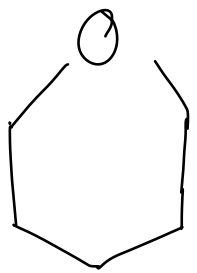
Ring size	Saturated	Unsaturated	Saturated (With Nitrogen)
3	-irane	-irine	-iridine
4	-etane	-ete	-etidine
5	-olane	-ole	-olidine
6	-inane	-ine	
7	-epane	-epine	
8	-ocane	-ocine	
9	-onane	-onine	
10	-ecane	-ecine	

Ring size	Saturated	Unsaturated	Saturated (With Nitrogen)
3	-irane	-irine	-iridine
4	-etane	-ete	-etidine
5	-olane	-ole	-olidine
6	-inane	-ine	-idine
7	-epane	-epine	-ocine
8	-ocane	-ocine	-onine
9	-onane	-onine	-ecine
10	-ecane	-ecine	

Perhydro → كاملة Saturated

hexahydro → ستة 6 atoms Saturated

- 4. If fully saturated, the suffix is -ane for all ring sizes,
- except forN, which uses -idine for rings of 3-, 4-, or 5-atoms,
- and for 6-atoms, a prefix of hexahydro- is used.
- Also, the name oxane, not oxinane, is used for the 6-membered ring with O present. Otherexceptions exist for P, As, and B rings, but they will not be given
- here.



oxa + in + ane

oxane ← oxinane ✗