Making ethanol by fermentation

This method *only* applies to ethanol. You can't make any other alcohol this way.

The process

The starting material for the process varies widely, but will normally be some form of starchy plant material such as maize (US: corn), wheat, barley or potatoes.

Starch is a complex carbohydrate, and other carbohydrates can also be used - for example, in the lab sucrose (sugar) is normally used to produce ethanol. Industrially, this wouldn't make sense. It would be silly to refine sugar if all you were going to use it for was fermentation. There is no reason why you shouldn't start from the original sugar cane, though.

The first step is to break complex carbohydrates into simpler ones.

For example, if you were starting from starch in grains like wheat or barley, the grain is heated with hot water to extract the starch and then warmed with malt. Malt is germinated barley which contains enzymes which break the starch into a simpler carbohydrate called maltose, $C_{12}H_{22}O_{11}$.

Maltose has the same molecular formula as sucrose but contains two glucose units joined together, whereas sucrose contains one glucose and one fructose unit.

Yeast is then added and the mixture is kept warm (say 35°C) for perhaps several days until fermentation is complete. Air is kept out of the mixture to prevent oxidation of the ethanol produced to ethanoic acid (vinegar).

Enzymes in the yeast first convert carbohydrates like maltose or sucrose into even simpler ones like glucose and fructose, both $C_6H_{12}O_6$, and then convert these in turn into ethanol and carbon dioxide.

You can show these changes as simple chemical equations, but the biochemistry of the reactions is much, much more complicated than this suggests.

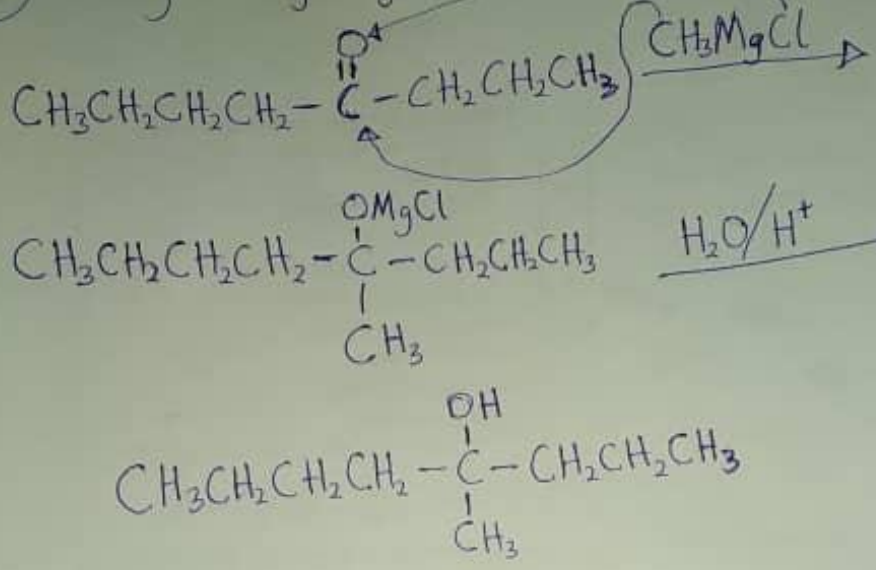
$$C_{12}H_{22}O_{11} + H_2O \longrightarrow 2C_6H_{12}O_6$$

$$C_6H_{12}O_6 \longrightarrow 2CH_3CH_2OH + 2CO_2$$

Yeast is killed by ethanol concentrations in excess of about 15%, and that limits the purity of the ethanol that can be produced. The ethanol is separated from the mixture by fractional distillation to give 96% pure ethanol.

For theoretical reasons, it is impossible to remove the last 4% of water by fractional distillation.

(2.) Using Methylmagnesium Chloride (CH_3MgCl)



① Primary Alcohols → In a primary alcohol, which is ~~Somotin~~ usually represented as 1°. The Carbon atom that carries the -OH group is only attached to one alkyl group. Examples of primary alcohols are; Ethanol (CH_3-CH_2-OH), Propan-1-ol ($CH_3CH_2CH_2OH$)

2-methyl propan-1-ol ($CH_3-\underset{CH_3}{\underset{|}{C}}H-CH_2OH$)

Secondary Alcohols → In a secondary alcohol, which is usually represented as 2°. The Carbon atom with the -OH group attached is joined directly to two alkyl groups, which maybe thesame or different. Examples include; Propan-2-ol ($CH_3-\underset{OH}{\underset{|}{C}}H-CH_3$), Pent-3-ol ($CH_3-CH_2-\underset{OH}{\underset{|}{C}}H-CH_2-CH_3$)

butan-2-ol ($CH_3-\underset{OH}{\underset{|}{C}}H-CH_2-CH_3$)

① Reduction of Alkanone Leads to a secondary alcohol and the reduction of Alkanal Leads to a primary alcohol. Hence, the specific examples; The reduction of Propanone Leads to Propan-2-ol and the reduction of ethanal Leads to ethanol.

$$CH_3-\underset{H}{\overset{O}{\overset{\|}{\underset{|}{C}}}} + 2H \longrightarrow CH_3-\underset{H}{\overset{OH}{\underset{|}{C}}}-H$$

$$CH_3-\underset{CH_3}{\overset{O}{\overset{\|}{\underset{|}{C}}}} + 2H \longrightarrow CH_3-\underset{OH}{\overset{H}{\underset{|}{C}}}-CH_3$$

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2-methyl propan-1-ol ($CH_3-\underset{CH_3}{CH}-CH_2OH$)

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$$CH_3-\underset{H}{\overset{O}{\overset{\|}{C}}} + 2H \rightarrow CH_3-\underset{H}{\overset{OH}{C}}-H$$

$$CH_3-\underset{CH_3}{\overset{O}{\overset{\|}{C}}} + 2H \rightarrow CH_3-\underset{OH}{\overset{H}{C}}-CH_3$$