

# Heterocyclen

Jede heterocyclische Verbindung lässt sich auf ein heterocyclisches Grundsystem zurückführen. Die heterocyclischen Grundsysteme besitzen nur H-Atome an den Ringatomen gebunden.

Nach den IUPAC-Regeln kommen zwei Nomenklatorsysteme zur Anwendung. Die *Hantzsch-Widman-Nomenklatur* wird bei drei- bis zehngliedrigen Heterocyclen und die *Austausch-Nomenklatur* bei höhergliedrigen Heterocyclen verwendet.

## Hantzsch-Widman-Nomenklatur

Die Art des Heteroatoms wird durch ein Präfix entsprechend der nachfolgenden Aufzählung bezeichnet.

O oxa, S thia, Se selena, Te tellura, N aza, P phospho, As arsa, Sb stiba, Bi bismuta, Si sila, Ge germa, Sn stanna, Pb plumba, B bora, Hg mercura

Die Größe des Ringes wird durch eine Endung entsprechend der nachfolgenden Übersicht zum Ausdruck gebracht.

Ringgröße	Endungen Stammverbindung		Endungen gesättigt	
	N-haltig	N-frei	N-haltig	N-frei
3	irin	iren	iridin	iran
4	et	et	etidin	etan
5	ol	ol	olidin	olan
6	in	in	inan	an
7	epin	epin	epan	epan
8	ocin	ocin	ocan	ocan
9	onin	onin	onan	onan
10	ecin	ecin	ecan	ecan

## Monocyclische Systeme

Die Stammverbindung wird benannt, indem man ein oder mehrere Präfixe mit einer Endung aus der Tabelle verbindet. Folgen zwei Vokale nacheinander, wird der Buchstabe a im Präfix weggelassen (z.B. Azin und nicht Azain) . Vollständig gesättigte Ringe bekommen eine besondere Endung (siehe Tabelle <Endungen gesättigt>).

Bei einem Heteroatom beginnt die Nummerierung des Systems beim Heteroatom.

Für zwei oder mehrere gleiche Heteroatome werden die Präfixe Di-, Tri-, Tetra- usw. verwendet und die Positionen durch kleinstmögliche Zahlen bezeichnet.

Für zwei oder mehrere verschiedene Heteroatome ist die oben aufgeführte Reihenfolge ( oxa, thia, selena usw.) maßgebend.

Das Heteroatom, welches in dieser Aufstellung zuerst genannt wird, erhält bei der Positionsangabe die Ziffer 1. Danach wird so nummeriert, daß die übrigen Heteroatome kleinstmögliche Zahlen erhalten.

## Bi- und polycyclische Systeme

Der Heterocyclen ist die Grundkomponente. Die Bindungen zwischen seinen Ringatomen werden entsprechend der Bezifferung der Ringatome durch die Buchstaben a, b, c usw. bezeichnet. Dabei sind möglichst niedrige Buchstaben zu vergeben. Die Vergabe der Buchstaben für die Bindungen muß entgegengesetzt der Atombezifferung erfolgen, wenn dadurch der Buchstabe kleiner wird.

Bei zwei oder mehreren heterocyclischen Ringen wird ein Ring als Grundkörper bestimmt. Zur Bestimmung werden die nachfolgenden Kriterien in der angegebenen Reihenfolge geprüft, bis eine Entscheidung getroffen werden kann.

Die Grundkomponente ist

- eine stickstoffhaltige Komponente,
- eine Komponente mit einem Heteroatom außer Stickstoff in der Reihenfolge der Präfixe (siehe oben: oxa, thia usw.),
- eine Komponente mit möglichst vielen Ringen,
- die Komponente mit dem größten Ring,
- die Komponente mit den meisten Heteroatomen,
- die Komponente mit der größten Zahl verschiedener Heteroatome,
- die Komponente mit den meisten Heteroatomen, die in der Übersicht der Präfixe (oxa,thia usw.) am höchsten steht
- die Komponente, deren Heteroatome die niedrigsten Zahlen aufweisen.

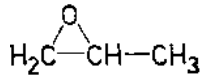
## Indizierter Wasserstoff

Bei vielen Heterocyclen existieren mehrere Konstitutionsisomere , die sich nur in der Stellung des H-Atoms am Ring unterscheiden. Bei den Isomeren wird vor dem Namen des Grundkörpers die Positionsanzahl und ein kursives großes H gesetzt. Dieses H-Atom wird als indizierter Wasserstoff bezeichnet. Beispiele: *2H*-Pyrrol, *6H*-Indol

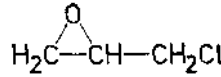
# 1 Heterocyclen mit 3-gliedrigem Ring (Oxirane, Aziridine)



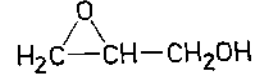
Oxiran  
*Ethylenoxid*  
F.-112°C, Kp.11°C



Methyloxiran  
*Propylenoxid*  
F.-112°C, Kp.34°C, LW.405



Chlormethyloxiran  
*Epichlorhydrin*  
F.-48°C, Kp.116°C, D.1,180, LW.60



Hydroxymethyloxiran  
*Glycidol*  
F.-54°C, Kp.161°C, D.1,115



Thiiran  
*Ethylensulfid*  
Kp.56°C



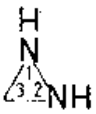
Aziridin



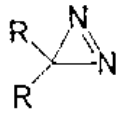
Oxaziran



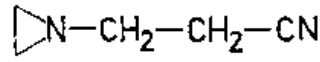
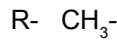
Diazirin



Diaziridin



3,3-Dimethyl-diazirin  
Kp.21°C



Cyanpropyl-aziridin

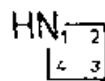
# 2 Heterocyclen mit 4-gliedrigem Ring (Oxetane)



Oxetan  
*Trimethylenoxid*  
F.-97°C, Kp.47°C, D.0,892



1,2-Dioxetan



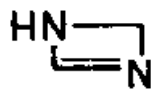
Azetidin



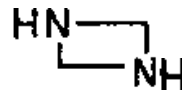
Azet



1,3-Diazet



1,3-Diazetin

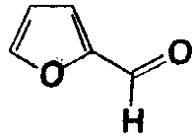


1,3-Diazetidin

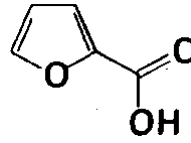
**3**  
**3.1 Heterocyclen mit 5-gliedrigem Ring**  
**Furane, Benzofurane**



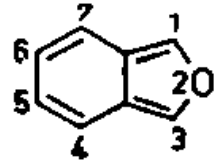
Furan  
 Kp.32°C



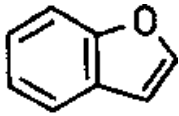
Furan-2-carbaldehyd  
*Furfural*  
 Kp.162°C



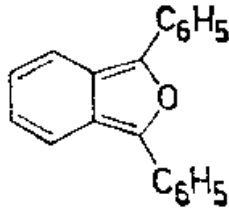
Furan-2-carbonsäure  
*Brenzschleimsäure*  
 F.128°C, Kp.231°C, LW.36



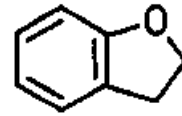
Benzo[c]furan  
*Isobenzofuran*



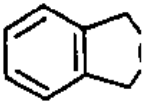
Benzo[b]furan  
*Cumaron*  
 Kp.174°C, D.1,095



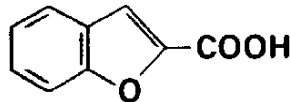
1,3-Diphenyl-benzo[c]furan



2,3-Dihydrobenzo[b]-furan  
 F.127°C



1,3-Dihydrobenzo[c]furan



Benzo[b]furan-2-carbonsäure  
*Cumarilsäure*  
 F.189°C, Z.310°C

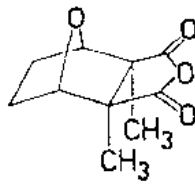
**3.2 Di- und Tetrahydrofurane**



2,5-Dihydrofuran  
 Kp.68°C, D.0,946

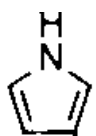


Tetrahydrofuran  
*Oxolan*

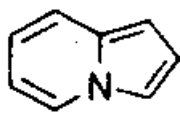


Cantharidin

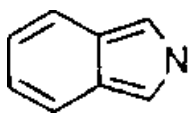
### 3.3 Pyrrole, Indole



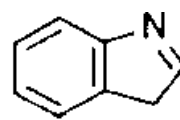
Pyrrol



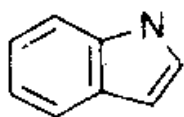
Indolizin



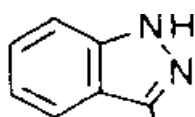
Isoindol



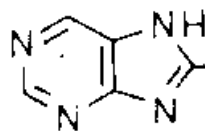
3H-Indol



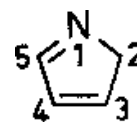
Indol



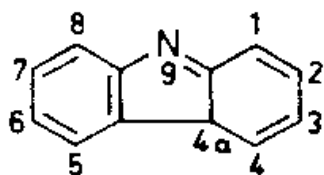
1H-Indazol



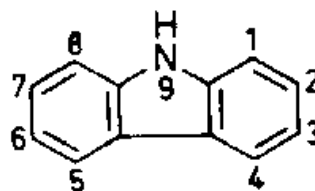
Purin



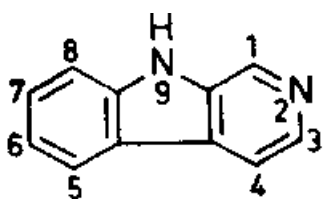
2H-Pyrrol



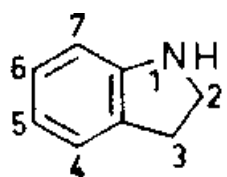
4aH-Carbazol



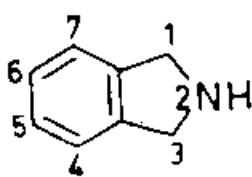
Carbazol



$\beta$ -Carbolin

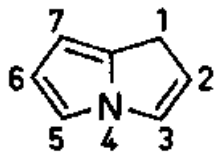


2,3-Dihydroindol  
Indolin

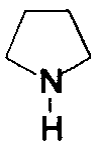


Isoindolin

### 3.4 Pyrrolidine, Pyrrolidone

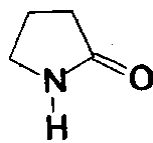


1H-Pyrrolizin

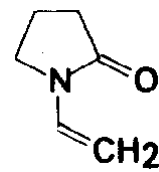


Pyrrolidin

F.-63°C, Kp.87°C, D.0,86



Pyrrolidin-2-on  
*γ-Butyrolactam*  
F.25°C, Kp.245°C, D.1,11



1-Ethenyl-pyrrolidin-2-on

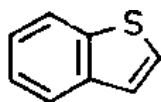
F.13°C, D.1,043

### 3.5 Thiophene (auch S,S-Dioxide)



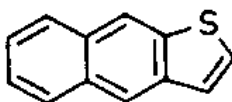
Thiophen

Kp.84°C

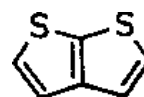


Benzo[b]thiophen  
*Thionaphthen*

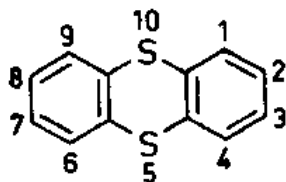
F.30°C, D.1,15



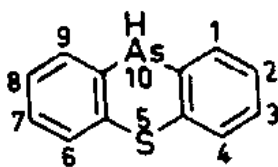
Naphtho[2,3-b]thiophen



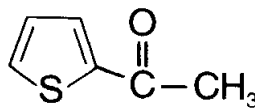
Thieno[2,3-b]thiophen  
*Thiophthen*



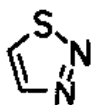
Thianthren



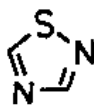
Phenothiarsin



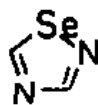
2-Acetylthiophen  
F.9°C, Kp.213°C



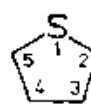
1,2,3-Thiadiazol



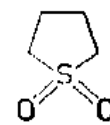
1,2,4-Thiadiazol



1,2,4-Selenadiazol



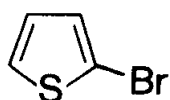
Tetrahydrothiophen



Thiolandioxid

*Thiolan*

*Sulfolan*  
F.27°C, Kp.285°C



2-Bromthiophen

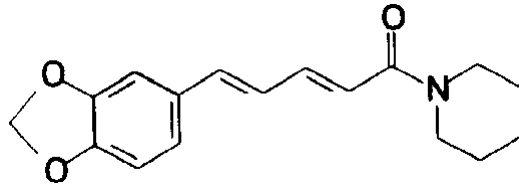
D.1,684

### 3.6 1,3-Dioxolane



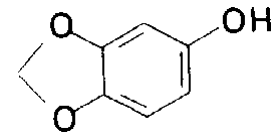
1,3-Dioxolan

F.-26°C, Kp.74°C, D.1,065



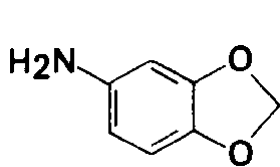
1-Piperoylpiperidin  
*Piperin*

F.129°C, LW.0,04

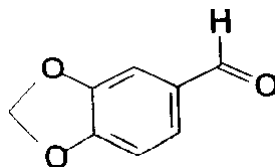


5-Hydroxy-benzo-1,3-dioxol  
*Sesamol*

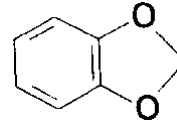
F.62°C



Benzo-1,3-dioxol-5-amin  
*3,4-Methylenedioxyanilin*  
F.43°C

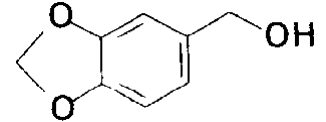


Benzo-1,3-dioxol-5-carbaldehyd  
*Heliotropin*



Benzo-1,3-dioxol

F.-18°C, Kp.174°C, D.1,185



5-(Hydroxymethyl)-benzo-1,3-dioxol  
*Piperonylalkohol*

F.53°C

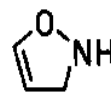
### 3.7 Isoxazole, Oxazole



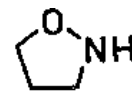
Isothiazol



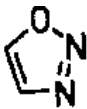
Isoxazol



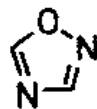
2,3-Dihydroisoxazol



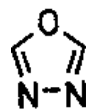
Tetrahydroisoxazol



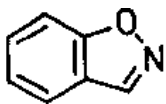
1,2,3-Oxadiazol



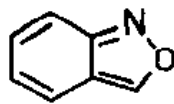
1,2,4-Oxadiazol



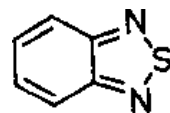
1,3,4-Oxadiazol



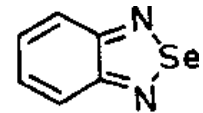
Benz[d]isoxazol



Benz[c]isoxazol

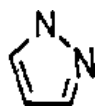


Benzo[c][1,2,5]thiadiazol

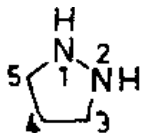


Benzo[c][1,2,5]selenadiazol

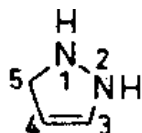
### 3.8 Pyrazole



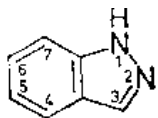
1,2-Diazol  
*Pyrazol*  
F.70°C



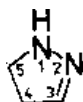
Pyrazolidin



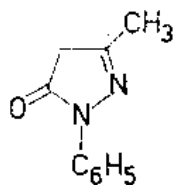
$\Delta^3$ -Pyrazolin



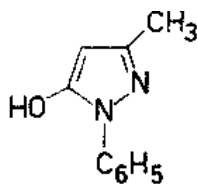
Indazol



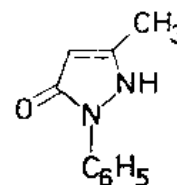
4,5-Dihydropyrazol  
*2-Pyrazolin*



3-Methyl-1-phenyl-2- pyrazolin-5-on



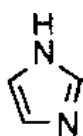
5-Hydroxy-3-methyl-1-phenyl-pyrazol



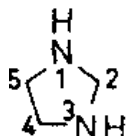
5-Methyl-2-phenyl-4-pyrazolin-3-on

F.127°C

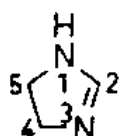
### 3.9 Imidazole, Benzimidazole



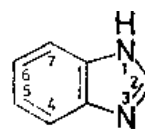
1,3-Diazol  
*Imidazol*  
F.90°C



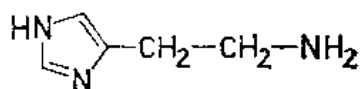
Imidazolidin



$\Delta^2$ -Imidazolin

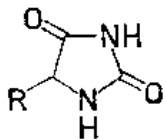


Benzimidazol

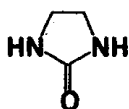


4-(2-Amino-ethyl)imidazol  
*Histamin*

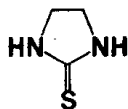
### 3.10 Imidazolidinone



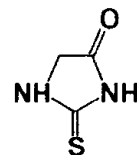
Imidazolidin-2,4-dione  
*Hydantoin*



Imidazolidin-2-on  
*N,N'-Ethylenharnstoff*

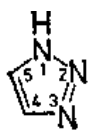


Imidazolidin-2-thion  
*N,N'-Ethylenthioharnstoff*  
Kp.198°C, LW.19

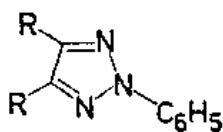


2-Thiohydantoin  
F.232°C

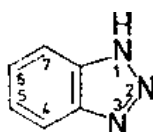
### 3.11 Triazole, Tetrazole



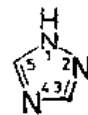
1,2,3-Triazol  
*vic-Triazol*



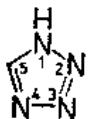
2-Aryl-1,2,3-triazole  
*Osotriazole*



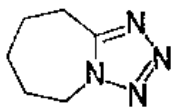
Benzotriazol



1,2,4-Triazol  
*sym-Triazol*

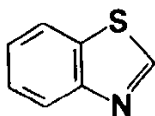


Tetrazol

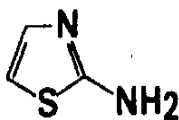


1,5-Pentamethylen-tetrazol  
*Pentetrazol*

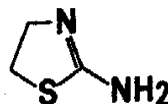
### 3.12 Thiazole



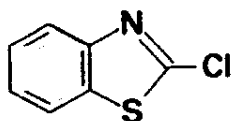
Benzothiazol  
F.2°C, D.1,244



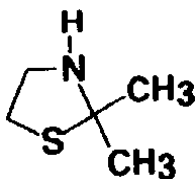
2-Aminothiazol  
*Thiazol-2-ylamin*  
F.87°C



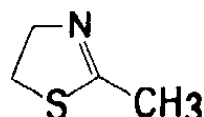
2-Amino-2-thiazolin  
F.78°C



2-Chlorbenzothiazol  
F.22°C



2,2-Dimethylthiazolidin  
D.1,016



2-Methyl-2-thiazolin  
Kp.145°C, D.1,076

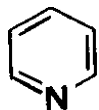


## 4 Heterocyklen mit 6-gliedrigem Ring

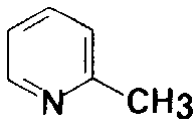
### 4.1 Pyridine

Dem N-Atom im Pyridin-Ring wird die Stellung 1 zugeordnet.

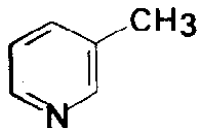
#### 4.1.1 Alkyl- und Aralkylpyridine



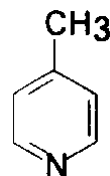
Azin  
*Pyridin*  
F. -41°C, Kp. 115°C  
D. 0,983



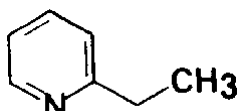
2-Methylpyridin  
*2-Picolin*  
F. -69°C, Kp. 129°C,  
D. 0,944



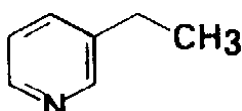
3-Methylpyridin  
*3-Picolin*  
F. -18°C, Kp. 144°C,  
D. 0,956



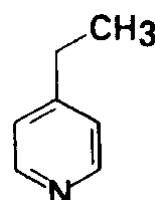
4-Methylpyridin  
*4-Picolin*  
F. 3°C, Kp. 145°C,  
D. 0,954



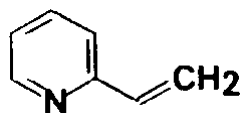
2-Ethylpyridin  
Kp. 148°C, D. 0,932, LW. 30



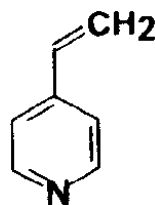
3-Ethylpyridin  
F. -77°C, Kp. 165°C, D. 0,941, LW. 28



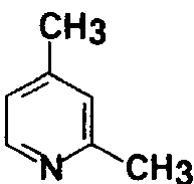
4-Ethylpyridin  
Kp. 168°C, D. 0,941



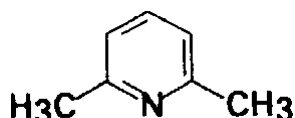
2-Ethenylpyridin  
*2-Vinylpyridin*  
D. 0,974, LW. 27



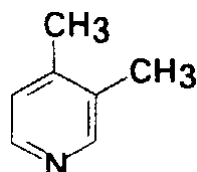
4-Ethenylpyridin  
*4-Vinylpyridin*  
D. 0,985, LW. 29



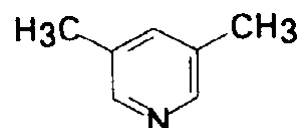
2,4-Dimethylpyridin  
*2,4-Lutidin*  
F. -60°C, Kp. 159°C, D. 0,931



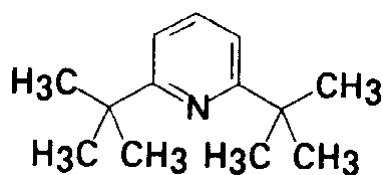
2,6-Dimethylpyridin  
*2,6-Lutidin*  
F. -6°C, Kp. 144°C, D. 0,923



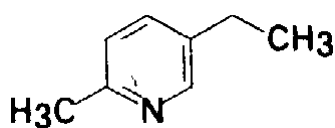
3,4-Dimethylpyridin  
*3,4-Lutidin*  
F. -12°C, Kp. 163°C, D. 0,956, LW. 52



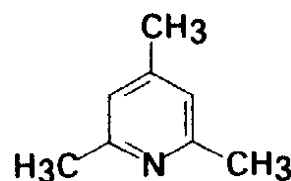
3,5-Dimethylpyridin  
*3,5-Lutidin*  
F. -9°C, Kp. 170°C, D. 0,942, LW. 33



2,6-Di-tert-butylpyridin  
D. 0,865

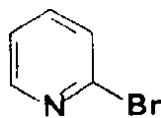


5-Ethyl-2-methylpyridin  
D. 0,919

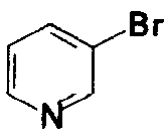


2,4,6-Trimethylpyridin  
*sym.-Collidin*  
F. -46°C, Kp. 171°C, LW. 35, D. 0,914

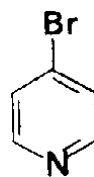
## 4.1.2 Halogen- und Hydroxypyridine



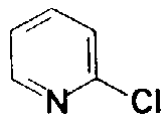
2-Bromopyridin  
Kp.193°C, D.1,617, LW.21



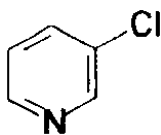
3-Bromopyridin  
Kp.174°C, D.1,624, LW.27



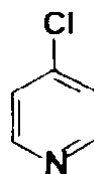
4-Bromopyridin



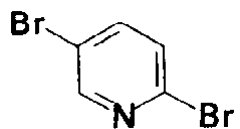
2-Chlorpyridin  
D.1,209



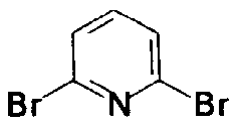
3-Chlorpyridin  
D.1,208, LW.10



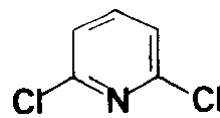
4-Chlorpyridin



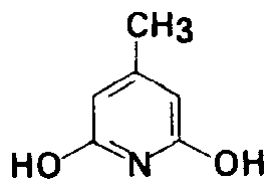
2,5-Dibrompyridin  
F.91°C



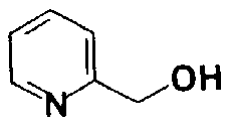
2,6-Dibrompyridin  
F.117°C, Kp.249°C



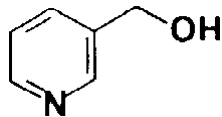
2,6-Dichlorpyridin  
F.84°C



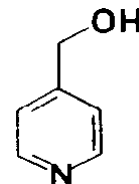
2,6-Dihydroxy-4-  
methylpyridin  
F.199°C



2-Pyridylmethanol  
2-(Hydroxymethyl)-  
pyridin  
D.1,132

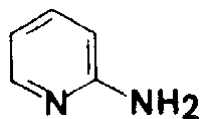


3-Pyridylmethanol  
3-(Hydroxymethyl)-  
pyridin  
D.1,135

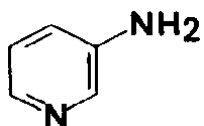


4-Pyridylmethanol  
4-(Hydroxymethyl)-  
pyridin  
F.57°C

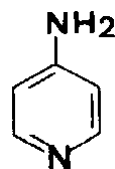
### 4.1.3 Aminopyridine



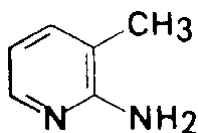
2-Aminopyridin  
F.57°C, Kp. 210°C



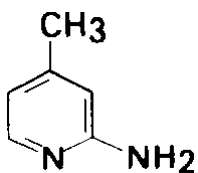
3-Aminopyridin  
F.61°C, Kp.251°C



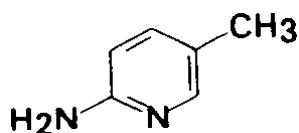
4-Aminopyridin  
F.158°C, Kp.274°C



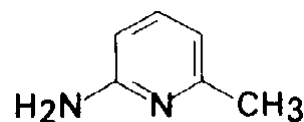
2-Amino-3-methylpyridin  
F.31°C, Kp.221°C



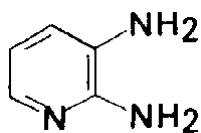
2-Amino-4-methylpyridin  
F.97°C, Kp.230°C



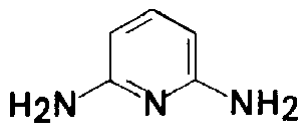
2-Amino-5-methylpyridin  
F.75°C, Kp.227°C, LW.100



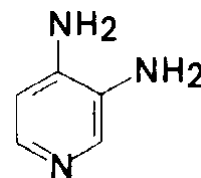
2-Amino-6-methylpyridin  
F.41°C, Kp.208°C



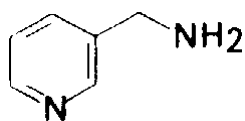
2,3-Diaminopyridin  
F.113°C



2,6-Diaminopyridin  
F.116°C

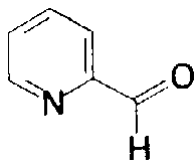


3,4-Diaminopyridin  
F.218°C

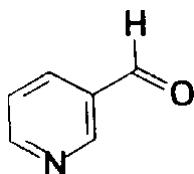


3-(Aminomethyl)-pyridin  
F.-21°C, D.1,069

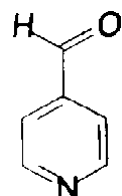
#### 4.1.4 Pyridinaldehyde, -ketone, -oxime



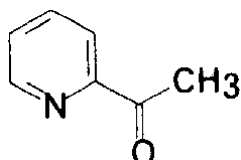
Pyridin-2-carbaldehyd  
*Picolinaldehyd*  
F.-21°C, Kp.181°C, D.1,121



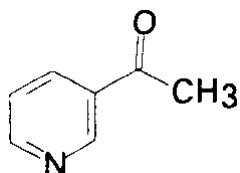
Pyridin-3-carbaldehyd  
*Nicotinaldehyd*  
Z.50°C, D.~1,14



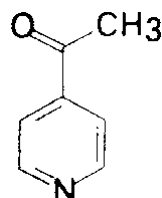
Pyridin-4-carbaldehyd  
*Isonicotinaldehyd*  
F.-4°C, Z.50°C, D.1,138



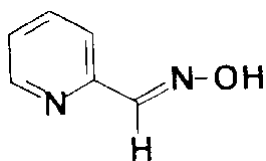
Methyl-2-pyridylketon  
*2-Acetylpyridin*  
Kp.188°C, D.1,082, LW.170



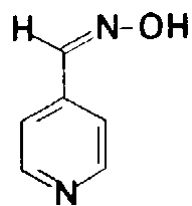
Methyl-3-pyridylketon  
*3-Acetylpyridin*  
Kp.224°C, D.1,106



Methyl-4-pyridylketon  
*4-Acetylpyridin*  
F.15°C, Kp.212°C, D.1,100, LW.0

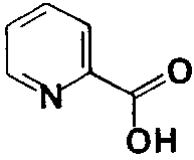


Pyridin-2-carbaldehydoxim  
*Picolinaldoxim*  
F.111°C, LW.20

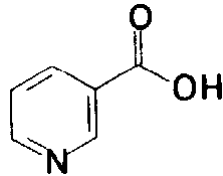


Pyridin-4-carbaldehydoxim  
*Isonicotinaldoxim*  
F.131°C, LW.10°C

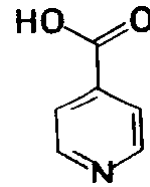
## 4.1.5 Pyridincarbonsäuren und Derivate



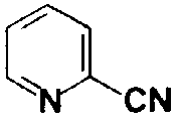
Pyridin-2-carbonsäure  
*Picolinsäure*  
F.135°C



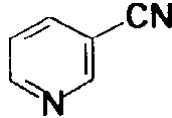
Pyridin-3-carbonsäure  
*Nicotinsäure*  
F.236°C



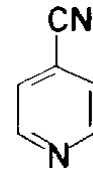
Pyridin-4-carbonsäure  
*Isonicotinsäure*  
LW.6 (25°C)



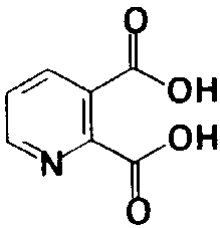
Pyridin-2-carbonitril  
*Picolinsäurenitril*  
*2-Cyanpyridin*  
F.26°C, Kp.213°C, LW.0



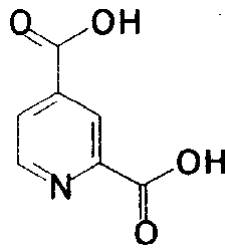
Pyridin-3-carbonitril  
*Nicotinsäurenitril*  
*3-Cyanpyridin*  
F.49°C, Kp.242°C, LW.140



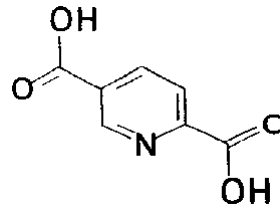
Pyridin-4-carbonitril  
*Isonicotinsäurenitril*  
*4-Cyanpyridin*  
F.77°C, Kp.195°C, LW.40



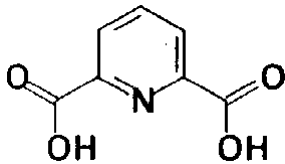
Pyridin-2,3-dicarbonsäure  
*Chinolinsäure*  
Z.185°C



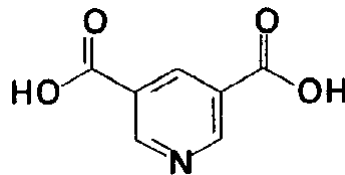
Pyridin-2,4-dicarbonsäure  
*Lutidinsäure*  
LW.0



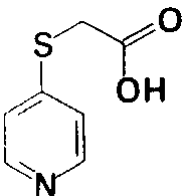
Pyridin-2,5-dicarbonsäure  
*Isocinchomeronsäure*  
LW.2



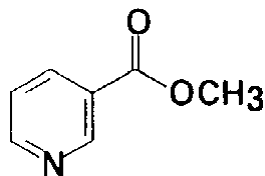
Pyridin-2,6-dicarbonsäure  
*Dipicolinsäure*  
Z.230°C, LW.5



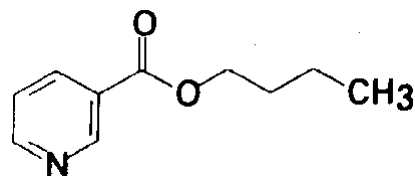
Pyridin-3,5-dicarbonsäure  
*Dinicotinsäure*  
Z.322°C, LW.0



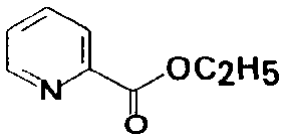
(4-Pyridylthio)-ethansäure  
F.256°C, LW.0



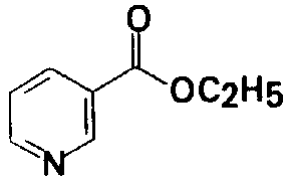
Pyridin-3-carbonsäuremethylester  
*Nicotinsäuremethylester*  
F.41°C, Kp.209°C



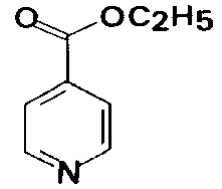
Pyridin-3-carbonsäurebutylester  
*Nicotinsäurebutylester*  
D.1,047



Pyridin-2-carbonsäureethylester  
*2-Picolinsäureäthylester*  
 F.2°C, Kp.240°C, D.1,118

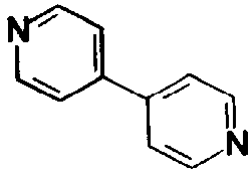


Pyridin-3-carbonsäureethylester  
*Nicotinsäureäthylester*  
 F.8°C, D.1,108

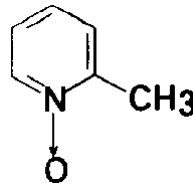


Pyridin-4-carbonsäureethylester  
*Isonicotinsäureäthylester*  
 D.1,104

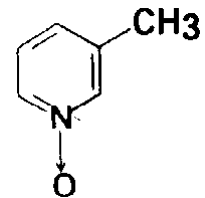
#### 4.1.6 Sonstige Pyridine



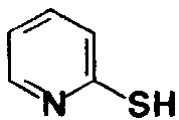
4,4'-Bipyridin  
*Dipyridil*  
 F.111°C, Kp.305°C



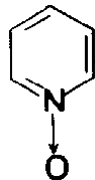
2-Methylpyridin-1-oxid  
*2-Picolin-N-oxid*  
 F.43°C



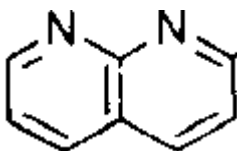
3-Methylpyridin-1-oxid  
*3-Picolin-N-oxid*  
 F.37°C



2-Pyridinthiol  
*2-Mercaptopyridin*  
 F.127°C, LW.50

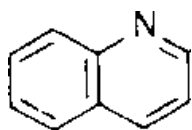


Pyridin-1-oxid  
 F.63°C, Kp.270°C

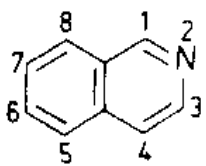


1,8-Naphthyridin

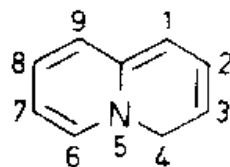
## 4.2 Chinoline, Acridine, Isochinoline



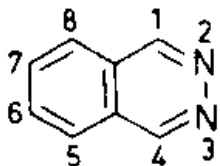
Chinolin



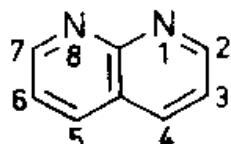
Isochinolin



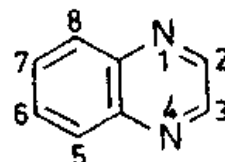
4H-Chinolizin



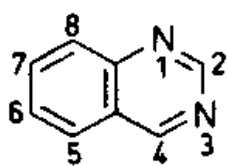
Phthalazin



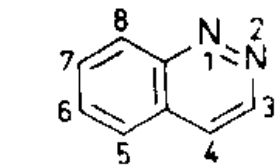
1,8-Naphthyridin



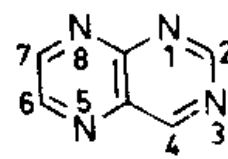
Chinoxalin



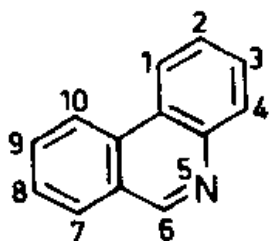
Chinazolin



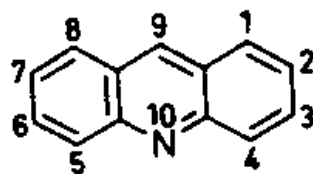
Cinnolin



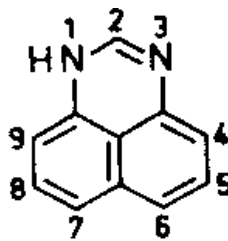
Pteridin



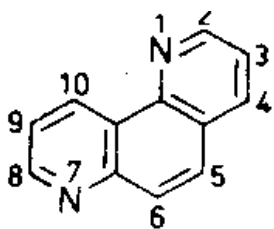
Phenanthridin



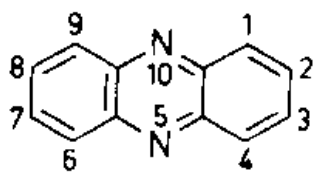
Acridin



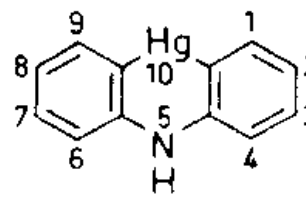
Perimidin



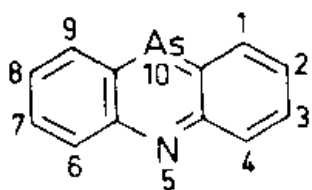
1,7-Phenanthrolin



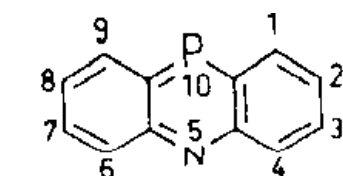
Phenazin



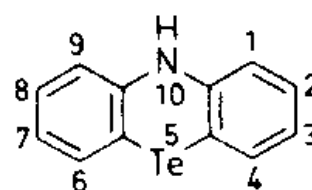
Phenomercazin



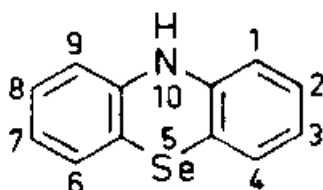
Phenarsazin



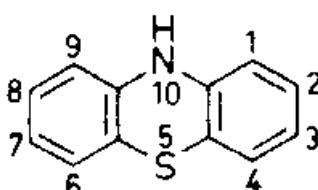
Phenophosphazin



Phenotellurazin

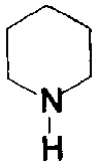


Phenoselenazin

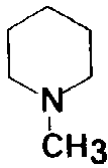


Phenothiazin

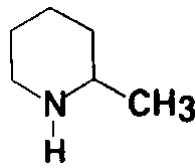
### 4.3 Piperidine



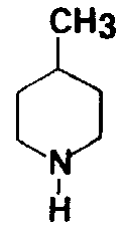
Piperidin  
*Hexahydropyridin*  
F. -10°C, Kp. 106°C, D. 0,862



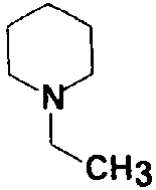
1-Methylpiperidin  
Kp. 106°C, D. 0,817



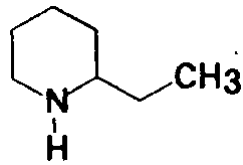
2-Methylpiperidin  
*2-Pipecolin*  
D. 0,841



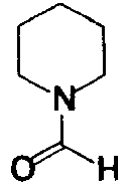
4-Methylpiperidin  
*4-Pipecolin*  
Kp. 124°C, D. 0,842



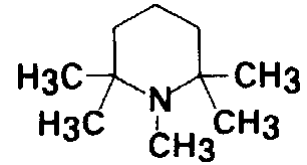
1-Ethylpiperidin  
Kp. 130°C, D. 0,825



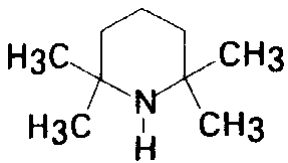
2-Ethylpiperidin  
F. -18°C, Kp. 142°C, LW. 60



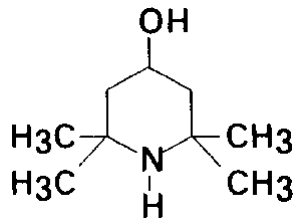
1-Formylpiperidin  
*1-Piperidincarboxaldehyd*  
Kp. 222°C, D. 1,019



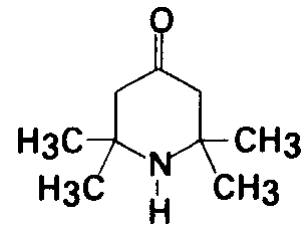
1,2,2,6,6-Pentamethylpiperidin  
*Pempidin*  
Kp. 187°C, D. 0,860



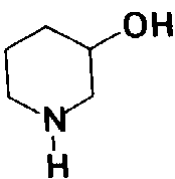
2,2,6,6-Tetramethylpiperidin  
Kp. 156°C, D. 0,831



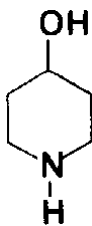
2,2,6,6-Tetramethyl-4-piperidinol  
*4-Hydroxy-2,2,6,6-tetramethylpiperidin*  
F. 129°C, Kp. 213°C, LW. 125



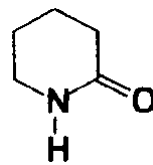
2,2,6,6-Tetramethyl-4-piperidinon  
F. 33°C



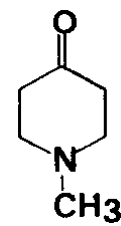
3-Piperidinol  
*3-Hydroxypiperidin*  
F. 57°C



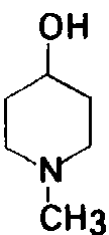
4-Piperidinol  
*4-Hydroxypiperidin*  
F. 87°C



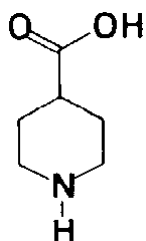
2-Piperidinon  
*2-Piperidon*  
F. 36°C



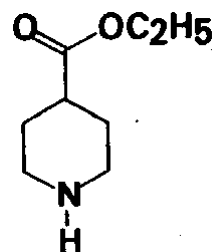
1-Methyl-4-piperidinon  
D. 0,973



1-Methyl-4-piperidinol  
*4-Hydroxy-1-methylpiperidin*  
F. 27°C, Kp. 200°C



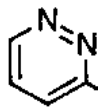
Piperidin-4-carbonsäure  
*Isonipecotinsäure*



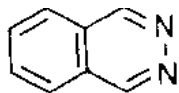
Piperidin-4-carbonsäureethylester  
*Äthyl-4-piperidincarboxylat*  
Kp. 204°C, D. 1,019



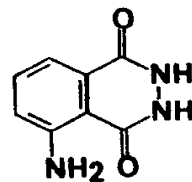
#### 4.4 1,2-Diazine



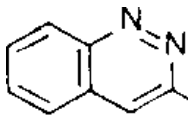
1,2-Diazin  
*Pyridazin*



Benzo[d]pyridazin  
*Phthalazin*

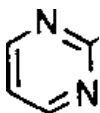


5-Amino-1,4-dihydroxy-phthalazin  
*Luminol*

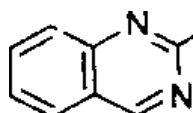


Benzo[c]pyridazin  
*Cinnolin*

#### 4.5 1,3-Diazine (Pyrimidine)

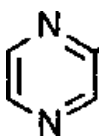


1,3-Diazin  
*Pyrimidin*

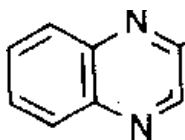


Benzo[d]pyrimidin  
*Chinazolin*

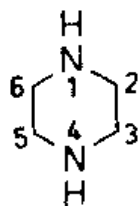
#### 4.6 1,4-Diazine, Piperazine



1,4-Diazin  
*Pyrazin*

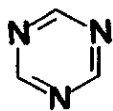


Benzopyrazin  
*Chinoxalin*



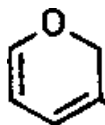
Hexahydropyrazin  
*Piperazin*

## 4.7 Triazine

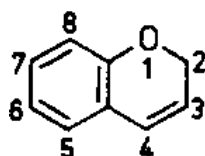


1,3,5-Triazin  
*s-Triazin*  
F.79°C, Kp.114°C

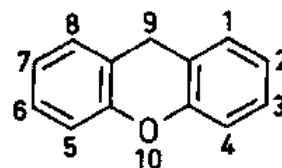
## 4.8 Pyrane



2H-Oxin  
2H-Pyran  
(hypothetisch)

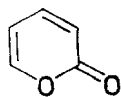


2H-Chromen

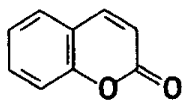


Xanthen

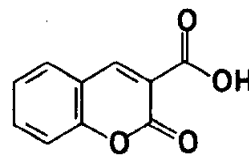
## 4.9 2-Pyranone (6-Ringlactone)



Pyran-2-on  
Kp.208°C

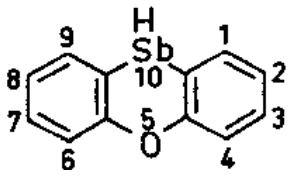


1-Benzopyran-2-on  
*Cumarin*  
F.69°C, Kp.298°C

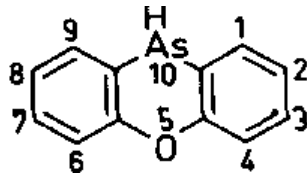


2-Oxo-2H-1-benzopyran-3-carbonsäure  
*Cumarin-3-carbonsäure*  
F.189°C, LW.13(37°C)

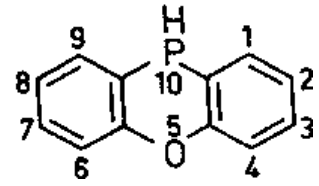
#### 4.10 1,2- und 1,3- und 1,4-Dioxane, 1,3,5-Trioxane



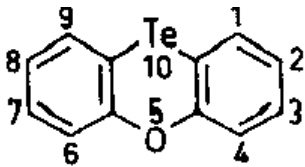
Phenoxantimon



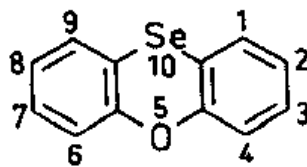
Phenoxarsin



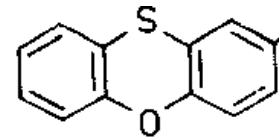
Phenoxaphosphin



Phenoxatellurin

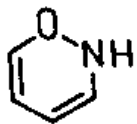


Phenoxaselenin

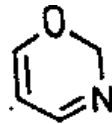


Phenoxathiin

#### 4.11 1,3-Oxazine

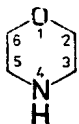


2H-1,2-Oxazin

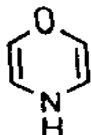


2H-1,3-Oxazin

## 4.12 1,4-Oxazine, Morpholine

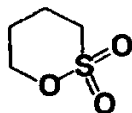


Tetrahydro-1,4-oxazin  
*Morpholin*  
Kp.128°C



4H-1,4-Oxazin

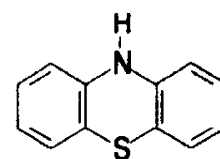
## 4.13 Schwefelverbindungen



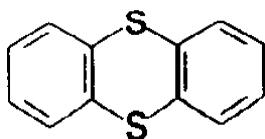
4-Hydroxy-1-butan-sulfonsäure-δ-sulton  
*1,4-Butansulton*  
F.13°C, D.1,335



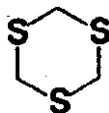
1,3-Dithian  
*Thiodiphenylamin*  
F.52°C, Kp.207°C



Phenothiazin  
F.183°C



Thianthren  
*Di-o-phenylendisulfid*  
F.155°C, Kp.365°C



1,3,5-Trithian  
*Trithioformaldehyd*  
F.214°C, LW.0

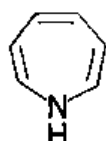
## 5 Heterocyclen mit 7-gliedrigem Ring



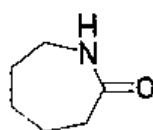
Oxepin



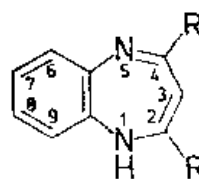
Thiopin



Azepin



Azepan-2-on  
*ε-Caprolactam*  
F.70°C



1H-1,5-Benzodiazepine