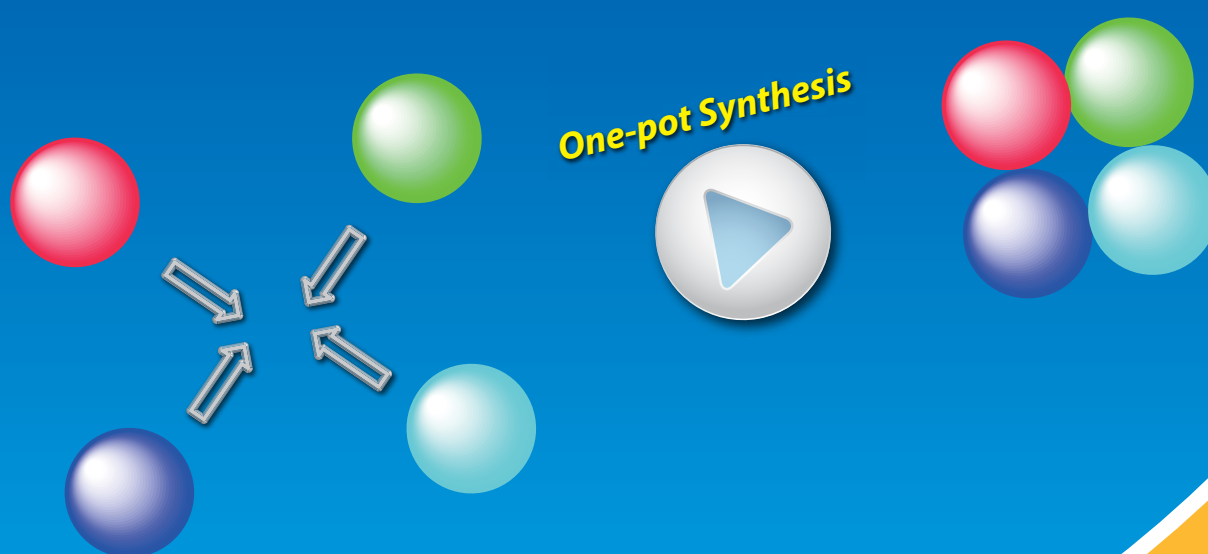


# Multicomponent Reaction (MCR)



Aldehydes

Amines

Carboxylic Acids

$\beta$ -Keto Esters

Isonitriles

Ureas

Thioureas

Dialkyl Phosphites

Benzyne Precursors

Lewis Acids

Ionic Liquids

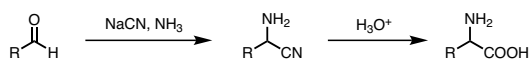
# Multicomponent Reactions (MCR)

Multicomponent reaction (MCR) is a synthetic methodology in which three or more reactants come together in a single reaction vessel to form a new product. The characteristic aspect of MCRs is that the final products contain almost all portions of substrates, generating almost no by-products. That makes MCRs an extremely ideal and eco-friendly reaction system. Target compounds can be obtained in one pot with much fewer steps. Therefore, MCRs have been paid much attention in various research fields, such as discovery of lead compounds in medicinal chemistry, or combinatorial chemistry.

There have been a number of reports on MCRs so far, and typical examples are described as below.

## 1. Strecker reaction (Three-component reaction: 3CR)

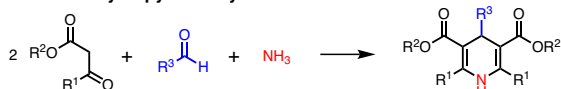
### Strecker Reaction (Amino Acid Synthesis)



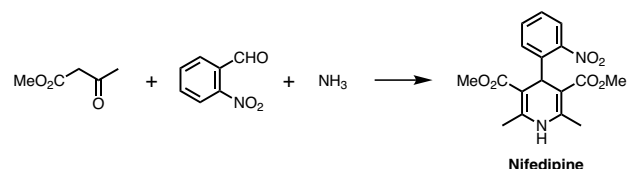
This reaction was reported by A. Strecker in 1850, and is extremely famous as the synthesis of  $\alpha$ -amino acids. This reaction is an MCR which comprises three components, aldehydes, hydrogen cyanide, and ammonia as substrates, and is recognized as the world's first MCR.<sup>1)</sup>

## 2. Hantzsch dihydropyridine synthesis (3CR)

### Hantzsch Dihydropyridine Synthesis

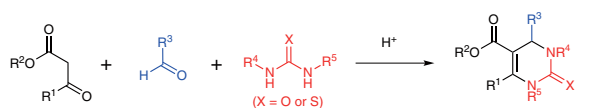


This reaction was reported by A. R. Hantzsch in 1881, and is the best-known three-component MCR, which affords 1,4-dihydropyridine derivatives using  $\beta$ -keto esters, aldehydes, and ammonia.<sup>2)</sup> For an example, a calcium channel blocker, "Nifedipine", is also synthesized by this reaction.<sup>3)</sup>



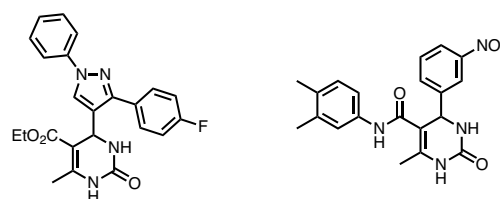
## 3. Biginelli reaction (3CR)

### Biginelli reaction



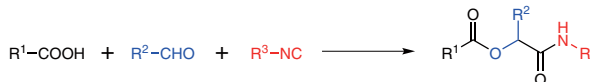
In 1891, an Italian chemist, P. Biginelli has reported the three-component MCR using  $\beta$ -keto esters such as ethyl acetoacetate [A0649], aromatic aldehydes such as benzaldehyde [B2379], and ureas (or thioureas) in the presence of acid catalyst (Brønsted or Lewis acids), affording dihydropyrimidinone derivatives.<sup>4)</sup> Dihydropyrimidinones have been paid much attention because of their various bioactivities such as anti-inflammatory or anti-bacterial activities. For an example of pharmaceuticals developed by using the reaction, several anti-tubercular agents have been reported as below.<sup>5)</sup>

### Examples of Anti-tubercular Agents using Biginelli Reaction

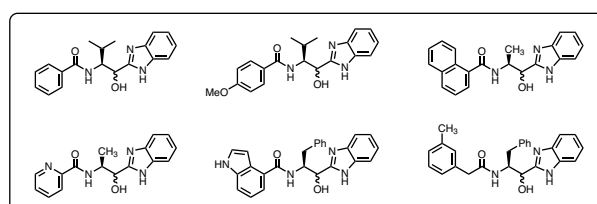
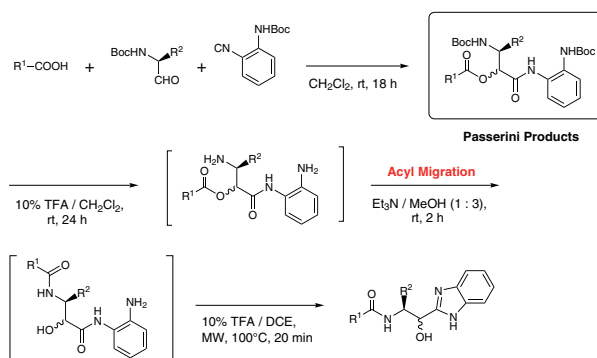


## 4. Passerini reaction (3CR)

### Passerini Reaction

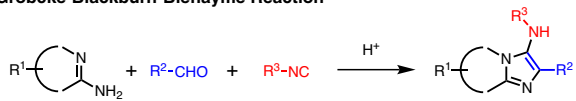


In 1921, an Italian chemist, M. Passerini *et al.* have reported the three-component reaction using carboxylic acids, aldehydes, and isonitriles, affording  $\alpha$ -acyloxy amides.<sup>6)</sup> The Passerini reaction also has been applied into pharmaceutical research, for example, Hulme *et al.* have reported the library synthesis of novel norstatine derivatives bearing benzimidazole moieties.<sup>7)</sup>

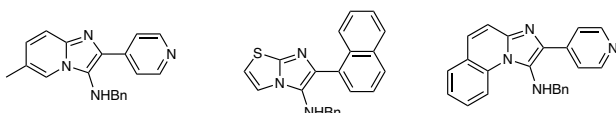


## 5. Gröbcke-Blackburn-Bienaymé reaction (3CR)

### Gröbcke-Blackburn-Bienaymé Reaction

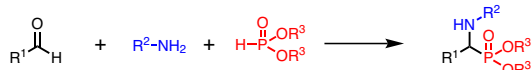


Gröbcke-Blackburn-Bienaymé reaction<sup>8)</sup> is a three-component MCR using aldehydes, isonitriles, and  $\alpha$ -aminoazines such as 2-aminoimidazole or 2-aminopyridine in the presence of acid catalyst. The reaction is applicable for the synthesis of fused nitrogen-containing aromatic compounds as below.



## 6. Kabachnik-Fields reaction (3CR)

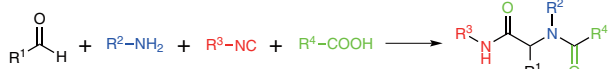
### Kabachnik-Fields Reaction



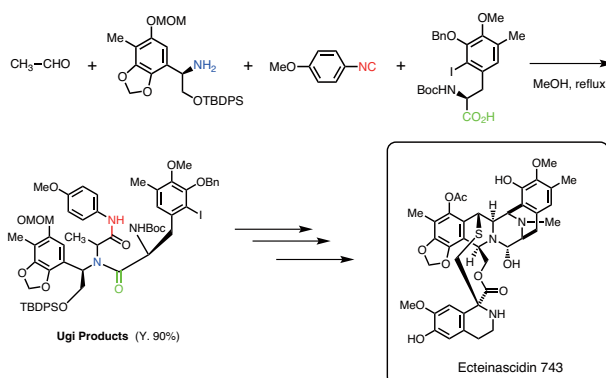
In 1952, M. I. Kabachnik *et al.* have reported the three-component MCR using aldehydes, amines, and dialkyl phosphites in the presence of acid catalyst (Brønsted or Lewis acids), affording  $\alpha$ -aminophosphonates.<sup>9)</sup> In recent years, much attention has been paid to  $\alpha$ -aminophosphonates since they can be considered as structural analogues of the corresponding  $\alpha$ -amino acids and transition state mimics of peptide hydrolysis. Thus,  $\alpha$ -aminophosphonates have been applied into several research areas, such as development of renin inhibitors or HIV protease inhibitors.<sup>10)</sup>

## 7. Ugi reaction (4CR)

### Ugi Reaction



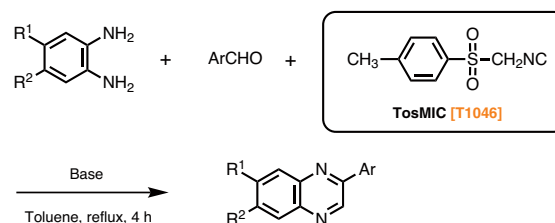
This reaction is the four-component MCR reported by I. K. Ugi *et al.* in 1962 for the first time.<sup>11)</sup> It enables one-pot condensation of four components (aldehydes, amines, isonitriles, and carboxylic acids), thus, it can be said that the Ugi reaction is the most versatile among MCRs. For an example of applications using this reaction, Fukuyama *et al.* have reported the synthesis of a marine tunicate, Ecteinascidin 743, which has extremely potent antitumor activity, using the Ugi reaction as a key step below.<sup>12)</sup>



## Other examples of MCR

### ● MCR using *p*-toluenesulfonylmethyl isocyanide (TosMIC) (3CR)

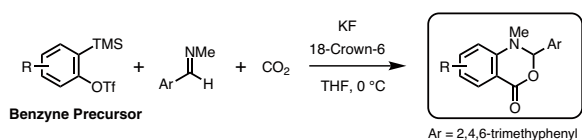
*p*-Toluenesulfonylmethyl isocyanide (TosMIC) [T1046] is a synthetic reagent, developed by Leusen *et al.*, and has both an isonitrile group and a tosyl group (leaving group) in one molecule.<sup>13)</sup> Different from other isonitrile compounds with odor character, TosMIC is an odorless and solid compound. Because of its easy-handling property, TosMIC has been widely used for the synthesis of nitrogen-containing aromatic heterocyclic compounds, such as oxazoles.<sup>14)</sup> TosMIC also has been used for MCRs, for example, Tsoleridis *et al.* have reported the synthesis of quinoxaline derivatives via the three-component condensation of *o*-phenylenediamines, aromatic aldehydes and TosMIC.<sup>15)</sup>



Entry	R <sup>1</sup>	R <sup>2</sup>	Ar	Base	Quinoxaline (Y. %)
1	H	H	phenyl	DABCO	91
2	H	H	2,4-dimethylphenyl	DABCO	81
3	H	H	4-chlorophenyl	DABCO	84
4	Me	Me	phenyl	DBU	86
5	Me	Me	2-methylphenyl	DBU	85

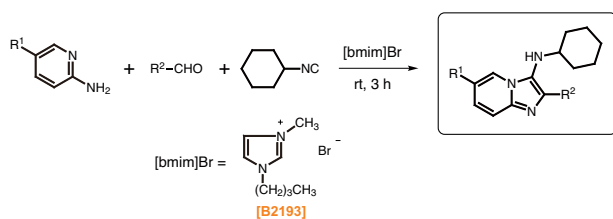
### ● MCR using benzyne (3CR)

Recently, there also have been several reports on MCRs using benzyne. For example, Yoshida *et al.* have reported the three-component MCR using *in situ* generated benzyne, imines, and carbon dioxide, affording benzoxadiones.<sup>16)</sup> Recently, much attention has been paid on organic synthesis using carbon dioxide as a carbon source from the ecological point of view, thus, the reaction above is an extremely useful and eco-friendly MCR.



Benzyne Precursor	Reaction time (h)	Product
	15	(Y. 82%)
	63	(Y. 63%, 4 : 1)
	46	(Y. 73%)
	60	(Y. 44%)

Thus, MCR is a strong synthetic methodology to enable condensation of various substrates in one pot, however, in some cases, reactions require long times for completion or result in undesired side reactions even after optimization of reaction conditions such as solvents or Lewis acid catalysts. For resolving these problems, there have been some successful reports on accelerating MCRs. For example, Shaabani *et al.* have reported the ionic liquid promoted Gröbcke-Blackburn-Bienaymé reaction.<sup>17)</sup> As indicated in the table below, in the case of using ionic liquids as solvents, reactions proceed smoothly to afford the desired products in excellent yields. On the other hand, the yield of product is poor even in the prolonged reaction time (Entry 2'). Moreover, as indicated in Entry 1, the ionic liquid can be reused for the same reactions, maintaining the high yields.



Entry	R <sup>1</sup>	R <sup>2</sup>	Yield (%)
1	Br	Ph	98 (95, 92, 90, 85) <sup>a</sup>
2	Me	Ph	98
2'	Me	Ph	25
3	Me	4-CH <sub>3</sub> C <sub>6</sub> H <sub>4</sub>	99
4	Me	4-O <sub>2</sub> NC <sub>6</sub> H <sub>4</sub>	92
5	Me	4-Pyridyl	97

<sup>a</sup> The same ionic liquid is used for each of the five runs.

<sup>b</sup> Ionic liquid is not used. Reaction time is 12 h.

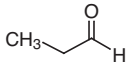
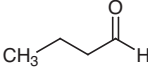
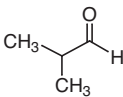
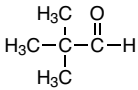
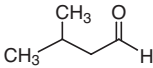
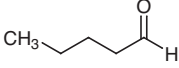
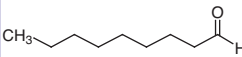
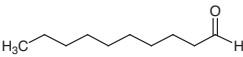
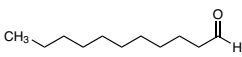
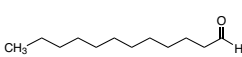
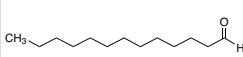
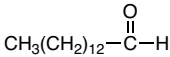
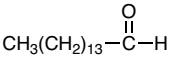
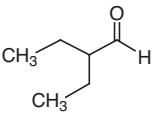
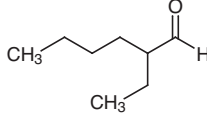
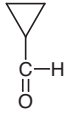
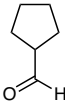
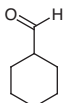
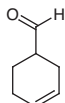
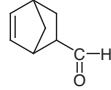
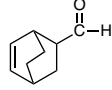
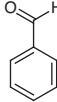
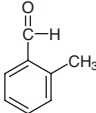
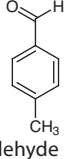
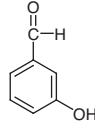
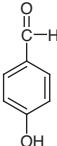
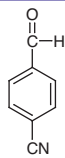
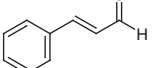
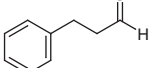
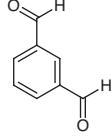
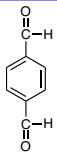
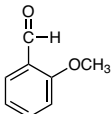
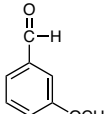
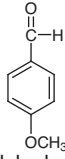
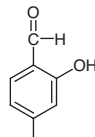
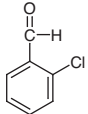
Ionic liquids can be generally recovered and recycled, which can help to reduce the waste of traditional solvents which are rarely reused. In addition, ionic liquids have attracted much attention as excellent solvents due to their low volatility. Judging from these points, this reaction can be regarded as a more eco-friendly reaction example.

TCl offers a variety of aldehyde, amine, carboxylic acid, β-keto ester, urea, thiourea, and dialkyl phosphite compounds readily available in MCRs. For aldehyde, amine, and carboxylic acid compounds, typical products selected are listed judging from reports on MCRs so far. In addition, benzyne precursors, Lewis acids, and ionic liquids used in MCRs are also listed in this brochure.

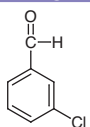
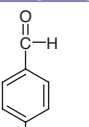
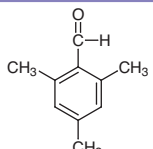
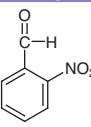
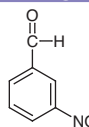
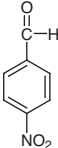
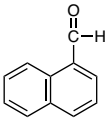
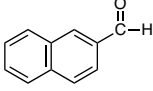
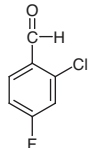
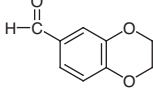
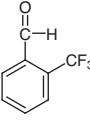
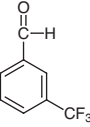
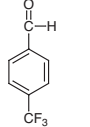
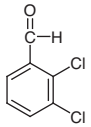
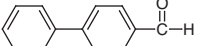
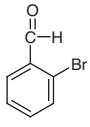
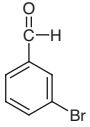
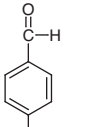
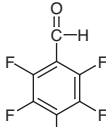
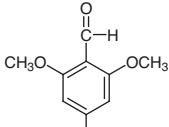
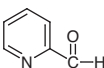
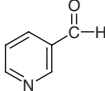
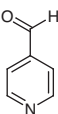
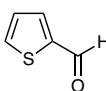
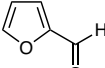
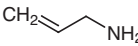
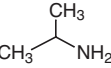
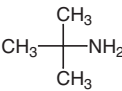

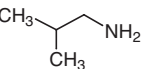



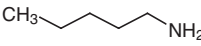


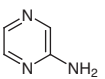
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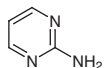
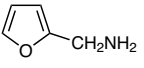

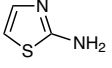
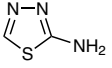

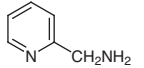
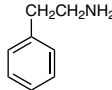
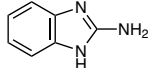


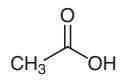
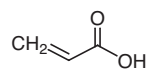
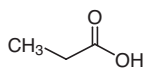
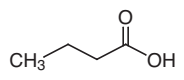
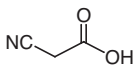
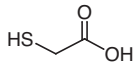
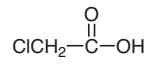
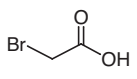
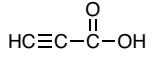
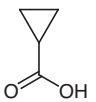
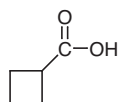
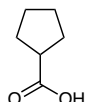
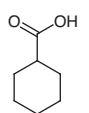
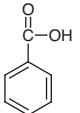
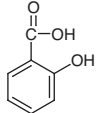
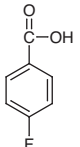
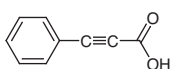
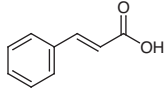
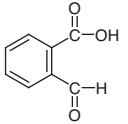
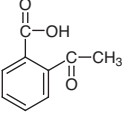
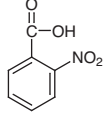
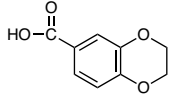
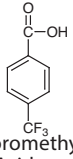
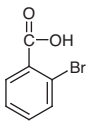
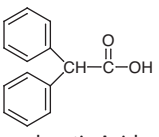
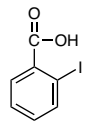
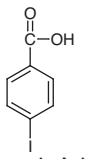
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## Aldehydes

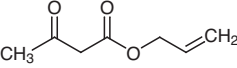
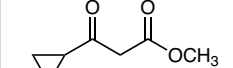
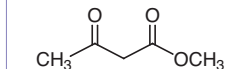
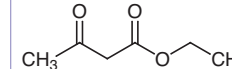
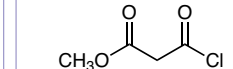
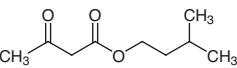
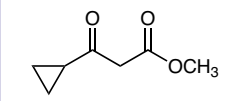
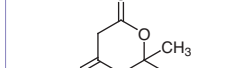
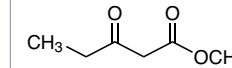
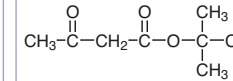
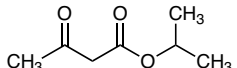
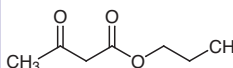
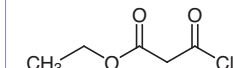
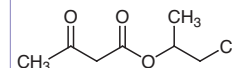
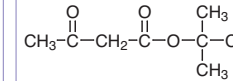
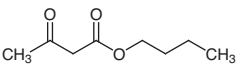
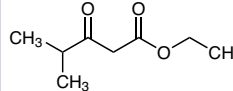
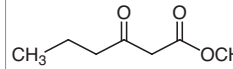
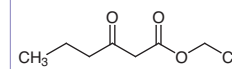
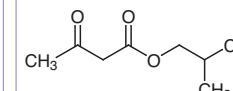
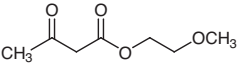
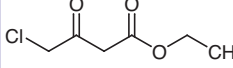
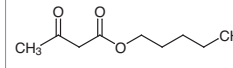
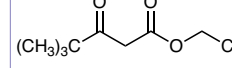
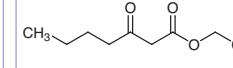
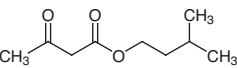
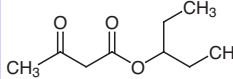
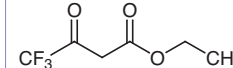
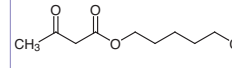
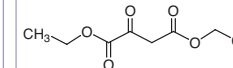
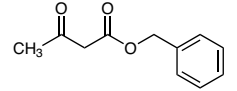
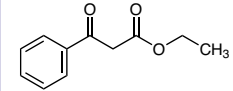
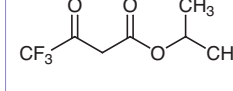
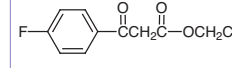
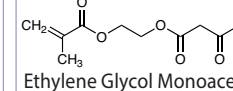
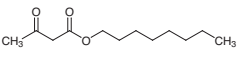
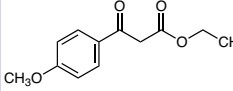
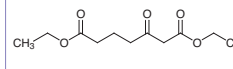
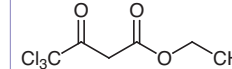
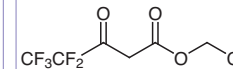
<b>Aldehydes</b>		<b>P0498</b> 25mL 500mL  Propionaldehyde CAS RN: 123-38-6	<b>B0751</b> 25mL 500mL  Butyraldehyde CAS RN: 123-72-8	<b>I0101</b> 25mL 500mL  Isobutyraldehyde CAS RN: 78-84-2
		<b>P0847</b> 5mL 25mL  Pivalaldehyde CAS RN: 630-19-3	<b>I0192</b> 25mL 100mL 500mL  Isovaleraldehyde CAS RN: 590-86-3	<b>V0001</b> 25mL 500mL  Valeraldehyde CAS RN: 110-62-3
<b>N0296</b> 25mL 100mL 500mL  Nonanal CAS RN: 124-19-6	<b>D0032</b> 25mL 500mL  Decanal CAS RN: 112-31-2	<b>U0009</b> 25mL 100mL 250mL  Undecanal CAS RN: 112-44-7	<b>D0979</b> 25mL 500mL  Dodecanal (stabilized with DL- $\alpha$ -Tocopherol) CAS RN: 112-54-9	<b>T0410</b> 5mL  Tridecanal CAS RN: 10486-19-8
<b>T2696</b> 1g  Tetradecanal CAS RN: 124-25-4	<b>P1869</b> 1g  Pentadecanal CAS RN: 2765-11-9	<b>E0069</b> 25mL 100mL 500mL  2-Ethylbutyraldehyde CAS RN: 97-96-1	<b>E0125</b> 25mL 500mL  2-Ethylhexanal CAS RN: 123-05-7	<b>C1707</b> 1g 5g  Cyclopropanecarboxaldehyde CAS RN: 1489-69-6
<b>C3019</b> 1mL 5mL  Cyclopentanecarboxaldehyde (stabilized with HQ) CAS RN: 872-53-7	<b>C0880</b> 25mL 100mL  Cyclohexanecarboxaldehyde CAS RN: 2043-61-0	<b>C0881</b> 25mL  3-Cyclohexene-1-carboxaldehyde CAS RN: 100-50-5	<b>N0504</b> 5mL 25mL  5-Norbornene-2-carboxaldehyde CAS RN: 5453-80-5	<b>B5279</b> 200mg 1g  Bicyclo[2.2.2]oct-5-ene-2-carboxaldehyde CAS RN: 38259-00-6
<b>B2379</b> 500g  Benzaldehyde CAS RN: 100-52-7	<b>T0566</b> 25g 100g 500g  o-Tolualdehyde CAS RN: 529-20-4	<b>T0259</b> 25mL 100mL 500mL  p-Tolualdehyde CAS RN: 104-87-0	<b>H0197</b> 25g 100g 500g  3-Hydroxybenzaldehyde CAS RN: 100-83-4	<b>H0198</b> 25g 100g 500g  4-Hydroxybenzaldehyde CAS RN: 123-08-0
<b>C0443</b> 5g 25g  4-Cyanobenzaldehyde CAS RN: 105-07-7	<b>C0352</b> 25mL 500mL  trans-Cinnamaldehyde CAS RN: 14371-10-9	<b>P0217</b> 25g 100g  3-Phenylpropionaldehyde CAS RN: 104-53-0	<b>I0153</b> 25g 100g 250g  Isophthalaldehyde CAS RN: 626-19-7	<b>T0010</b> 25g 100g 500g  Terephthalaldehyde CAS RN: 623-27-8
<b>A0479</b> 25g 100g 500g  o-Anisaldehyde CAS RN: 135-02-4	<b>A0478</b> 25mL 100mL 500mL  m-Anisaldehyde CAS RN: 591-31-1	<b>A0480</b> 25mL 500mL  p-Anisaldehyde CAS RN: 123-11-5	<b>D0564</b> 25g 100g 500g  2,4-Dihydroxybenzaldehyde CAS RN: 95-01-2	<b>C0561</b> 25g 500g  2-Chlorobenzaldehyde CAS RN: 89-98-5

## Multicomponent reaction (MCR)

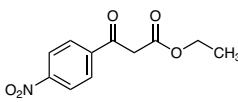
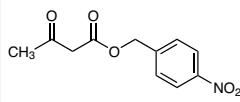
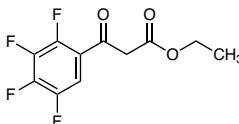
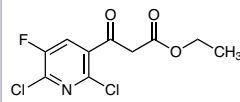
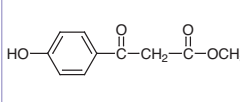
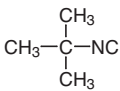

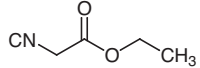

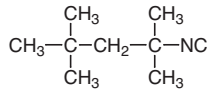
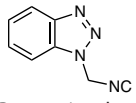

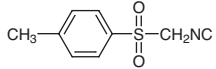
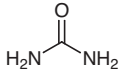
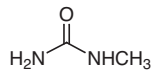
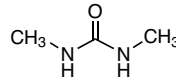
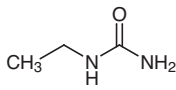
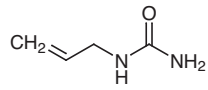
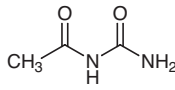
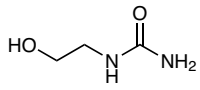
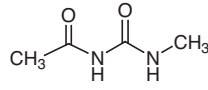
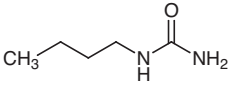
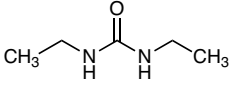
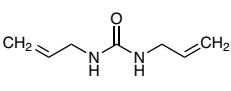
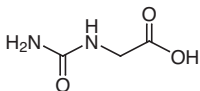
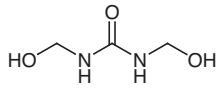
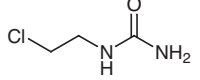
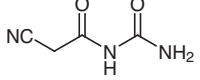
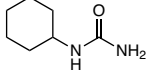
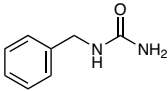
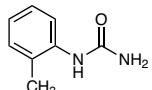
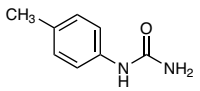
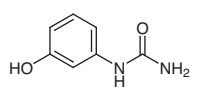
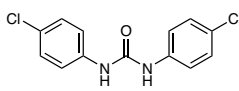
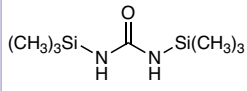
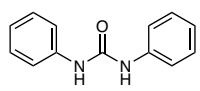
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<b>N0559</b> 25g 100g 500g  4-Nitrobenzaldehyde CAS RN: 555-16-8	<b>N0002</b> 25mL 100mL 500mL  1-Naphthaldehyde CAS RN: 66-77-3	<b>N0003</b> 5g 25g  2-Naphthaldehyde CAS RN: 66-99-9	<b>C1465</b> 1g 5g  2-Chloro-4-fluorobenzaldehyde CAS RN: 84194-36-5	<b>B2019</b> 1g 5g  3,4-Ethylenedioxybenzaldehyde CAS RN: 29668-44-8
<b>T1281</b> 25g  2-(Trifluoromethyl)benzaldehyde CAS RN: 447-61-0	<b>T1399</b> 5g 25g  3-(Trifluoromethyl)benzaldehyde CAS RN: 454-89-7	<b>T1091</b> 5g 25g 250g  4-(Trifluoromethyl)benzaldehyde CAS RN: 455-19-6	<b>D1666</b> 25g 500g  2,3-Dichlorobenzaldehyde CAS RN: 6334-18-5	<b>B0242</b> 5g 25g 250g  4-Phenylbenzaldehyde CAS RN: 3218-36-8
<b>B0836</b> 25g 100g 500g  2-Bromobenzaldehyde CAS RN: 6630-33-7	<b>B0548</b> 25g 100g 500g  3-Bromobenzaldehyde CAS RN: 3132-99-8	<b>B0549</b> 25g 250g  4-Bromobenzaldehyde CAS RN: 1122-91-4	<b>P0746</b> 5g 25g  Pentafluorobenzaldehyde CAS RN: 653-37-2	<b>T2651</b> 5g 25g  2,4,6-Trimethoxybenzaldehyde CAS RN: 830-79-5
<b>P0425</b> 25g 100g 500g  2-Pyridinecarboxaldehyde CAS RN: 1121-60-4	<b>N0090</b> 25mL 100mL  3-Pyridinecarboxaldehyde CAS RN: 500-22-1	<b>I0143</b> 25mL 500mL  4-Pyridinecarboxaldehyde CAS RN: 872-85-5	<b>T0725</b> 25mL 100mL 500mL  2-Thiophenecarboxaldehyde (stabilized with HQ) CAS RN: 98-03-3	<b>F0073</b> 25g 500g  Furfural CAS RN: 98-01-1
<h1>Amines</h1>				
<b>P0911</b> 5mL 25mL $\text{HC}\equiv\text{CCH}_2\text{NH}_2$ Propargylamine CAS RN: 2450-71-7				
<b>A0219</b> 25mL 500mL  Allylamine CAS RN: 107-11-9				
<b>I0165</b> 25mL 500mL  Isopropylamine CAS RN: 75-31-0				
<b>B0709</b> 25mL 100mL 500mL  tert-Butylamine CAS RN: 75-64-9	<b>B0707</b> 25mL 500mL  Butylamine CAS RN: 109-73-9	<b>I0095</b> 25mL 500mL  Isobutylamine CAS RN: 78-81-9	<b>A1859</b> 5g 25g  3-Aminopyrazole CAS RN: 1820-80-0	<b>A0432</b> 25g 100g 500g  3-Amino-1,2,4-triazole CAS RN: 61-82-5
<b>C0887</b> 25mL 500mL  Cyclopentylamine CAS RN: 1003-03-8	<b>A0445</b> 25mL 100mL 500mL  Amylamine CAS RN: 110-58-7	<b>A0463</b> 500g  Aniline CAS RN: 62-53-3	<b>A0411</b> 25g 100g 500g  2-Aminopyridine CAS RN: 504-29-0	<b>A0989</b> 5g 25g  2-Aminopyrazine CAS RN: 5049-61-6

<b>A0412</b> 25g  2-Aminopyrimidine CAS RN: 109-12-6	<b>F0091</b> 25mL 100mL 500mL  Furfurylamine CAS RN: 617-89-0	<b>C0494</b> 25mL 500mL  Cyclohexylamine CAS RN: 108-91-8	<b>A0633</b> 25g 100g 500g  2-Aminothiazole CAS RN: 96-50-4	<b>A1060</b> 5g 25g  2-Amino-1,3,4-thiadiazole CAS RN: 4005-51-0
<b>B0406</b> 25mL 500mL  Benzylamine CAS RN: 100-46-9	<b>A1161</b> 25g 250g  2-Picolylamine CAS RN: 3731-51-9	<b>P0085</b> 25mL 100mL 500mL  2-Phenylethylamine CAS RN: 64-04-0	<b>A0850</b> 5g 25g  2-Aminobenzimidazole CAS RN: 934-32-7	<b>B0541</b> 25g 250g  2-Bromoaniline CAS RN: 615-36-1
<b>Carboxylic Acids</b>		<b>F0513</b> 300mL  Formic Acid CAS RN: 64-18-6	<b>A2035</b> 300mL  Acetic Acid CAS RN: 64-19-7	<b>A0141</b> 25g 500g  Acrylic Acid (stabilized with MEHQ) CAS RN: 79-10-7
<b>P0500</b> 25mL 500mL  Propionic Acid CAS RN: 79-09-4	<b>B0754</b> 25mL 500mL  Butyric Acid CAS RN: 107-92-6	<b>C0439</b> 25g 500g  Cyanoacetic Acid CAS RN: 372-09-8	<b>M0052</b> 25g 500g  Thioglycolic Acid CAS RN: 68-11-1	<b>C2123</b> 25g 500g  Chloroacetic Acid CAS RN: 79-11-8
<b>B0531</b> 25g 500g  Bromoacetic Acid CAS RN: 79-08-3	<b>P0497</b> 5g 25g  Propiolic Acid CAS RN: 471-25-0	<b>C0387</b> 25mL 100mL 500mL  Cyclopropanecarboxylic Acid CAS RN: 1759-53-1	<b>C0888</b> 10g 25g  Cyclobutanecarboxylic Acid CAS RN: 3721-95-7	<b>C0512</b> 5g 25g  Cyclopentanecarboxylic Acid CAS RN: 3400-45-1
<b>C0470</b> 25g 500g  Cyclohexanecarboxylic Acid CAS RN: 98-89-5	<b>B2635</b> 25g 500g  Benzoic Acid CAS RN: 65-85-0	<b>H0206</b> 25g 500g  2-Hydroxybenzoic Acid CAS RN: 69-72-7	<b>F0112</b> 25g  4-Fluorobenzoic Acid CAS RN: 456-22-4	<b>P0610</b> 5g 25g  Phenylpropionic Acid CAS RN: 637-44-5
<b>C0353</b> 25g 100g 500g  <i>trans</i> -Cinnamic Acid CAS RN: 140-10-3	<b>P0281</b> 25g 100g 500g  Phthalaldehydic Acid CAS RN: 119-67-5	<b>A1075</b> 5g 25g  2-Acetylbenzoic Acid CAS RN: 577-56-0	<b>N0155</b> 25g 500g  2-Nitrobenzoic Acid CAS RN: 552-16-9	<b>B3764</b> 5g 25g  1,4-Benzodioxane-6-carboxylic Acid CAS RN: 4442-54-0
<b>T1145</b> 5g 25g  4-(Trifluoromethyl)-benzoic Acid CAS RN: 455-24-3	<b>B0552</b> 25g 100g 500g  2-Bromobenzoic Acid CAS RN: 88-65-3	<b>D0869</b> 25g 100g 500g  Diphenylacetic Acid CAS RN: 117-34-0	<b>I0053</b> 25g 100g 500g  2-Iodobenzoic Acid CAS RN: 88-67-5	<b>I0054</b> 5g 25g  4-Iodobenzoic Acid CAS RN: 619-58-9

# β-Keto Esters

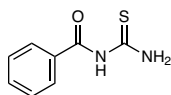
<p><b>A1981</b> 25g 500g</p>  <p>Allyl Acetoacetate CAS RN: 1118-84-9</p>	<p><b>M2277</b> 5g 25g</p>  <p>Methyl 3-Cyclopropyl-3-oxopropionate CAS RN: 32249-35-7</p>	<p><b>A0650</b> 25g 500g</p>  <p>Methyl Acetoacetate CAS RN: 105-45-3</p>	<p><b>A0649</b> 25g 500g</p>  <p>Ethyl Acetoacetate CAS RN: 141-97-9</p>	<p><b>M2315</b> 5g 25g</p>  <p>Methyl Malonyl Chloride CAS RN: 37517-81-0</p>
<p><b>A0812</b> 25mL 500mL</p>  <p>Isoamyl Acetoacetate CAS RN: 2308-18-1</p>	<p><b>M0799</b> 25g 100g 500g</p>  <p>Meldrum's Acid (=2,2-Dimethyl-1,3-dioxane-4,6-dione) CAS RN: 2033-24-1</p>	<p><b>K0035</b> 25g 100g 500g</p>  <p>Methyl 3-Oxovalerate CAS RN: 30414-53-0</p>	<p><b>K0031</b> 5g 25g</p>  <p>Ethyl 3-Oxovalerate CAS RN: 4949-44-4</p>	<p><b>A0816</b> 25mL 100mL 500mL</p>  <p>tert-Butyl Acetoacetate CAS RN: 1694-31-1</p>
<p><b>I0826</b> 25g 500g</p>  <p>Isopropyl Acetoacetate CAS RN: 542-08-5</p>	<p><b>A0817</b> 25mL 500mL</p>  <p>Propyl Acetoacetate CAS RN: 1779-60-8</p>	<p><b>E0484</b> 5g 25g</p>  <p>Ethyl Malonyl Chloride CAS RN: 36239-09-5</p>	<p><b>A0815</b> 25mL</p>  <p>sec-Butyl Acetoacetate CAS RN: 13562-76-0</p>	<p><b>A0816</b> 25mL 100mL 500mL</p>  <p>tert-Butyl Acetoacetate CAS RN: 1694-31-1</p>
<p><b>A0795</b> 25mL</p>  <p>Butyl Acetoacetate CAS RN: 591-60-6</p>	<p><b>E0882</b> 5g 25g</p>  <p>Ethyl Isobutyrylacetate CAS RN: 7152-15-0</p>	<p><b>K0037</b> 25mL 500mL</p>  <p>Methyl 3-Oxohexanoate CAS RN: 30414-54-1</p>	<p><b>K0030</b> 25mL 500mL</p>  <p>Ethyl 3-Oxohexanoate CAS RN: 3249-68-1</p>	<p><b>A0814</b> 25mL 500mL</p>  <p>Isobutyl Acetoacetate CAS RN: 7779-75-1</p>
<p><b>A1583</b> 25g 500g</p>  <p>2-Methoxyethyl Acetoacetate CAS RN: 22502-03-0</p>	<p><b>C0911</b> 25g 500g</p>  <p>Ethyl 4-Chloroacetoacetate CAS RN: 638-07-3</p>	<p><b>A0811</b> 25mL 500mL</p>  <p>Amyl Acetoacetate CAS RN: 6624-84-6</p>	<p><b>D1891</b> 5mL 25mL</p>  <p>Ethyl 4,4-Dimethyl-3-oxovalerate CAS RN: 17094-34-7</p>	<p><b>O0216</b> 10g 25g</p>  <p>Ethyl 3-Oxoheptanoate CAS RN: 7737-62-4</p>
<p><b>A0812</b> 25mL 500mL</p>  <p>Isoamyl Acetoacetate CAS RN: 2308-18-1</p>	<p><b>A0813</b> 25mL</p>  <p>3-Pentyl Acetoacetate CAS RN: 13562-81-7</p>	<p><b>T0810</b> 25g 100g 500g</p>  <p>Ethyl 4,4,4-Trifluoroacetoacetate CAS RN: 372-31-6</p>	<p><b>A0913</b> 25mL</p>  <p>Hexyl Acetoacetate CAS RN: 13562-84-0</p>	<p><b>O0073</b> 5g 25g</p>  <p>Diethyl Oxalacetate CAS RN: 108-56-5</p>
<p><b>A1080</b> 25mL 100mL 500mL</p>  <p>Benzyl Acetoacetate CAS RN: 5396-89-4</p>	<p><b>B0097</b> 25g 100g 500g</p>  <p>Ethyl Benzoylacetate CAS RN: 94-02-0</p>	<p><b>T1530</b> 25g</p>  <p>Isopropyl 4,4,4-Trifluoroacetoacetate CAS RN: 175230-50-9</p>	<p><b>F0435</b> 1g 5g 25g</p>  <p>Ethyl (4-Fluorobenzoyl)acetate CAS RN: 1999-00-4</p>	<p><b>E0489</b> 25g 500g</p>  <p>Ethylene Glycol Monoacetoacetate Monomethacrylate (stabilized with BHT) CAS RN: 21282-97-3</p>
<p><b>A0915</b> 25mL</p>  <p>n-Octyl Acetoacetate CAS RN: 16436-00-3</p>	<p><b>M1380</b> 5g 25g</p>  <p>Ethyl 4-Methoxybenzoylacetate CAS RN: 2881-83-6</p>	<p><b>O0229</b> 1g 5g</p>  <p>Diethyl 3-Oxopimelate CAS RN: 40420-22-2</p>	<p><b>T1285</b> 10g 25g</p>  <p>Ethyl 4,4,4-Trichloroacetoacetate CAS RN: 3702-98-5</p>	<p><b>P1062</b> 5g</p>  <p>Ethyl 4,4,5,5,5-Pentafluoro-3-oxovalerate CAS RN: 663-35-4</p>



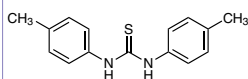
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<h2>Isonitriles</h2>		<b>B1274</b> 5mL 25mL  tert-Butyl Isocyanide CAS RN: 7188-38-7	<b>C1438</b> 1g 5g  Cyclohexyl Isocyanide CAS RN: 931-53-3	<b>I0562</b> 5g 25g  Ethyl Isocyanoacetate CAS RN: 2999-46-4
<b>B2185</b> 1g 5g  Benzyl Isocyanide CAS RN: 10340-91-7	<b>T1054</b> 1mL 5mL  1,1,3,3-Tetramethylbutyl Isocyanide CAS RN: 14542-93-9	<b>I0455</b> 1g 5g  1(1H-Benzotriazol-1-yl)-methyl Isocyanide CAS RN: 87022-42-2	<b>I0824</b> 1g 5g  1-Adamantyl Isocyanide CAS RN: 22110-53-8	<b>T1046</b> 5g 25g  p-Toluenesulfonylmethyl Isocyanide (= TosMIC) CAS RN: 36635-61-7
<h2>Ureas</h2>		<b>U0073</b> 300g  Urea CAS RN: 57-13-6	<b>M0455</b> 25g 500g  1-Methylurea CAS RN: 598-50-5	<b>D0289</b> 25g 500g  1,3-Dimethylurea CAS RN: 96-31-1
<b>E0192</b> 25g 500g  Ethylurea CAS RN: 625-52-5	<b>A0237</b> 25g  Allylurea CAS RN: 557-11-9	<b>A0124</b> 25g  Acetylurea CAS RN: 591-07-1	<b>H0700</b> 25g  2-Hydroxyethylurea CAS RN: 2078-71-9	<b>A0101</b> 25g  1-Acetyl-3-methylurea CAS RN: 623-59-6
<b>B1831</b> 25g  Butylurea CAS RN: 592-31-4	<b>D0534</b> 25g 500g  1,3-Diethylurea CAS RN: 623-76-7	<b>D5170</b> 1g 5g  1,3-Diallylurea CAS RN: 1801-72-5	<b>H0655</b> 25g  N-Carboxymethylurea CAS RN: 462-60-2	<b>D0767</b> 25g 500g  1,3-Bis(hydroxymethyl)-urea CAS RN: 140-95-4
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<b>T0328</b> 25g  p-Tolylurea CAS RN: 622-51-5	<b>H0438</b> 25g  3-Hydroxyphenylurea CAS RN: 701-82-6	<b>B4529</b> 1g 5g  1,3-Bis(4-chlorophenyl)urea CAS RN: 1219-99-4	<b>B1103</b> 25g  N,N'-Bis(trimethylsilyl)urea CAS RN: 18297-63-7	<b>C0031</b> 25g 100g 500g  1,3-Diphenylurea CAS RN: 102-07-8

<p><b>T2890</b> 5g</p> <p><i>p</i>-Toluenesulfonylurea CAS RN: 1694-06-0</p>	<p><b>B2833</b> 5g</p> <p>(2-Bromophenyl)urea CAS RN: 13114-90-4</p>	<p><b>B2834</b> 5g 25g</p> <p>(4-Bromophenyl)urea CAS RN: 1967-25-5</p>	<p><b>T1915</b> 25g 250g</p> <p>1-[3-(Trimethoxysilyl)propyl]urea CAS RN: 23843-64-3</p>	<p><b>B2842</b> 25g</p> <p>1-(2-Bromoisovaleryl)urea CAS RN: 496-67-3</p>
<p><b>D0441</b> 25g 100g 500g</p> <p>1,3-Dicyclohexylurea CAS RN: 2387-23-7</p>	<p><b>C2266</b> 5g</p> <p>(4-Chlorophenylsulfonyl)urea CAS RN: 22663-37-2</p>	<p><b>C0926</b> 5g</p> <p>1-(2-Chloro-4-pyridyl)-3-phenylurea CAS RN: 68157-60-8</p>	<p><b>U0048</b> 25mL 500mL</p> <p>1-[3-(Triethoxysilyl)propyl]urea (40-52% in Methanol) CAS RN: 23779-32-0</p>	<p><b>C1220</b> 25g</p> <p>1-(4-Chlorophenylsulfonyl)-3-propylurea CAS RN: 94-20-2</p>
<p><b>O0209</b> 10g</p> <p><i>N</i>-Octadecylurea CAS RN: 2158-08-9</p>	<p><b>T1015</b> 25g 500g</p> <p>3,4,4'-Trichlorodiphenylurea CAS RN: 101-20-2</p>	<p><b>I0665</b> 25g 250g</p> <p>Imidazolidinyl Urea CAS RN: 39236-46-9</p>	<p><b>E1171</b> 200mg 1g</p> <p>(4-Ethoxyphenyl)urea CAS RN: 150-69-6</p>	<p><b>B4483</b> 1g 5g</p> <p>1,3-Bis(4-methoxyphenyl)urea CAS RN: 1227-44-7</p>
<h2>Thioureas</h2>				
<p><b>A0220</b> 25g 100g 500g</p> <p>1-Allyl-2-thiourea CAS RN: 109-57-9</p>	<p><b>B4612</b> 1g 5g</p> <p>Benzylthiourea CAS RN: 621-83-0</p>	<p><b>A0117</b> 25g 500g</p> <p>1-Acetyl-2-thiourea CAS RN: 591-08-2</p>	<p><b>G0234</b> 25g 100g 500g</p> <p>Guanlylthiourea CAS RN: 2114-02-5</p>	<p><b>D0530</b> 25g 500g</p> <p>1,3-Diethyl-2-thiourea CAS RN: 105-55-5</p>
<p><b>P0237</b> 25g 500g</p> <p>1-Phenyl-2-thiourea CAS RN: 103-85-5</p>	<p><b>D0253</b> 25g</p> <p>1,3-Diisopropylthiourea CAS RN: 2986-17-6</p>	<p><b>T0657</b> 25g</p> <p><i>o</i>-Tolylthiourea CAS RN: 614-78-8</p>	<p><b>B4484</b> 1g 5g</p> <p>(4-Bromophenyl)thiourea CAS RN: 2646-30-2</p>	<p><b>C3168</b> 1g 5g</p> <p>(3-Chlorophenyl)thiourea CAS RN: 4947-89-1</p>
<p><b>T0656</b> 5g</p> <p><i>p</i>-Tolylthiourea CAS RN: 622-52-6</p>	<p><b>F0836</b> 5g 25g</p> <p>(4-Fluorophenyl)thiourea CAS RN: 459-05-2</p>	<p><b>D0802</b> 25g 500g</p> <p>1,3-Di(<i>o</i>-tolyl)thiourea CAS RN: 137-97-3</p>	<p><b>B4611</b> 1g 5g</p> <p>1,3-Bis[4-(trifluoromethyl)phenyl]thiourea CAS RN: 1744-07-6</p>	<p><b>D0301</b> 25g 500g</p> <p>1,3-Dibutylthiourea CAS RN: 109-46-6</p>
<p><b>P1167</b> 5g</p> <p>1-Phenyl-3-guanlylthiourea CAS RN: 15989-47-6</p>	<p><b>N0071</b> 5g 25g</p> <p>1-(1-Naphthyl)-2-thiourea CAS RN: 86-88-4</p>	<p><b>M2786</b> 1g 5g</p> <p>1-Methyl-3-phenylthiourea CAS RN: 2724-69-8</p>	<p><b>T0197</b> 25g 500g</p> <p>1,3-Diphenylthiourea CAS RN: 102-08-9</p>	<p><b>D0440</b> 5g 25g</p> <p>1,3-Dicyclohexylthiourea CAS RN: 1212-29-9</p>

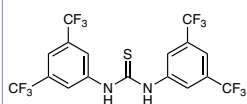
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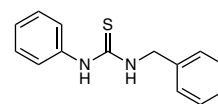
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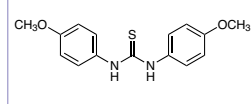
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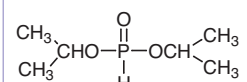
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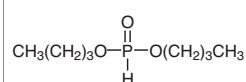
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## Dialkyl Phosphites

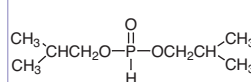
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Diisopropyl Phosphite  
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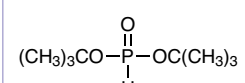
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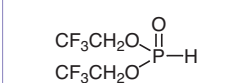
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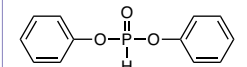
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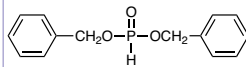
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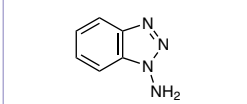
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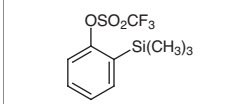
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## Benzyne Precursors

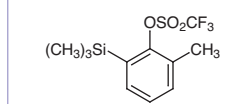
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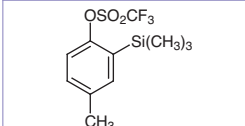
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2-(Trimethylsilyl)phenyl Trifluoromethanesulfonate  
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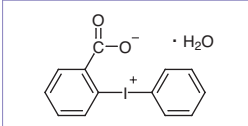
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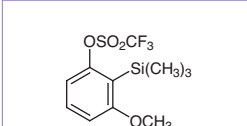
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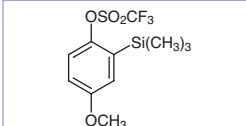
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Diphenyliodonium-2-carboxylate Monohydrate  
CAS RN: 96195-89-0

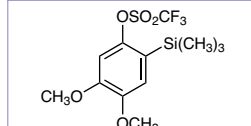
M1884 1g 5g

3-Methoxy-2-(trimethylsilyl)phenyl Trifluoromethanesulfonate  
CAS RN: 217813-03-1

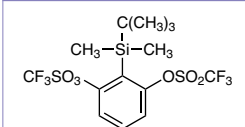
M1885 1g 5g

4-Methoxy-2-(trimethylsilyl)phenyl Trifluoromethanesulfonate  
CAS RN: 556812-41-0

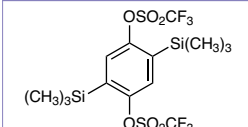
D3883 1g 5g

4,5-Dimethoxy-2-(trimethylsilyl)-phenyl Triflate  
CAS RN: 866252-52-0

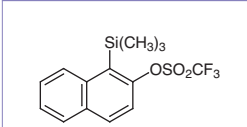
B5557 200mg 1g

2-(tert-Butyldimethylsilyl)-1,3-phenylene Triflate  
CAS RN: 1637638-66-4

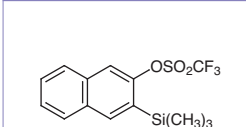
B5559 1g

2,5-Bis(trimethylsilyl)-1,4-phenylene Triflate  
CAS RN: 613676-07-6

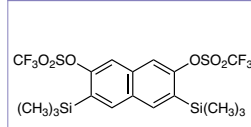
T2465 1g 5g

1-(Trimethylsilyl)-2-naphthyl Trifluoromethanesulfonate  
CAS RN: 252054-88-9

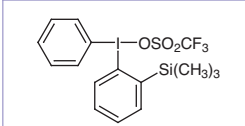
T2466 1g 5g

3-(Trimethylsilyl)-2-naphthyl Trifluoromethanesulfonate  
CAS RN: 780820-43-1

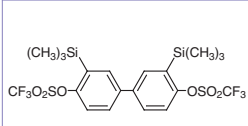
B5080 1g

3,6-Bis(trimethylsilyl)-naphthalene-2,7-diyl Ditriflate  
CAS RN: 947488-89-3

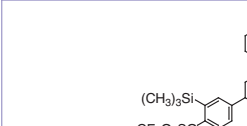
P1620 1g 5g

Phenyl[2-(trimethylsilyl)phenyl]-iodonium Trifluoromethanesulfonate  
CAS RN: 164594-13-2

B3047 1g 5g

3,3'-Bis(trimethylsilyl)biphenyl-4,4'-diyl Bis(trifluoromethanesulfonate)  
CAS RN: 828282-80-0

T2467 1g

1,3,5-Tris[4-(trifluoromethanesulfonyloxy)-3-(trimethylsilyl)phenyl]benzene  
CAS RN: 847925-63-7

## Lewis Acids

L0204 25g 300g

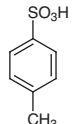
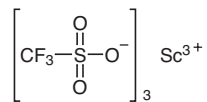
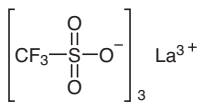
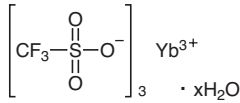
LiCl  
Lithium Chloride Anhydrous  
CAS RN: 7447-41-8

L0210 25g 100g 500g

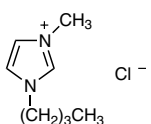
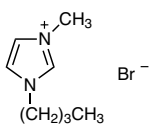
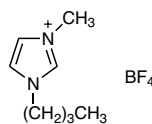
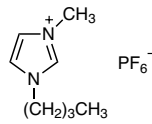
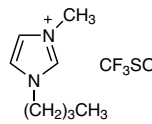
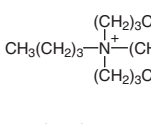
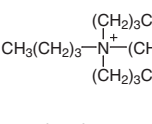
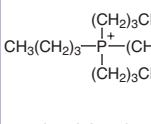
LiBr  
Lithium Bromide  
CAS RN: 7550-35-8

N0850 25g 500g

NiCl<sub>2</sub>  
Nickel(II) Chloride Anhydrous  
CAS RN: 7718-54-9

<b>Z0014</b> 25g 300g  <b>ZnCl<sub>2</sub></b>  Zinc Chloride CAS RN: 7646-85-7	<b>B0527</b> 25mL 100mL 500mL  $\text{BF}_3 \cdot \text{CH}_3\text{CH}_2\text{OCH}_2\text{CH}_3$  Boron Trifluoride - Ethyl Ether Complex CAS RN: 109-63-7	<b>T0267</b> 25g 500g  $\cdot \text{H}_2\text{O}$  <i>p</i> -Toluenesulfonic Acid Monohydrate CAS RN: 6192-52-5	<b>T3238</b> 100mL 500mL  <b>TiCl<sub>4</sub></b>  Titanium(IV) Chloride (ca. 19% in Toluene, ca. 1.0mol/L) CAS RN: 7550-45-0	<b>T2052</b> 100mL 500mL  <b>TiCl<sub>4</sub></b>  Titanium(IV) Chloride (14% in Dichloromethane, ca. 1.0mol/L) CAS RN: 7550-45-0
<b>R0074</b> 1g 5g  <b>RuCl<sub>3</sub> · xH<sub>2</sub>O</b>  Ruthenium(III) Chloride Hydrate CAS RN: 14898-67-0	<b>I0778</b> 5g 25g  <b>InCl<sub>3</sub></b>  Indium(III) Chloride Anhydrous CAS RN: 10025-82-8	<b>B3546</b> 25g 250g  <b>BiCl<sub>3</sub></b>  Bismuth(III) Chloride Anhydrous CAS RN: 7787-60-2	<b>T1663</b> 1g 5g   Scandium(III) Trifluoromethanesulfonate CAS RN: 144026-79-9	<b>T1293</b> 5g 25g   Lanthanum(III) Trifluoromethanesulfonate CAS RN: 52093-26-2
<b>T1610</b> 5g 25g   Ytterbium(III) Trifluoromethanesulfonate Hydrate CAS RN: 54761-04-5				

## Ionic Liquids

<b>B2194</b> 5g 25g 100g   1-Butyl-3-methylimidazolium Chloride CAS RN: 79917-90-1	<b>B2193</b> 5g   1-Butyl-3-methylimidazolium Bromide CAS RN: 85100-77-2	<b>B2195</b> 5g 25g 100g   1-Butyl-3-methylimidazolium Tetrafluoroborate CAS RN: 174501-65-6		
<b>B2320</b> 5g 25g   1-Butyl-3-methylimidazolium Hexafluorophosphate CAS RN: 174501-64-5	<b>B2337</b> 5g 25g   1-Butyl-3-methylimidazolium Trifluoromethanesulfonate CAS RN: 174899-66-2	<b>T0055</b> 5g 25g 100g   Tetrabutylammonium Chloride CAS RN: 1112-67-0	<b>T0054</b> 25g 100g 500g   Tetrabutylammonium Bromide CAS RN: 1643-19-2	<b>T1124</b> 25g 100g 500g   Tetrabutylphosphonium Bromide CAS RN: 3115-68-2

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