Biology and Chemistry of stink
MIT ESP Splash 2013

Andrew Thompson

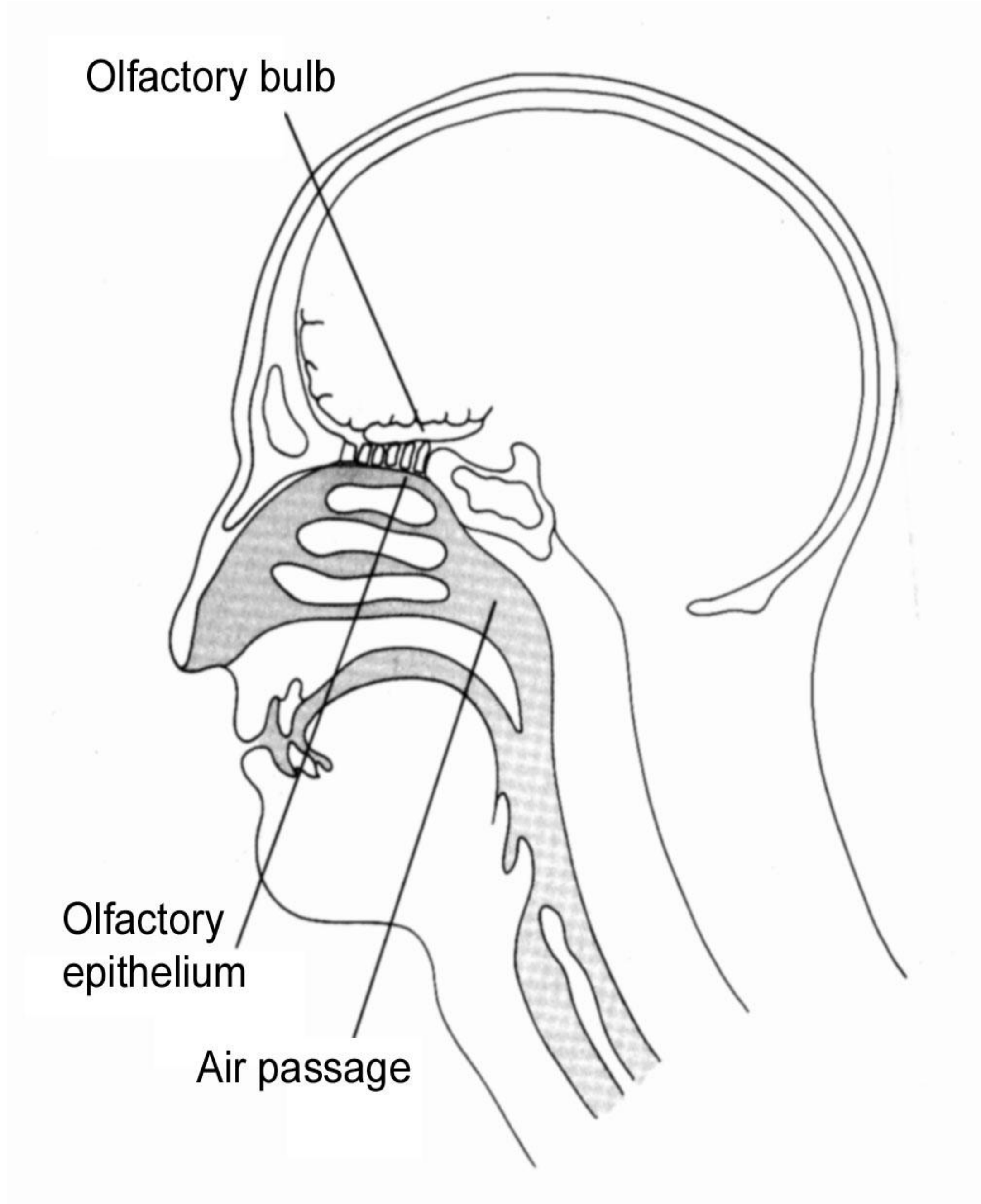
Chemical detection the nose

Human nose olfactory (smell) receptors send input through the cribiform plate of the the skull to olfactory bulb

olfactory cortex is referred to as paleocortex as it is not organized like the cerebral cortex.

The fish brain can be described as containing almost exclusively paleocortex (smelling brain.)

rostral migratory stream- makes new inter neurons in some animals



requirements for odor

detection limits
must be volatile -solids do not have an odor.

some volatile element must be able to reach your nose in order to smell it.

Some solids such as ferric chloride appear to have an odor because they react with the air (or moisture in it) to produce a volatile odor (in this case HCl)

In the case of heroin, police dogs are trained to smell the trace acetic acid (vinegar) associated with the heroin from its manufacture/purification.

In the case of cocaine (an ester) police dogs are trained to detect methyl benzoate, a pleasant smelling substance released from the decay of cocaine in humid air.

Stink -abritrary categories

<u>spoiled food/putrefaction</u> -volatile fatty acids

<u>natural odor/defense</u> -skunks-thiols, stinky food

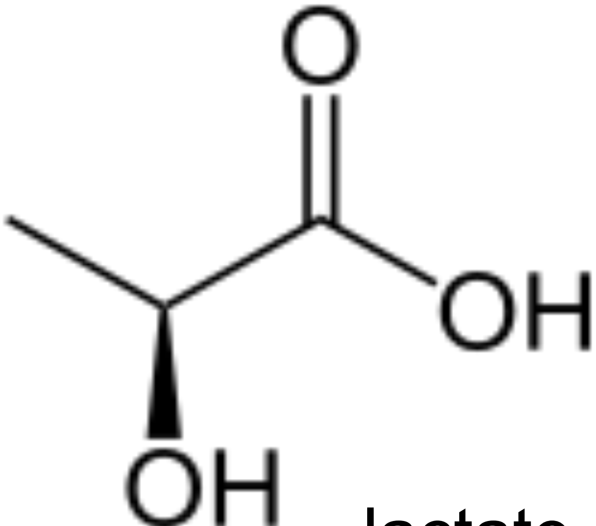
<u>odor removal-acid/base</u>

<u>other noteworthy odors</u>- unique historical
 -phenol

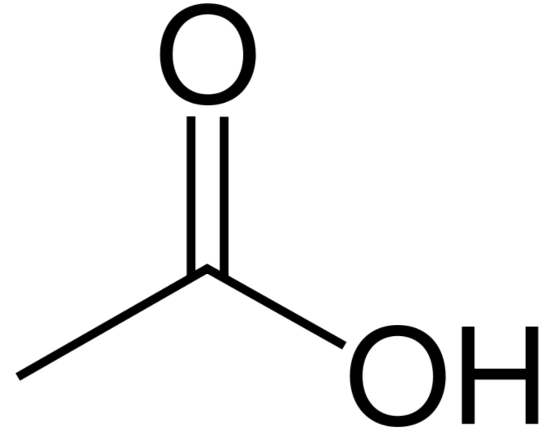
spoiled food- the fridge

pseudomonads-sweet fruit like? mostly on plants
acetophenone
actinomycetes- eg.streptomyces -earthy smells - geosmin
molds-musty
Streptococci- meat, putrid odors- short chain fatty acids
E. Coli, Salmonella- fecal odors- indoles

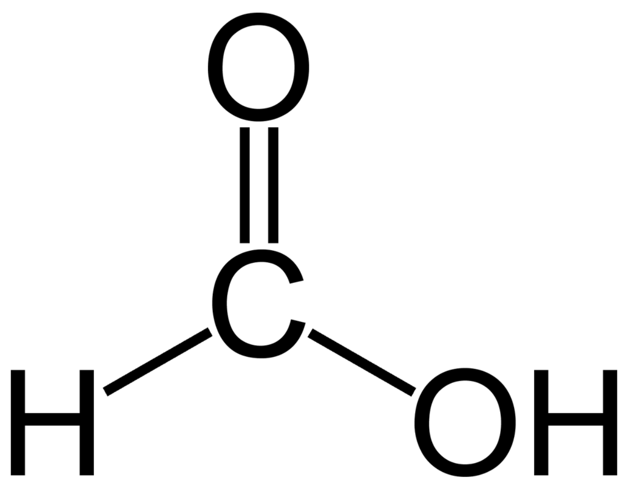
Mouth: HACEK bacteria -cause endocarditis?
* **Haemophilus** (Haemophilus parainfluenzae)
* **Actinobacillus** (actinomycetemcomitans)
* **Cardiobacterium** hominis
* **Eikenella corrodens** (commonly isolated from human bites)
* **Kingella** (Kingella kingae)



lactate

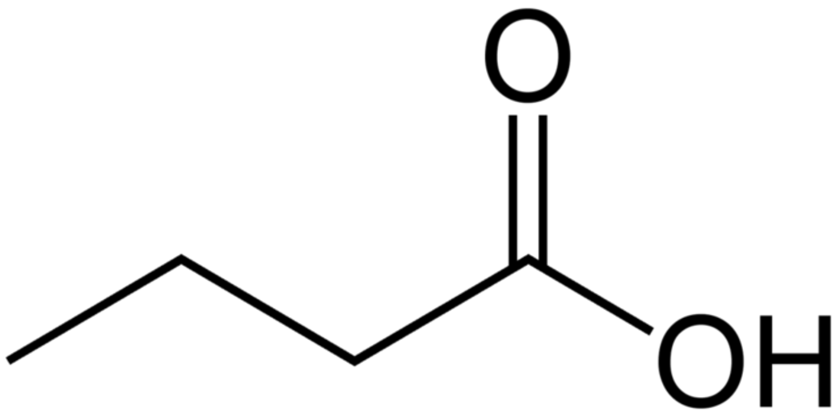


acetate

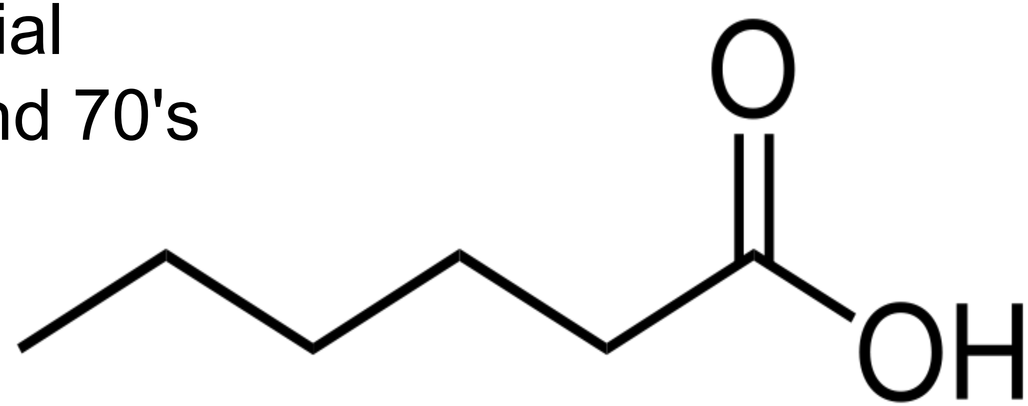


formic acid

butyric & hexanoic acid



Abbie Hoffman advocated using butyric acid as a "stink bomb" weapon in his Yippie social "revolution" of the 60's and 70's



Short chain fatty acids

formic, acetic, propionic, butyric acid(butanoic acid)

Thus far most of the stinky molecules released by spoiling bacteria are short (short carbon chains) acids.

Further digestion by bacteria will release the longer fatty acids which are a part of fat in meat. Giving rancid sorts of odors.

This fatty acid release is connected with adipocere formation covered later.

bacteria

clostridia -lipase
gram negatives E.Coli-indoles, pseudomonas
gram positives Staphlacoccus, streptococcus, clostridia
pseudomonas -acetophenone
actinomycetes -geomisin

gram negative(-) tend to be gut bacteria. Pseudomonas a notable exception

gram positive(+) tend to be found on the skin or associated with meat. Cl
is a notable exception (obligate anaerobe)

putrefaction

bacteria
Louis Pasteur described the spoiling of wine (and food) due to bacteria which required exposure to at least some oxygen. eg. Spoiled wine alcohol (Ethanol) is converted to acetic acid (Ethanoic acid) by acetobacter bacteria

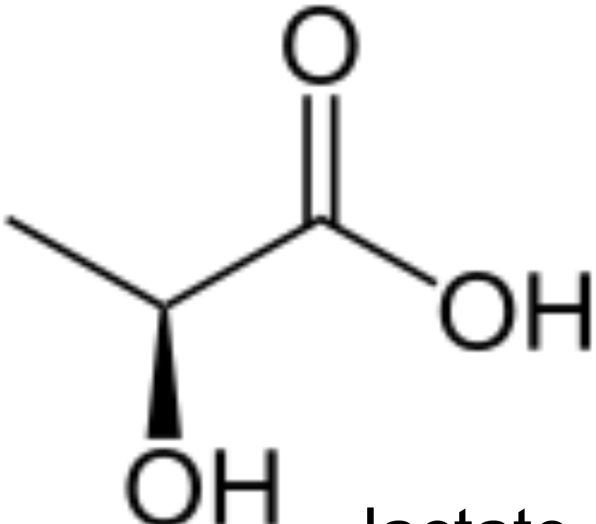
facultative anerobes and oxygen -acetic acid bacteria/wine
VFA (volatile fatty acid) products- respiration needs oxygen
typically acetic, propionic,lactic, formic acids sometimes butyric acid

indole from tryptophan metabolism -enterobacteria/coliforms such as E.Coli

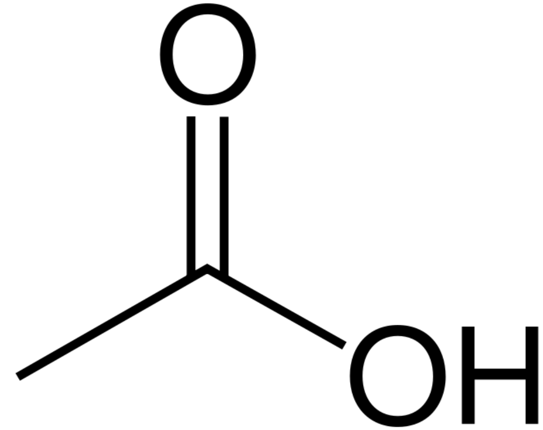
strict anaerobic- Clostridium bacteria produce butyric acid -very putrid odor.
After facultative anaerobic bacteria use all available oxygen, clostridia take over eco-environent.

Clostridium tetanae -tetanus needs deep puncture wound to grow (zero oxygen)

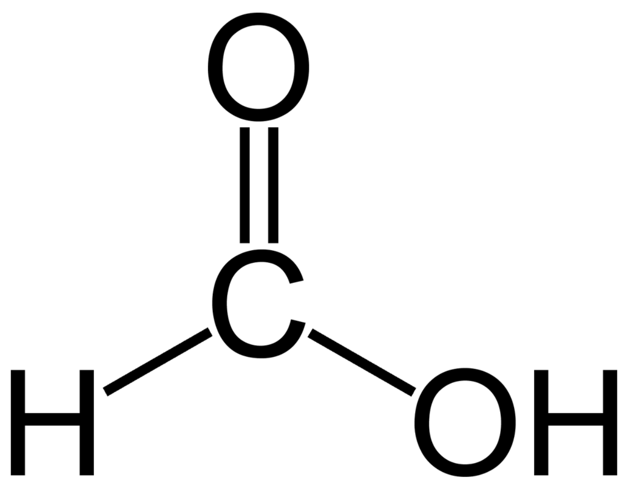
ammonia releasers-to obtain the 2-carbon acetate from amino acids the ammonium group is removed and released



lactate



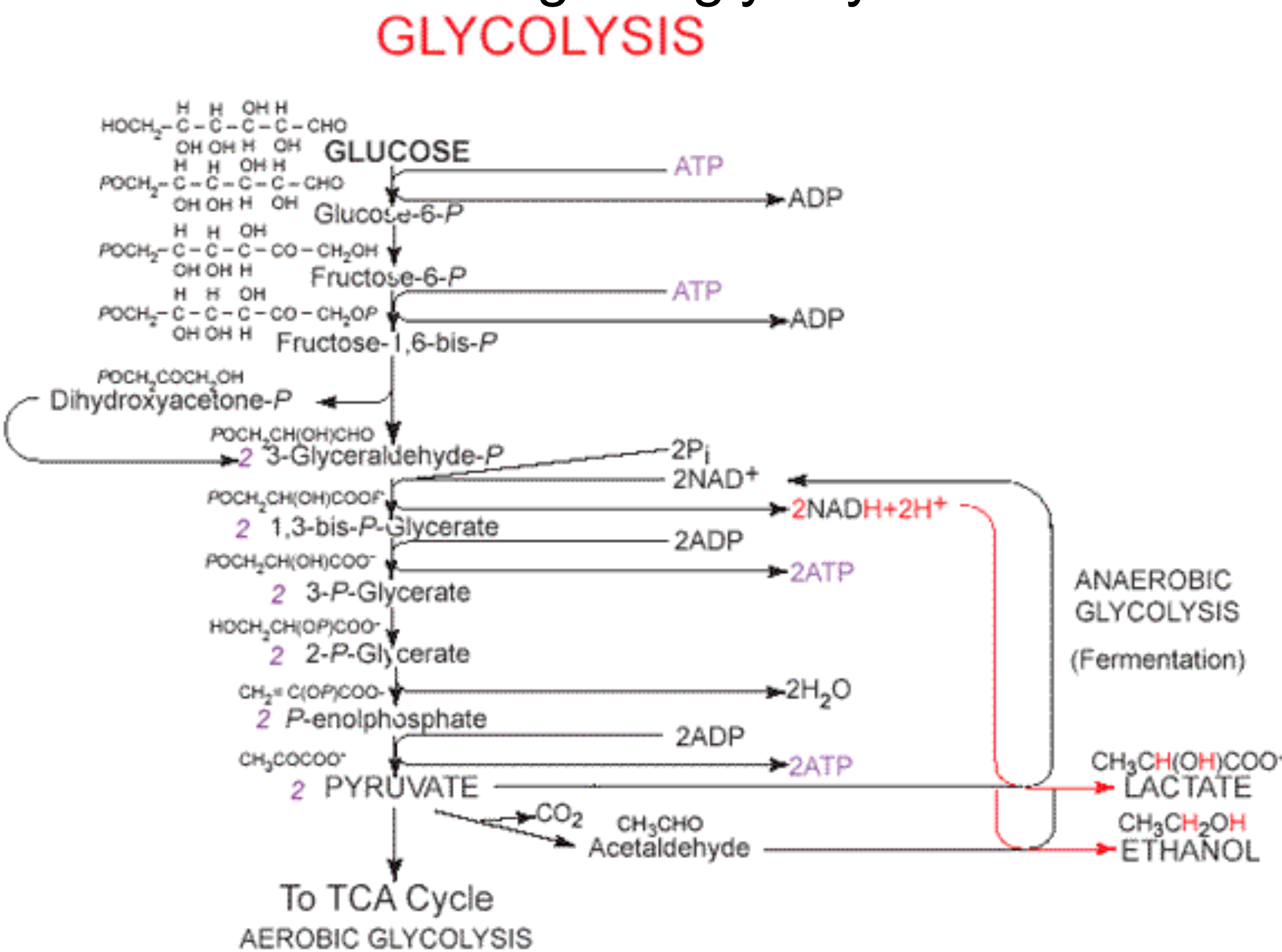
acetate



formic acid

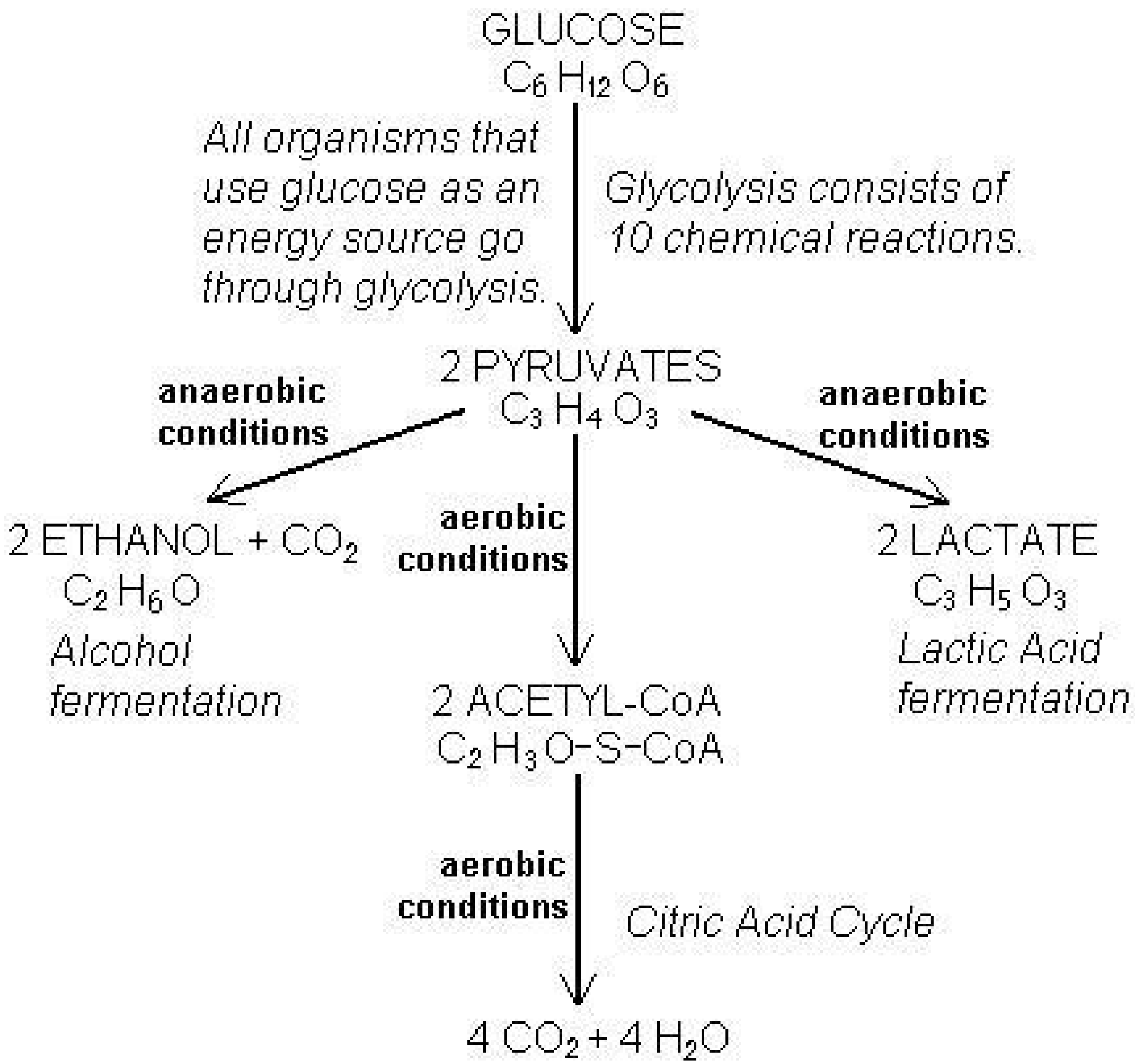
glycolysis

http://www.iubmb-nicholson.org/swf/glycolysis.swf -nice animation!



http://www.sigmaaldrich.com/etc/medialib/life-science/biochemicals/migrationbiochemicals1/Glycolysis_Map_v3.Par.0001.Image.-1.-1.1.gif

Glycolysis II



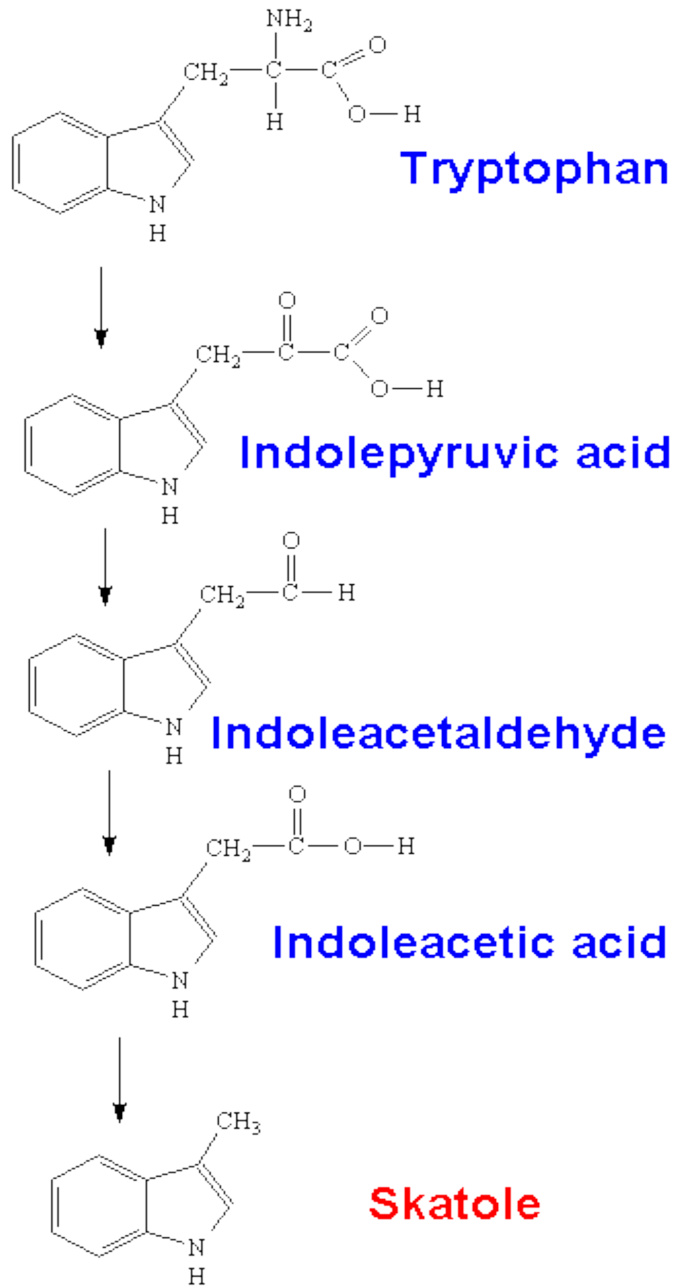
http://homepages.ius.edu/GKIRCHNE/flowdiagram.jpg

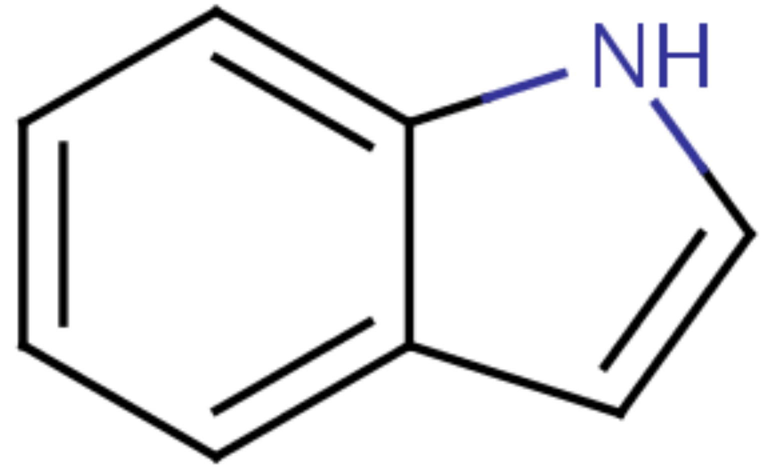
bacterial stink

Indoles

short chain fatty acids (short carbon chain)
-also called volatile fatty acids (VFAs)

tryptophan metabolism in bacteria





indole

Most characteristic fecal odor comes from indole and skatole produced from tryptophan metabolism. Same tryptophan described in turkey and other meat.

imvics- tests to distinguish various gut bacteria

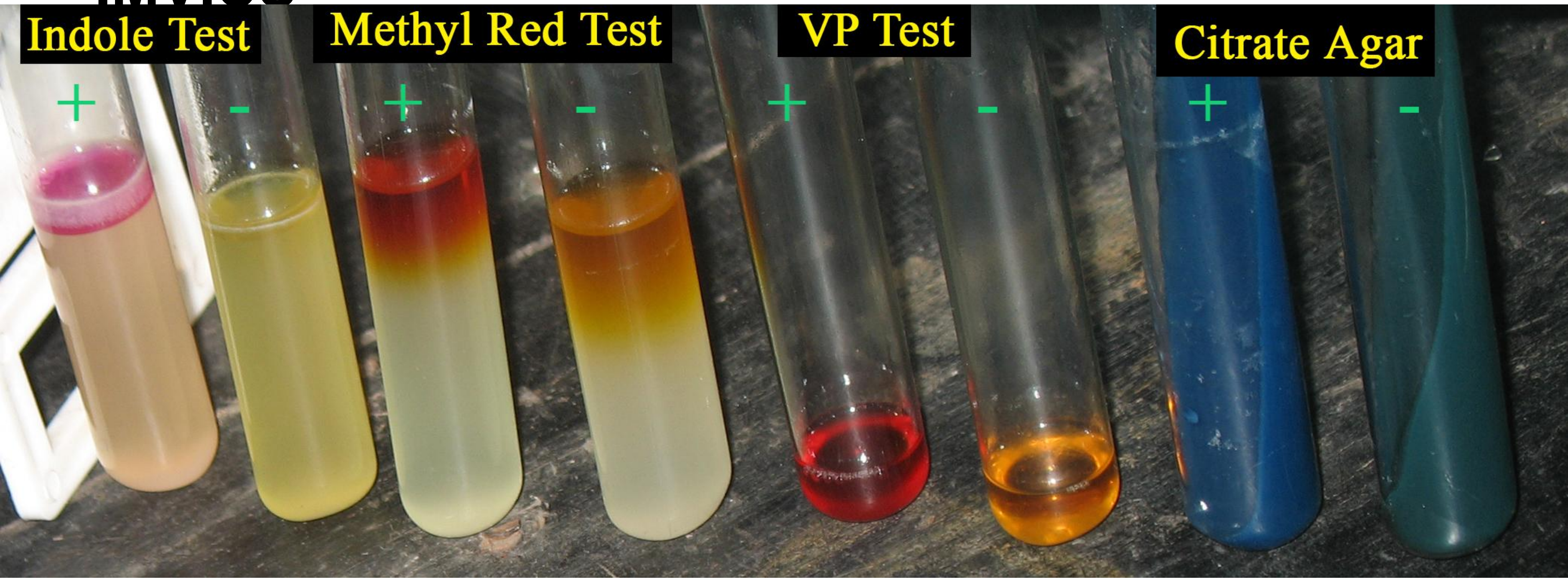
indole -Does it produce indole from tryptophan?

methyl red -Does it produce acidic (stinky) by-products?

voges-proskauer test -does it produce acetoin by-product (a non-acidic substance)

citrate -can it use citrate (citric acid) as a sole source of carbon/food?

IMVICS



human body

bile and feces- residual bile not absorbed by small intestine is oxidized/degraded by bacteria giving feces a characteristic brown color.
Bile duct obstruction or gall bladder disfunction often yield pale colored stool.

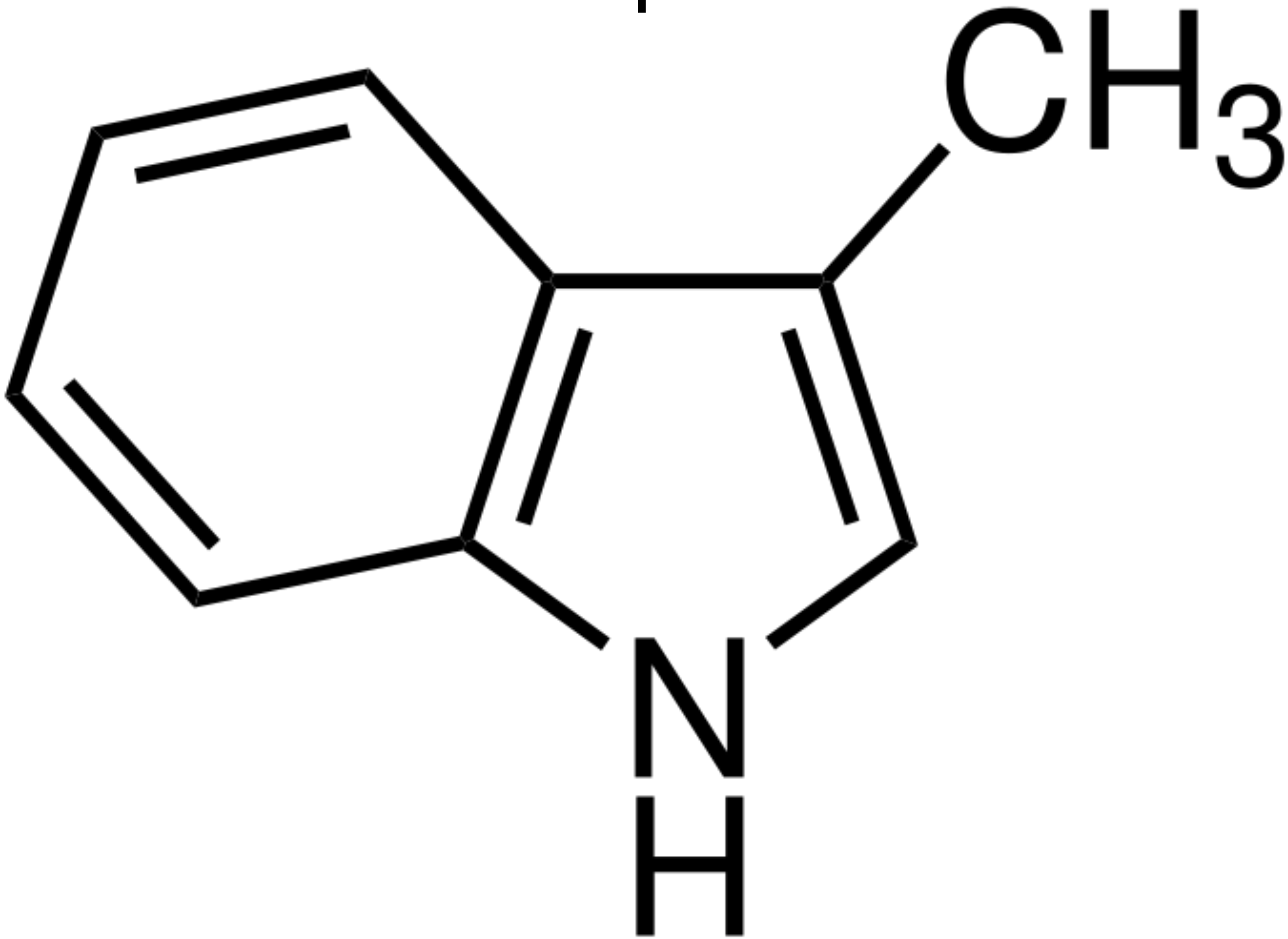
bacteroides- common bacteria, more numerous in the gut as you grow older

clostridium- strictly anaerobic but makes super stinky butyric acid
famous clostridia species include C. perfingens of gas gangrene or corpse bloating
C. tetanae of tetanus/"lockjaw" and C. botulinum -botulin toxin and "Botox" wrinkle injections

klebseilla- most common bacteria found at hospital autopsy (recent death)

E.coli- another enterobacter. Used famously in genetics research. Produces indole from tryptophan. Strain 0157:H often implicated in serious food poisoning.

skatole -smells like poo



Death and odor

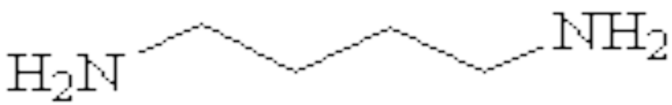
use of lime -alkaline lime neutralizes stinky acids and prevents growth

klebseilla first at autopsy

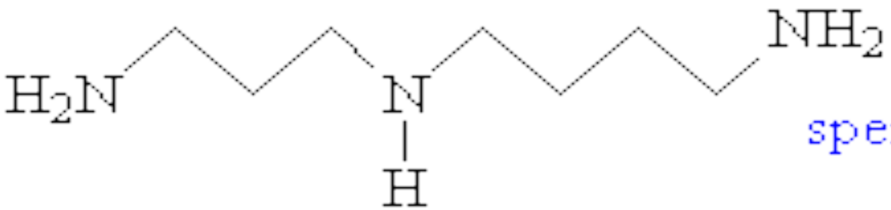
clostridia bloat- after things like E.Coli and Klebseilla use up all oxygen the clostridia take over. Clostridia responsible for gas gangrene

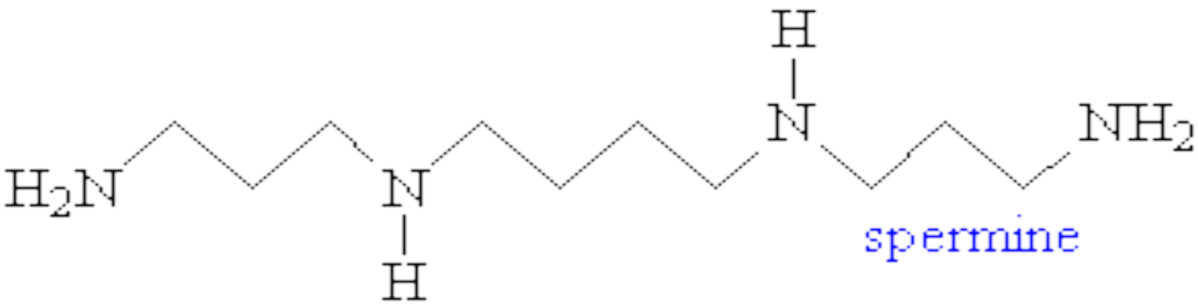
blood marbling

http://img.medscape.com/pi/emed/ckb/pathology/1603817-1607640-1680032-1714492.jpg


putrescine

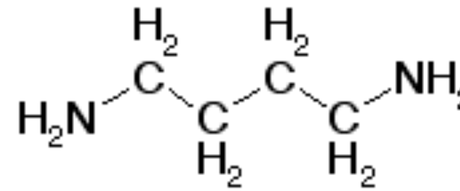

cadaverine

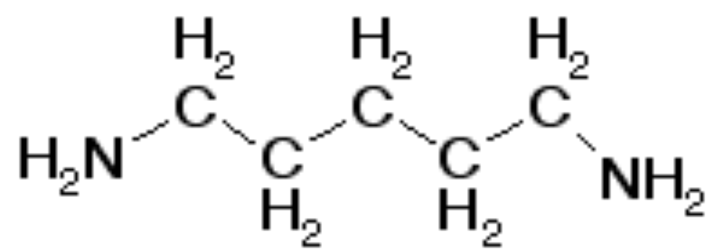

spermidine


spermine

Some longer molecules
associated with putrefaction

Primary amines


putrescine


cadaverine

acid/base

amines vs lemon -the alkaline amines of stinky fish may be neutralized with (acidic) lemon

baking soda vs fridge.- shorty acids may be neutralized with the weakly alkaline baking soda

outhouse vs lime &wood ashes -short acid products and released fatty acids may be effectively neurtalized with the strongly alkaline Calcium hydroxide (hydrated lime) or wood ashes (potassium carbonate).

The strongly alkalkine pH shift also prevents the growth of decay bacteria, improving the odor but slowing the decomposition

Lime or is it lime?

powdered limestone lime-calcium carbonate $CaCO_3$

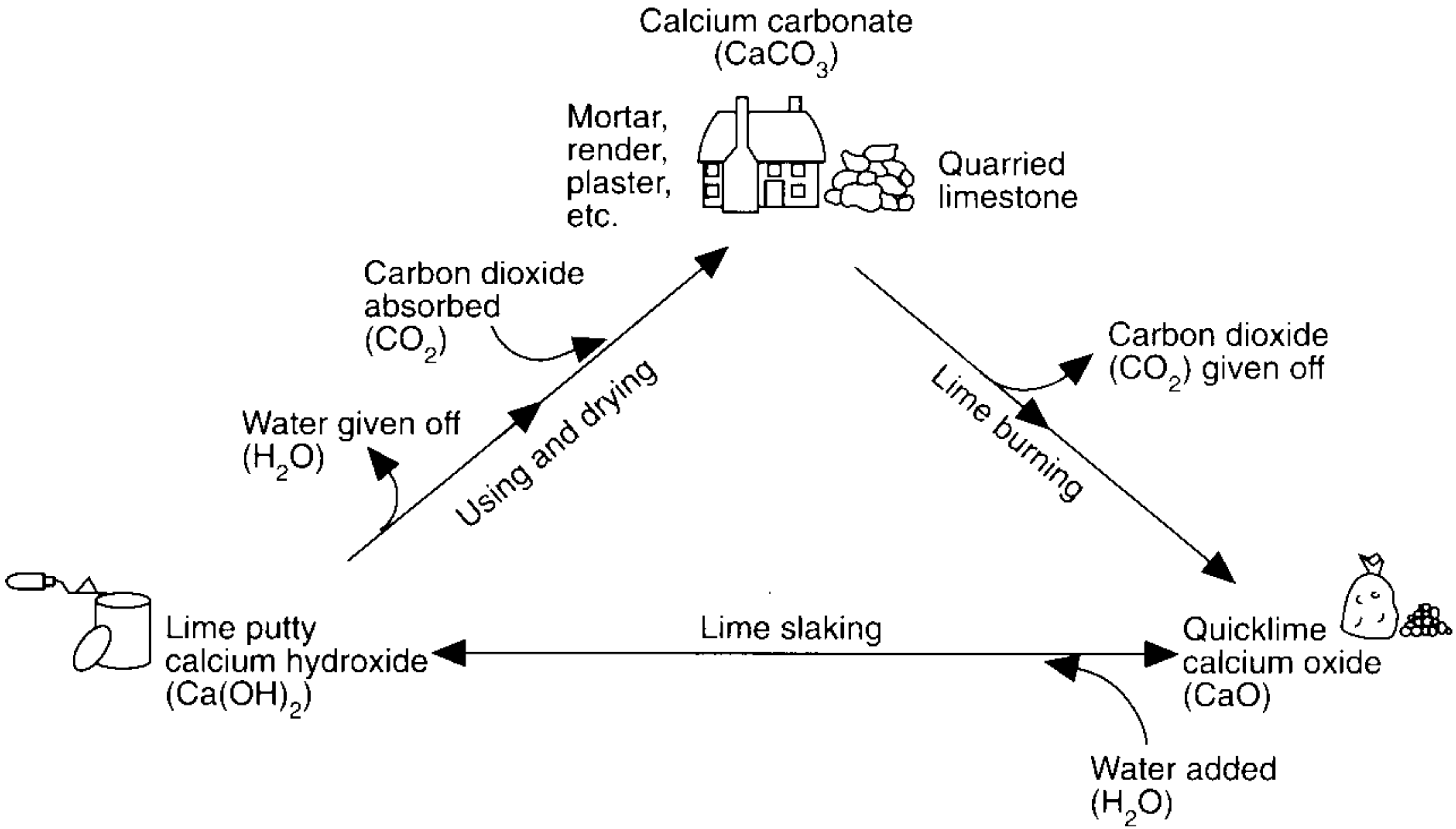
quicklime calcium oxide CaO CO_2 removed

hydrated lime $CaOH$ H_2O added

lime water -calcium hydroxide in water
chloride of lime -Ignaz Semmelweis, bubbled chlorine into lime water

calcium carbonate or calcium hydroxide?
burning seashells and Roman concrete

lime cycle



http://www.emeraldinsight.com/fig/1100130201001.png

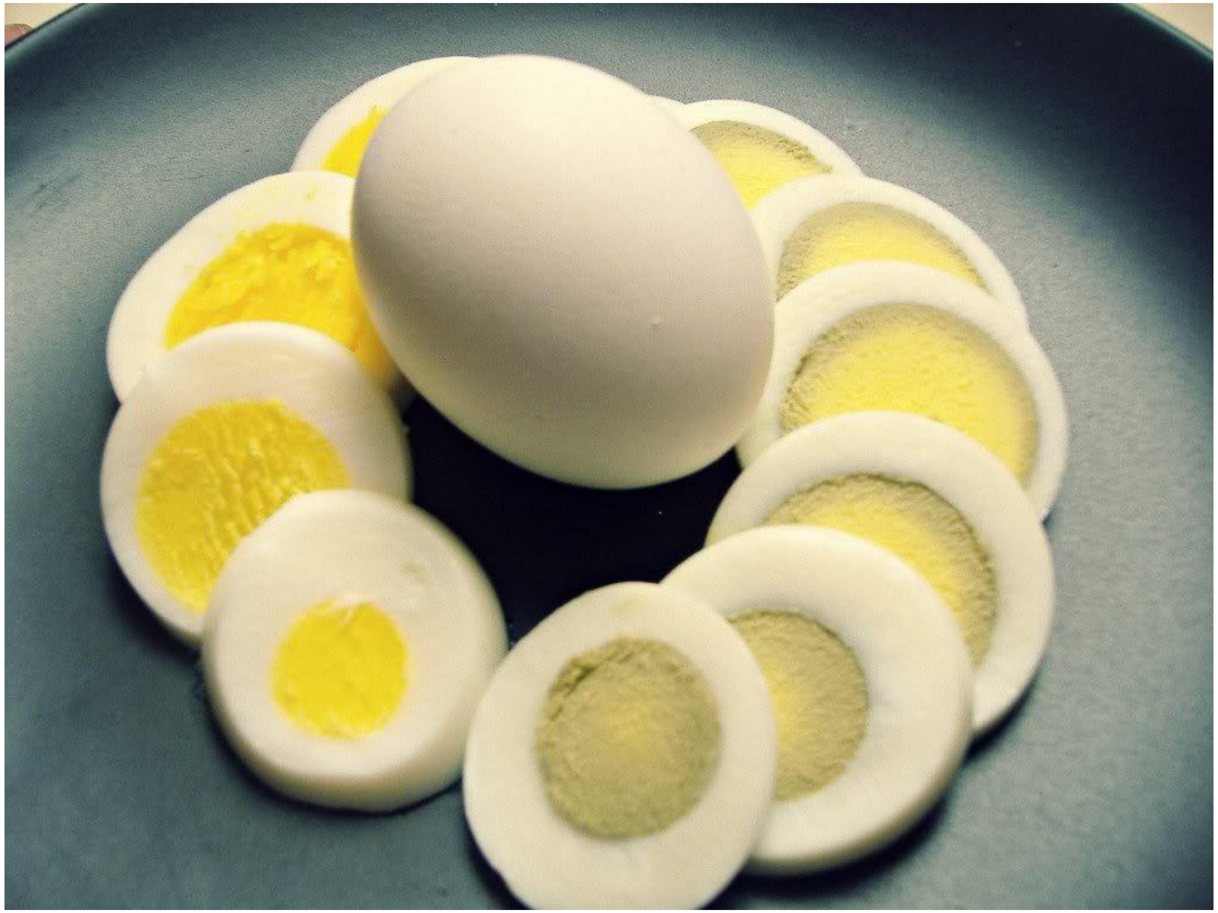
Nature's funk

thiols and protection-skunk, mercaptans, garlic
saute in oil?
ammonium thioglycolate
sodium thioglycolate
rotten and green egg
Habituation to H_2S ???

Short chain fatty acids
fishies

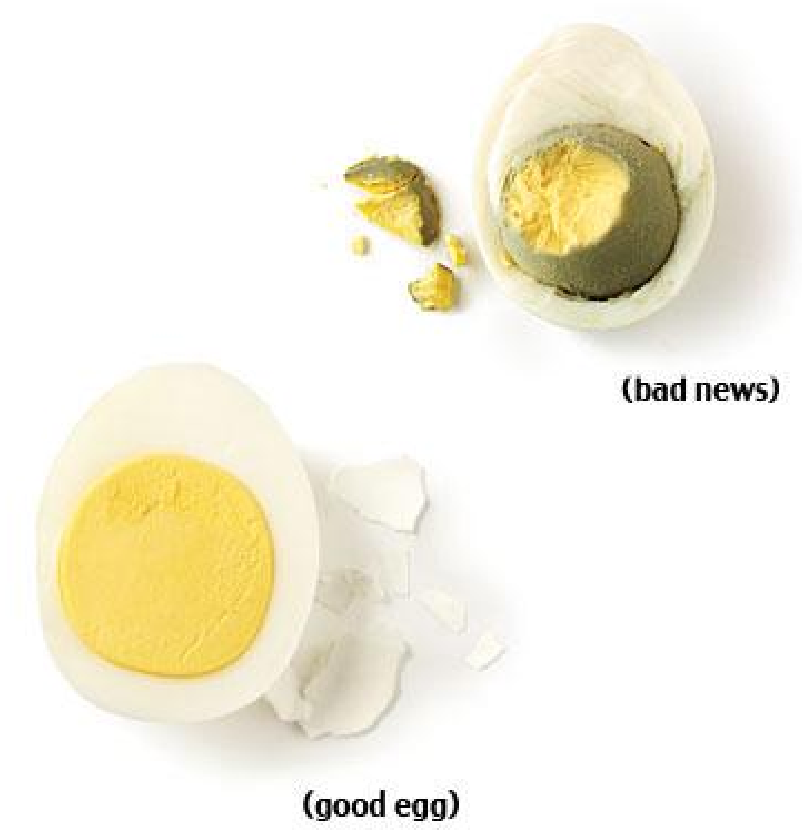
egg yolk

http://manfuel.files.wordpress.com/2013/05/green-and-yellow-yolk-in-hard-boiled-eggs.jpg



eggs

http://img4-3.cookinglight.timeinc.net/i/2011/07/1107p152-mistake-34-your-hard-cooked-eggs-are-icky-l.jpg?400:400



thiols

hair -cysteine bridges
mercaptan -methanethiol, ethanthiol
beta-mercaptoethanol
thioglycolate
asparagus

-S-H

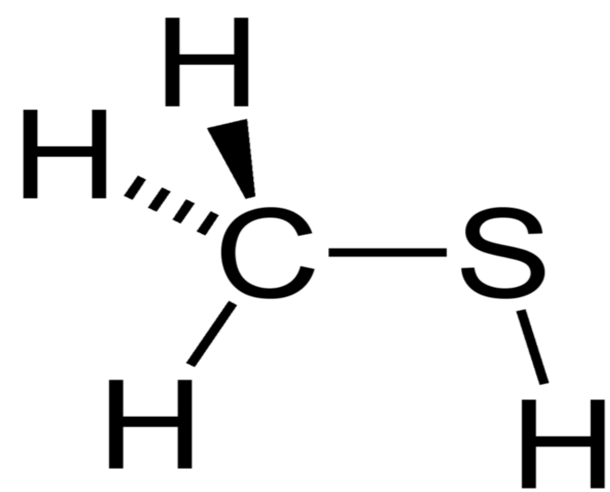

STINKBOMBEN
STINK BOMBS
Zerstören der Ampullen nur durch Hinwerfen oder Zertreten. Es verbreitet sich dann ein übler Geruch, der aber bald verschwindet.

Ammonium sulfide & Hydrogen Sulfide

$(NH_4)SH$ $NH_3 + H_2S$

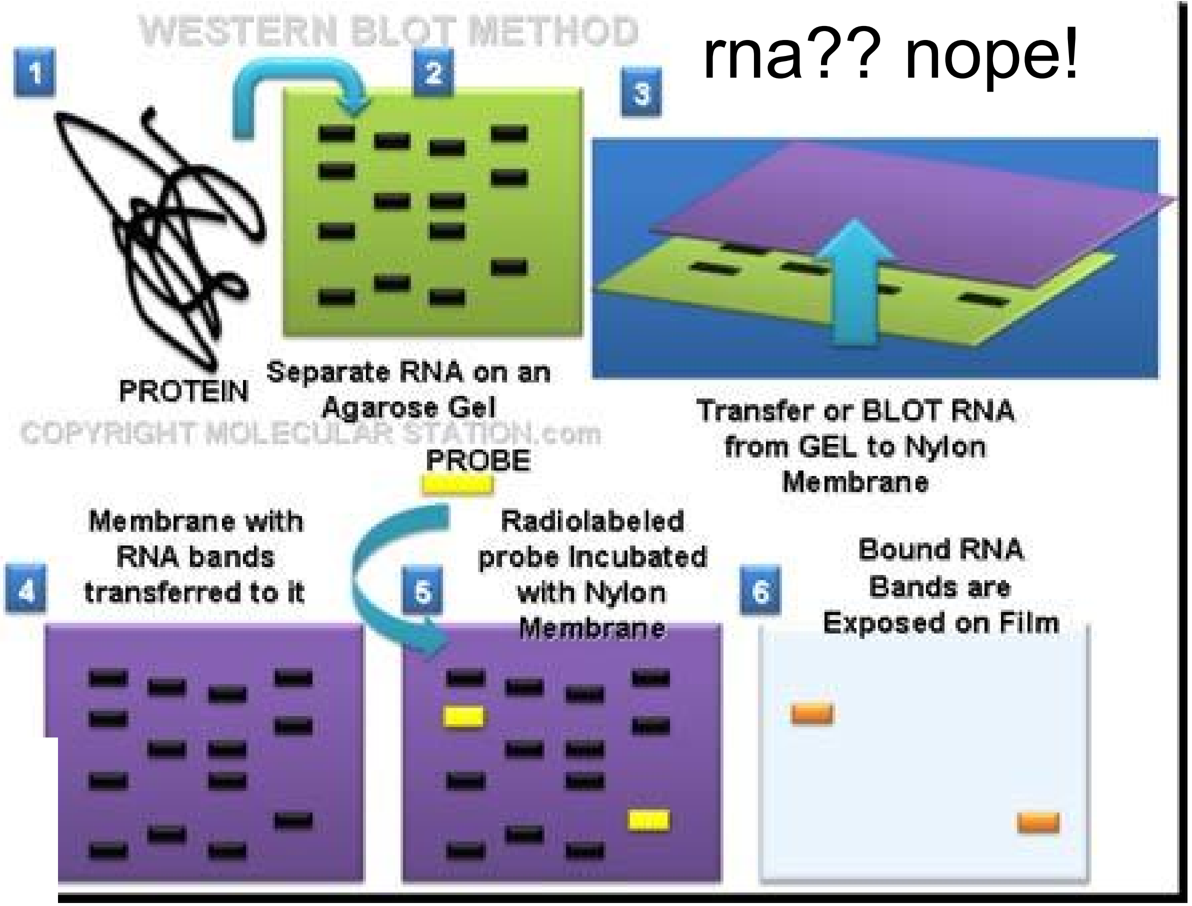
mercaptan

methanethiol
added to natural gas to allow gas leak detection
result from bacterial decay
asparagus urine???
natural gas and buzzards
turkey buzzards detect mercaptan from decaying animals- will often be seen circling natural gas leaks/gas lines

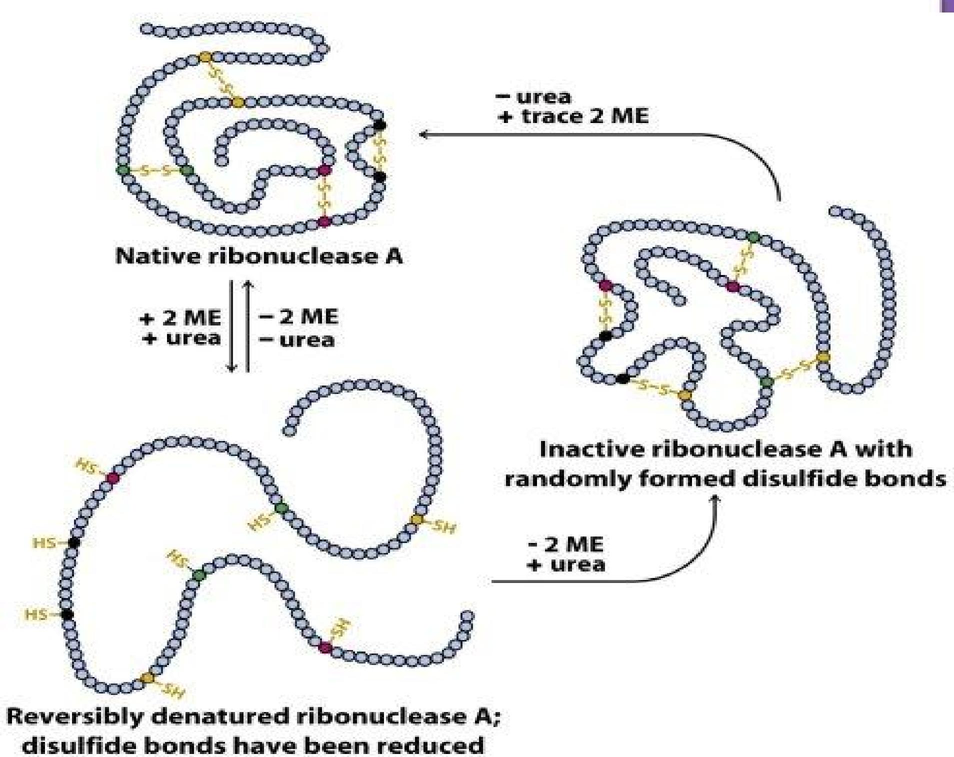


western blot

rna?? nope!



http://www.molecularstation.com/images/western-blot.jpg

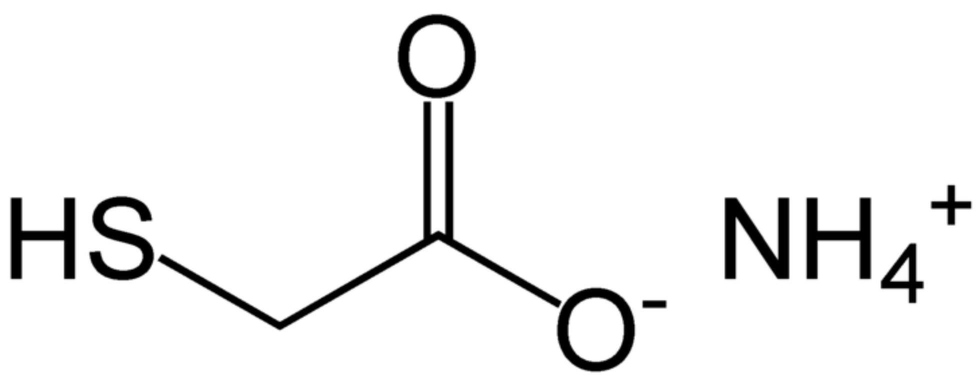


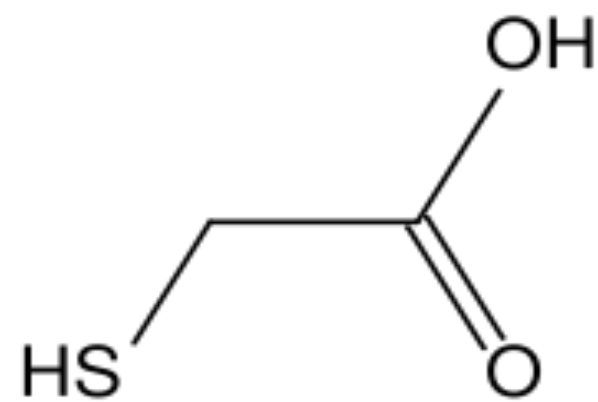
mecaptan type molecules used to reduce disulfide bridges in proteins allowing for analysis of each protein chain in separate

Ammonium thioglycolate - perms

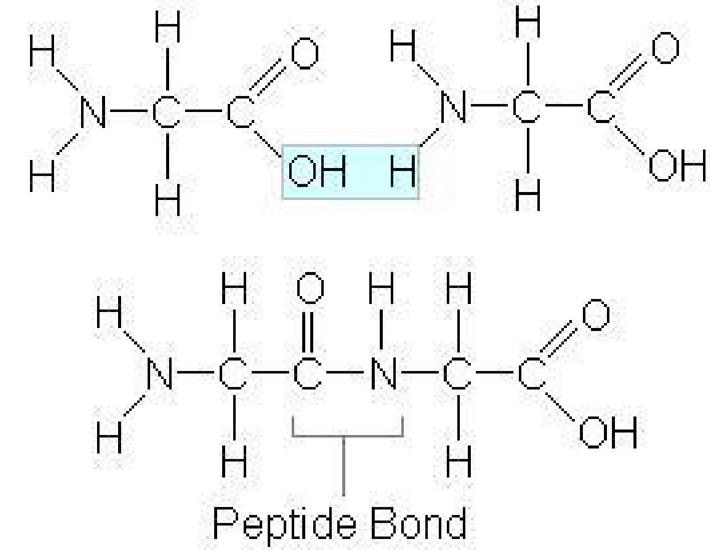
Used to reduce disulfide bridges (cysteine bridges) in hair to introduce permanent waves "Perms"

After curl/wave introduced hydrogen peroxide used to re-establish cysteine bridges. Making the perm "permanent"

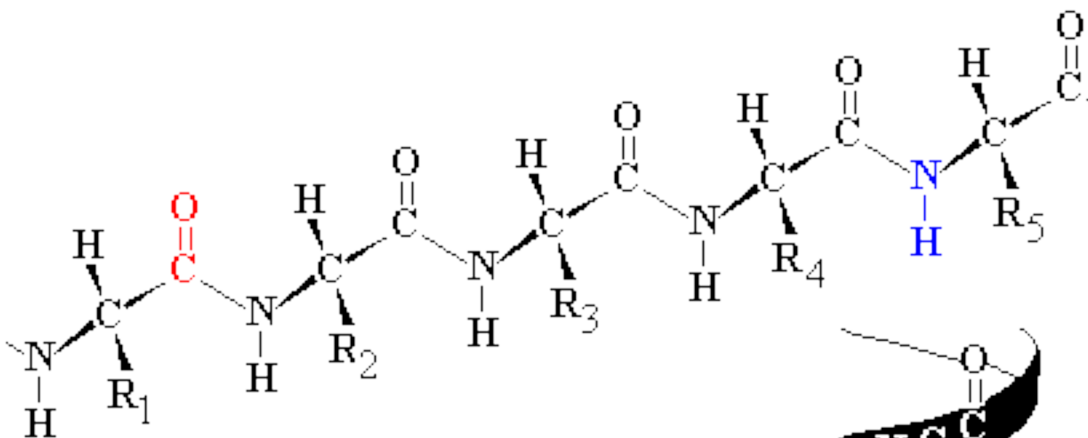


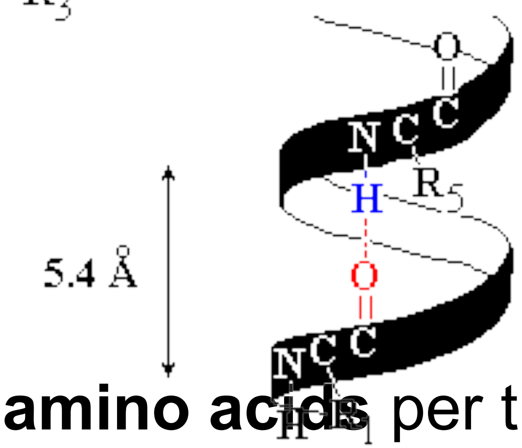


hair



A molecule of water is removed from two glycine amino acids to form a peptide bond.

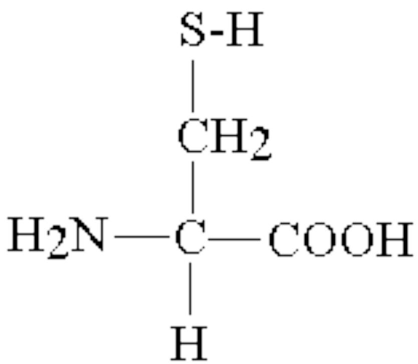




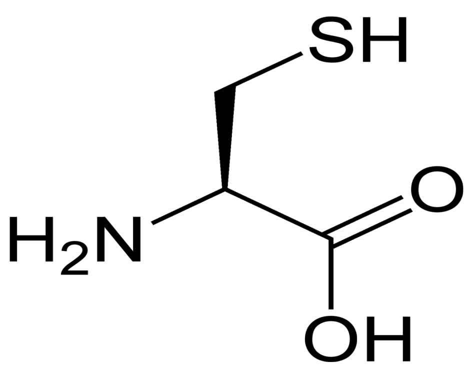
Alpha helix: has **3.6 amino acids** per turn of the helix, which places the **C=O group of amino acid #1 exactly in line with the H-N group of amino acid #5** (and C=O #2 with H-N #6)

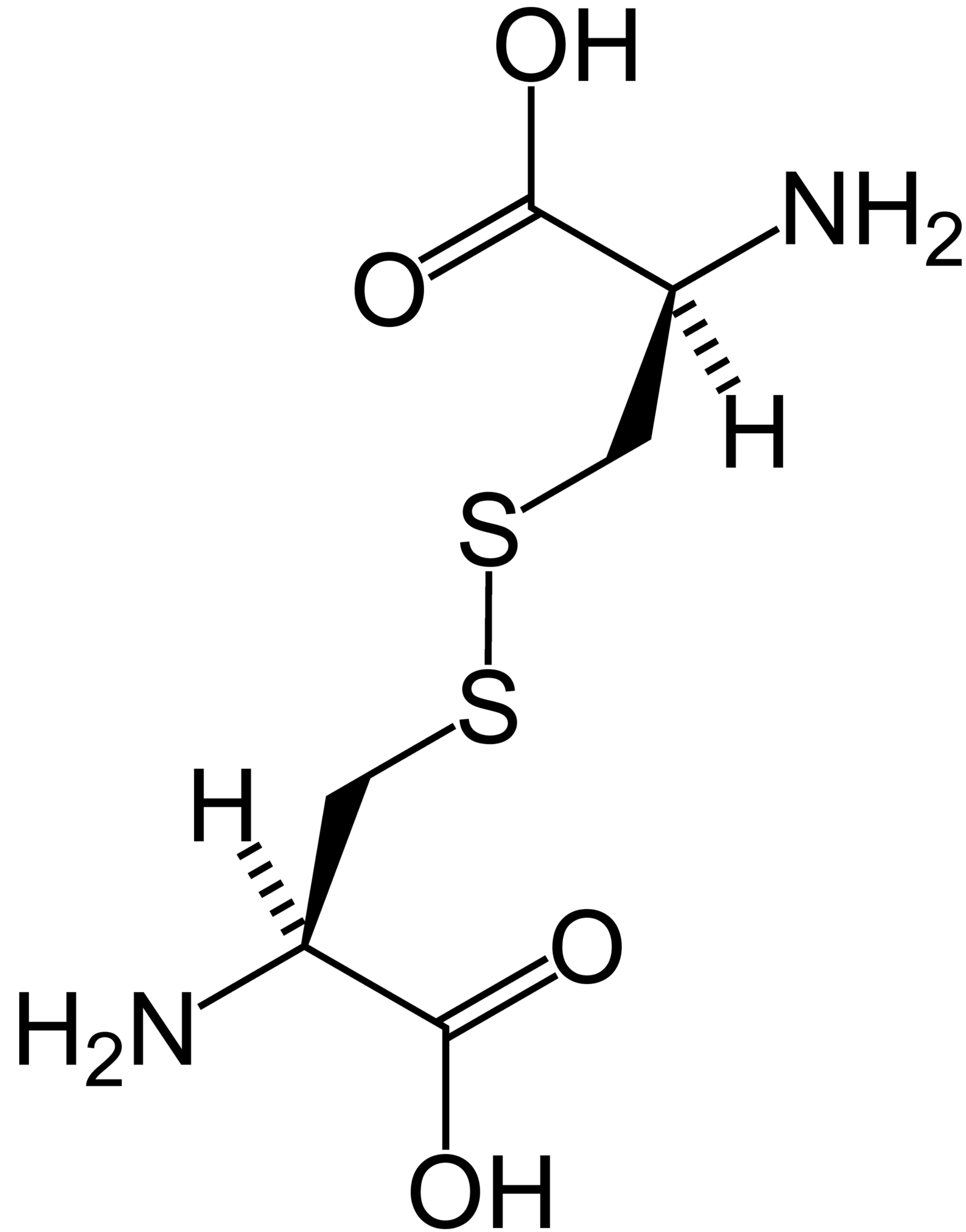
http://www.chembio.uoguelph.ca/educmat/phy456/456lec01.htm

cysteine disulfide bridge



cysteine

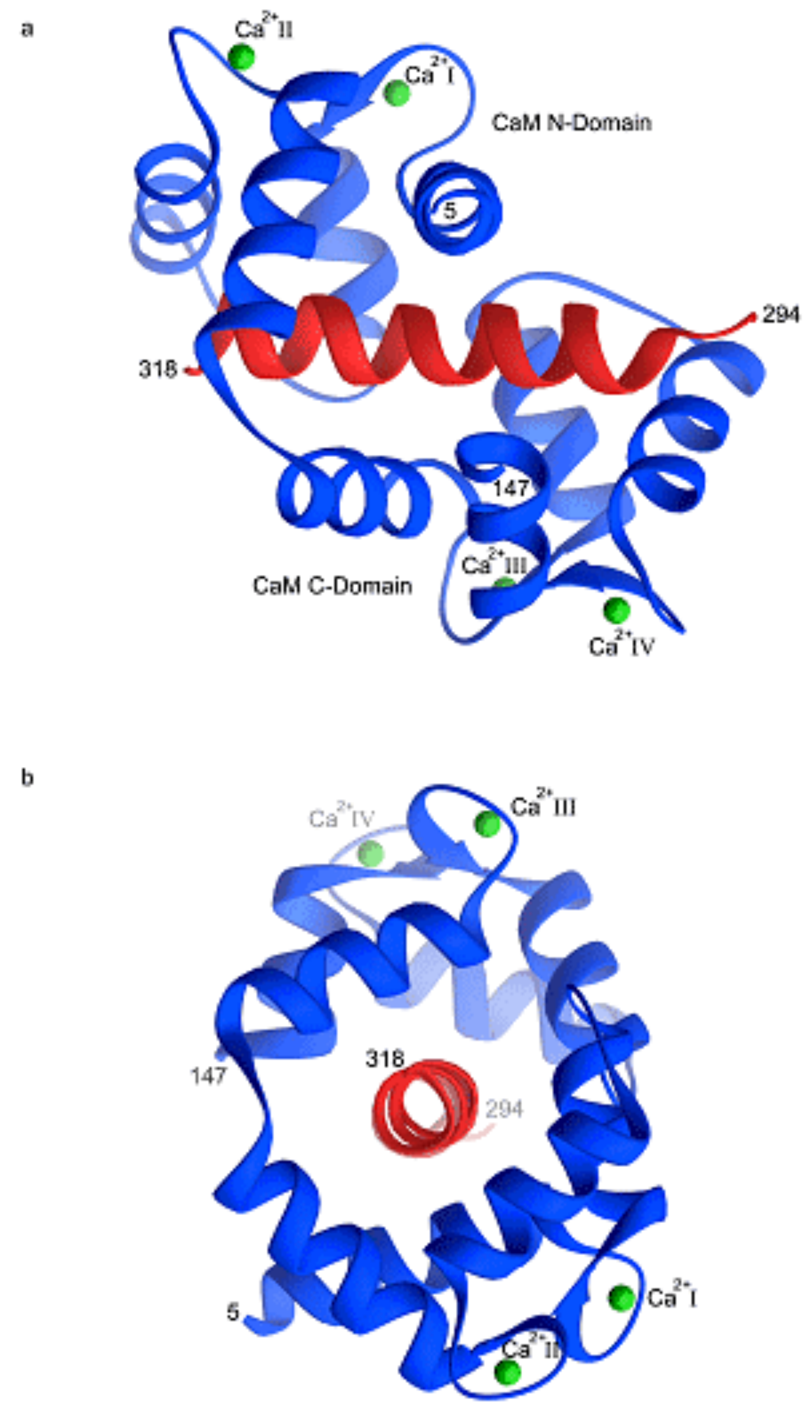




hair 3

not a picture of hair!

reduce with thioglycolate
bend hair
oxidize with peroxide
rotten egg smell from the THIOL
as in THIOglycolate



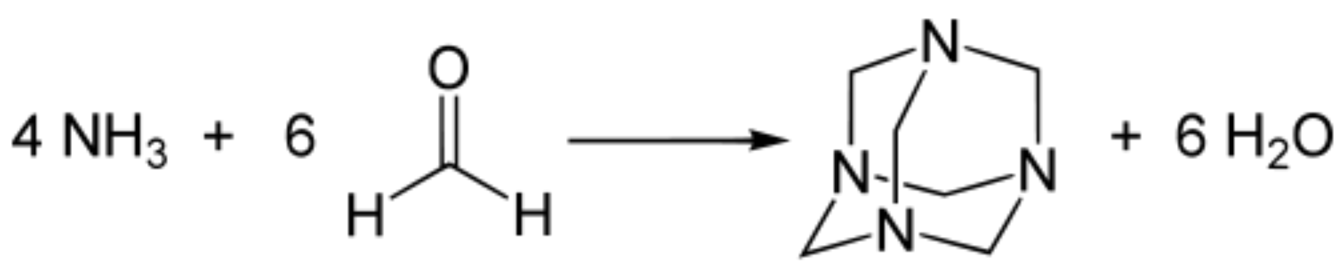
amines/fishy

methenamine -esbit camping fuel, smells fishy
amines weakly basic-alkaline

saltwater fish use trimethylamine oxide (TMAO) to maintain osmotic balance within cells.

Trimethylamine oxide reductase is a very common bacterial enzyme-
Reduces trimethylamine oxide to Trimethylamine in order to produce ATP. Releases fishy odor-trimethylamine

Odor difficult to control as coldblooded fish enzymes still work well at cool (almost freezing) temperatures.



methenamine or hexamine

esbit stove hexicooker

http://www.1944militaria.com/reproduction_persor
htm

The other stuff

durian fruit
ginkgo biloba fruit -female trees
phenols/terpenes -ceder
actinomycetes
citrus
HCL odor
bleach compounds

durian

Popular in South East asia. Sweet custard like inside but awful sulfur (thiol) and fecal (indole) like odor.

The five cells are silky-white within, and are filled with a mass of firm, cream-coloured pulp, containing about three seeds each. This pulp is the edible part, and its consistence and flavour are indescribable. A rich custard highly flavoured with almonds gives the best general idea of it, but there are occasional wafts of flavour that call to mind cream-cheese, onion-sauce, sherry-wine, and other incongruous dishes. Then there is a rich glutinous smoothness in the pulp which nothing else possesses, but which adds to its delicacy. It is neither acid nor sweet nor juicy; yet it wants neither of these qualities, for it is in itself perfect. It produces no nausea or other bad effect, and the more you eat of it the less you feel inclined to stop. In fact, to eat Durians is a new sensation worth a voyage to the East to experience. ... as producing a food of the most exquisite flavour it is unsurpassed.

Wallace, Alfred Russel (1856). "On the Bamboo and Durian of Borneo"

more durian quotes from wikipedia

British novelist Anthony Burgess writes that eating durian is "like eating sweet raspberry blancmange in the lavatory"

Burgess, Anthony (1993, first printed in 1956). The Long Day Wanes: A Malayan Trilogy. W. W. Norton & Company. pp. 68. ISBN 0393309436.

Travel and food writer Richard Sterling says:

“ ... its odor is best described as pig-shit, turpentine and onions, garnished with a gym sock. It can be smelled from yards away. Despite its great local popularity, the raw fruit is forbidden from some establishments such as hotels, subways and airports, including public transportation in Southeast Asia.

Winokur, Jon (Ed.) (2003). The Traveling Curmudgeon: Irreverent Notes, Quotes, and Anecdotes on Dismal Destinations, Excess Baggage, the Full Upright Position, and Other Reasons Not to Go There. Sasquatch Books. pp. 102. ISBN 1-57061-389-3

signs from Singapore

Durian componants

VOLATILE FLAVORING CONSTITUENTS OF DURIAN BALDRY J, HOWARD GE, DOUGAN J PHYTOCHEMISTRY Volume: 11 Issue: 6 Pages: 2081-& 1972

likely therefore that most of the minor constituents were of little importance individually, although their combined effect might be important.

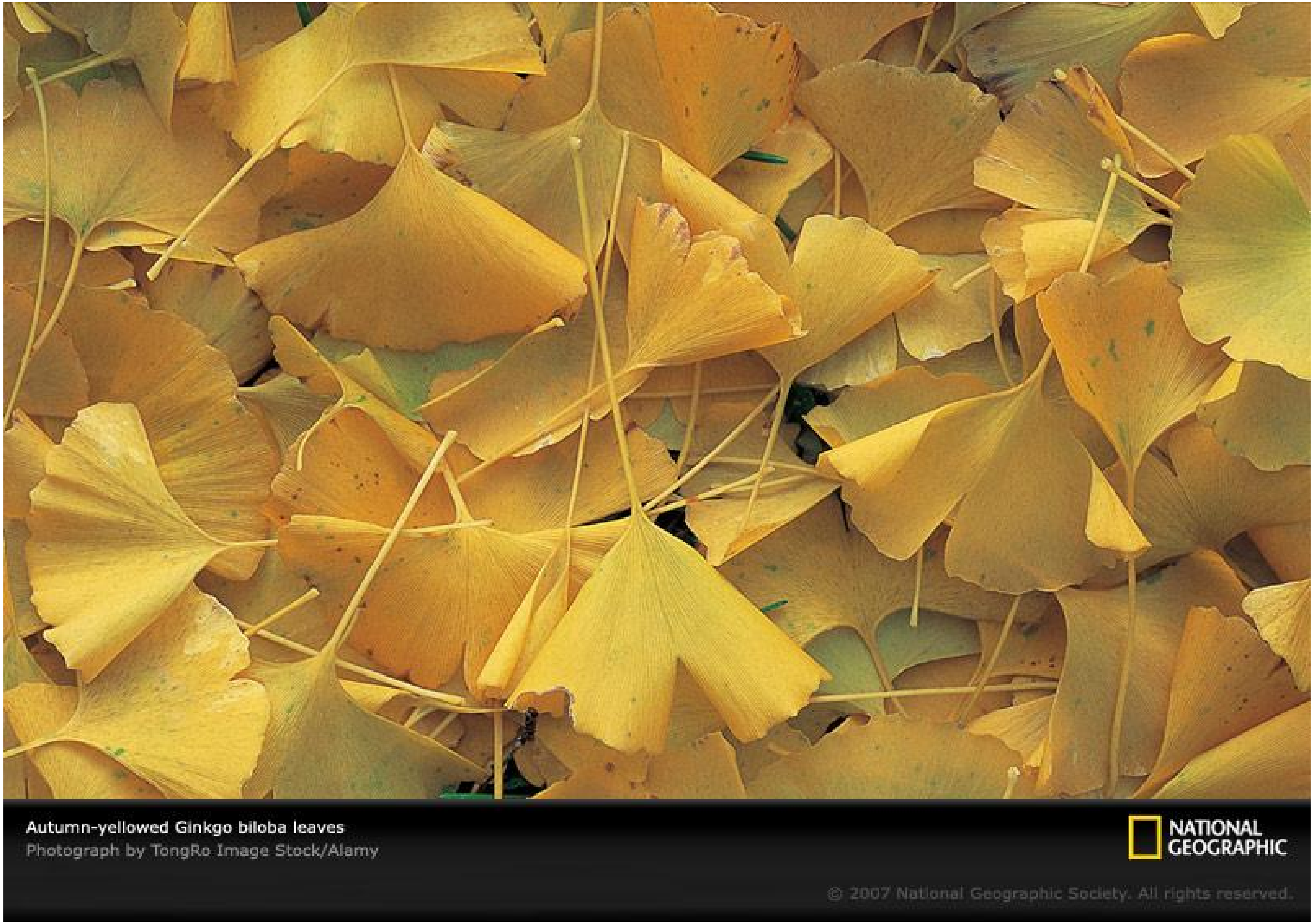
TABLE 1. VOLATILE FLAVOURING COMPOUNDS OF DURIAN

Hydrogen sulphide		Methyl acetate	(1)
Methanethiol	*	Ethyl acetate	(3)
Ethanethiol	*	Methyl propionate	(3)
Propanethiol		Ethyl propionate	(1)
Dimethylthioether	*	*n*-Propyl propionate	(1)
Diethylthioether	*	Ethyl *iso*-butyrate	(1)
Diethyldisulphide	(1)	Ethyl butyrate	
Methanol	(2)	Methyl α-methylbutyrate	(2)
Ethanol	(5)	Ethyl α-methylbutyrate	(5)
n-Propanol	(4)	*n*-Propyl α-methylbutyrate	(1)
3-Methylbutan-1-ol		Ethyl iso-valerate	(1)
Acetaldehyde	(1)	Ethyl methacrylate	(1)
Propionaldehyde	(2)	Ethyl benzene	(1)

The relative proportions are based on the height of the GLC peaks as a percentage of recorder full-rate deflection: (1) 10; (2) 10–30; (3) 30–60; (4) 60–100; (5) over 100%. Compounds marked * were identified by TLC in one solvent. All other compounds were identified by their MS obtained from condensed headspace vapours. Identifications were confirmed by comparing MS and chromatograms with those of authentic specimens.

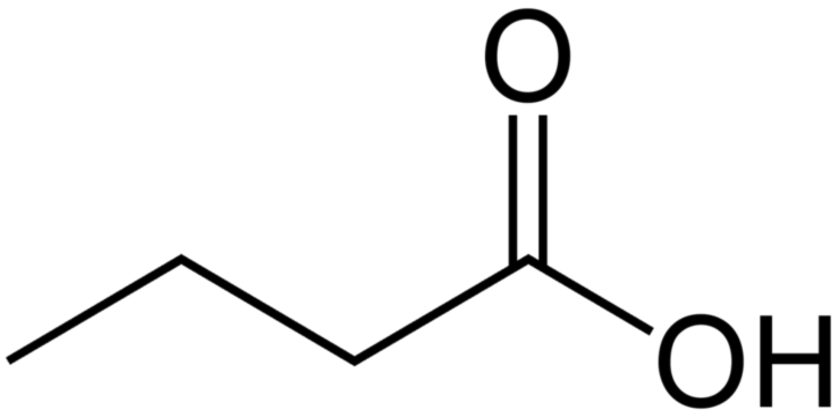
In order to confirm the conclusion that propanethiol and ethyl α-methylbutyrate were the predominant constituents of the odour of durian, an aqueous solution containing 2·5 ppm of propanethiol and 20 ppm of ethyl α-methylbutyrate was prepared. The odour of the resulting mixture was very similar in character to that of durian although it was not a precise imitation. The result was considered to be very satisfactory, however, since several substances present in the fruit in concentrations approaching half that of ethyl α-methylbutyrate were omitted from the synthetic mixture.

ginkgo

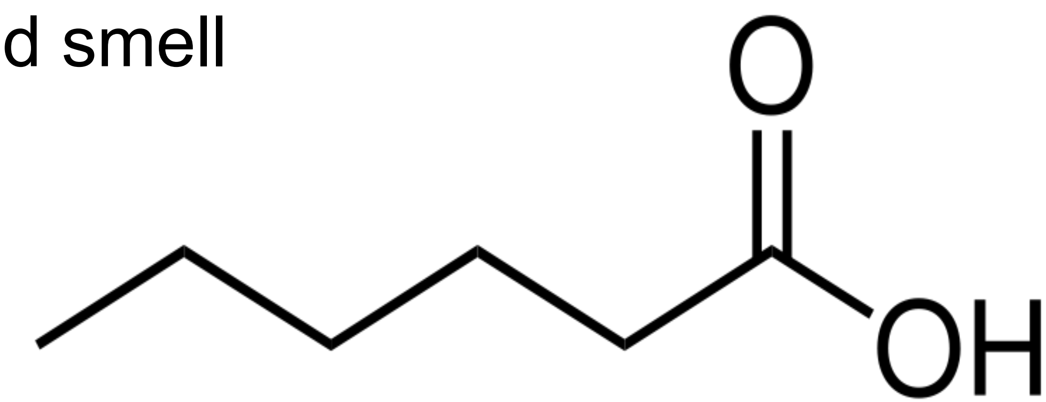

Autumn-yellowed Ginkgo biloba leaves
Photograph by TongRo Image Stock/Alamy
NATIONAL GEOGRAPHIC
© 2007 National Geographic Society. All rights reserved.

ginkgo2

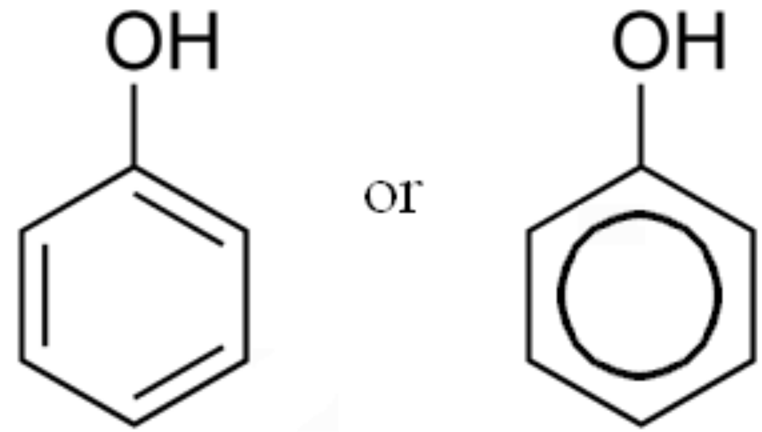
butyric/hexanoic acid



berries from female gingko trees decay and release butyric and hexanoic acids- truly putrid smell



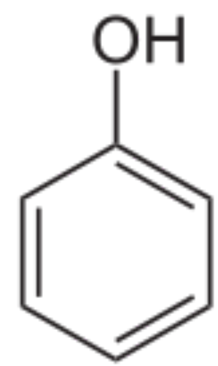
phenols



Joseph Lister   -first use of antiseptic
Antiseptic Principle Of The Practice Of Surgery 1867
Dr. Lister read -work from 1865 Louis Pasteur
carbolic acid -used to deodorize London sewage
weakly acidic, numbing, antiseptic

phenol

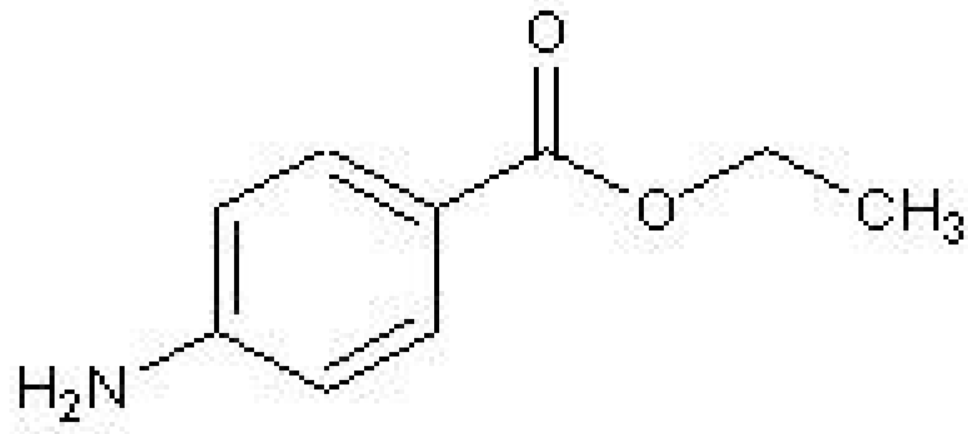
Active Ingredient: Phenol 1.4%
Inactive Ingredients: Flavor, Glycerin, Purified Water, Red 40, Saccharin Sodium



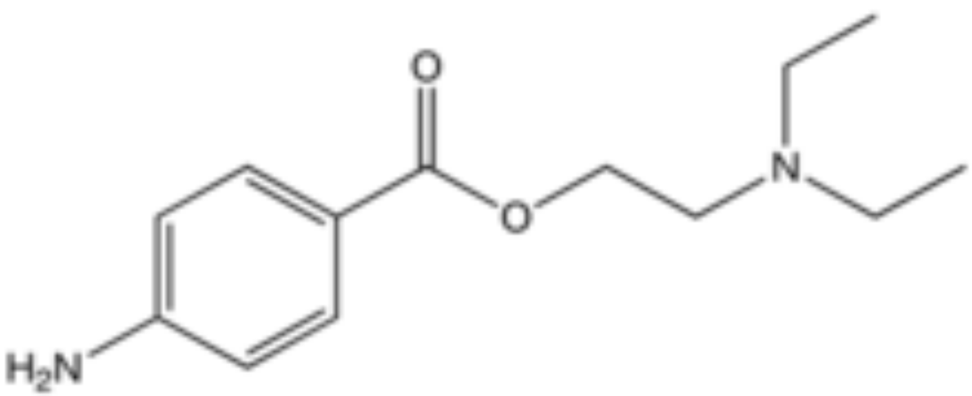
chloro-phenol still very similar
odor and disinfectant activity

Numbing mechanism

Blocks sodium from entering neurons, just like these popular numbing medications.
A structrural similarity to the ring group????



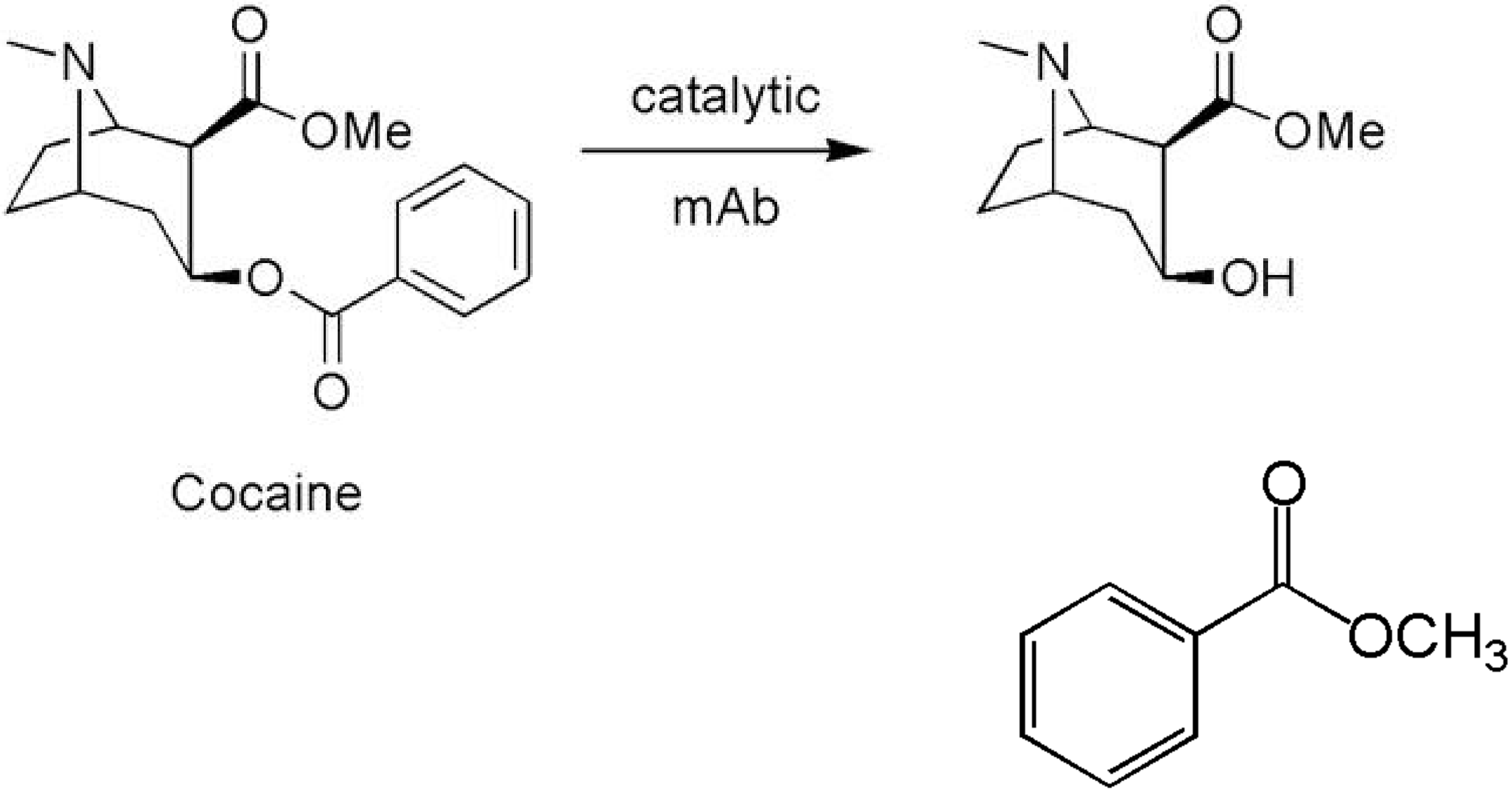
benzocaine



novocaine

Cocaine numbs too

methyl ecgonine



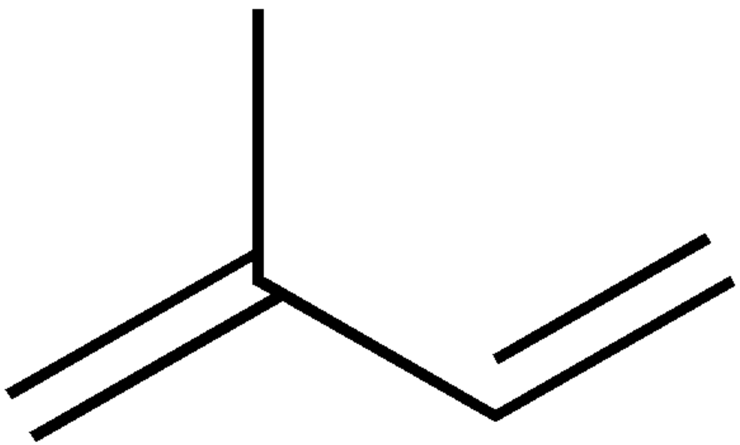
Cocaine

methyl benzoate

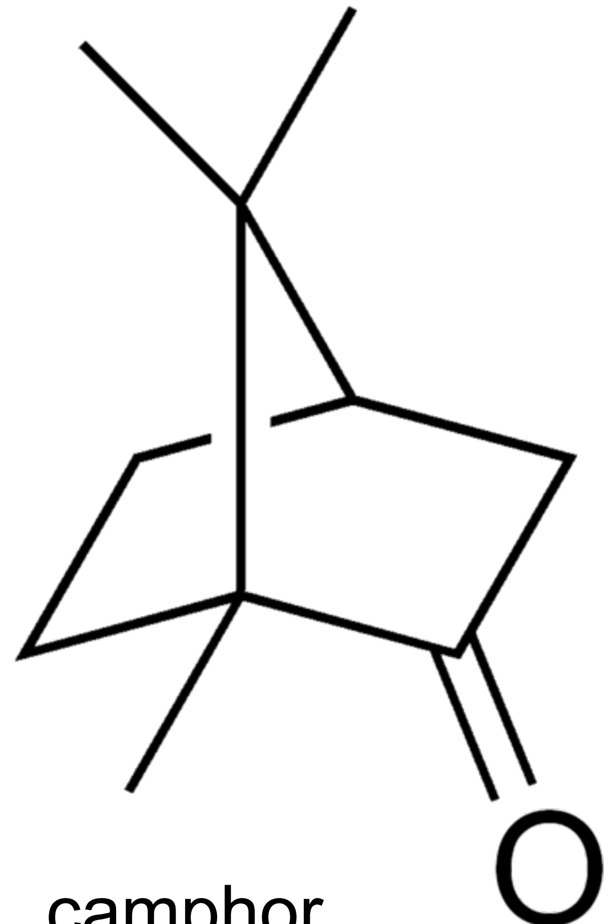
phenol terpene examples

juniper cedar trees - wood doesn't rot! phenols kill the bugs/bacteria/moths
carbolic-phenol
Lysol- chlorophenol
menthol -mildly antiseptic
thymol-Listerine -antiseptic named after Joseph Lister
eucalyptus -antiseptic too!

terpenes/terpenoids

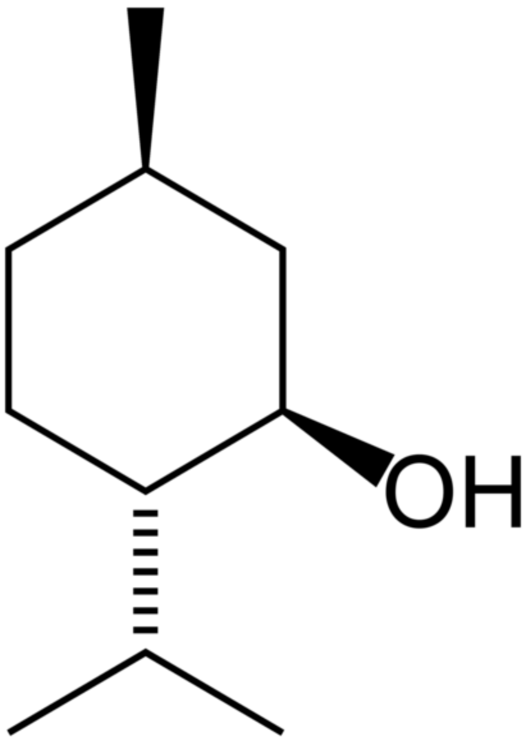


isoprene

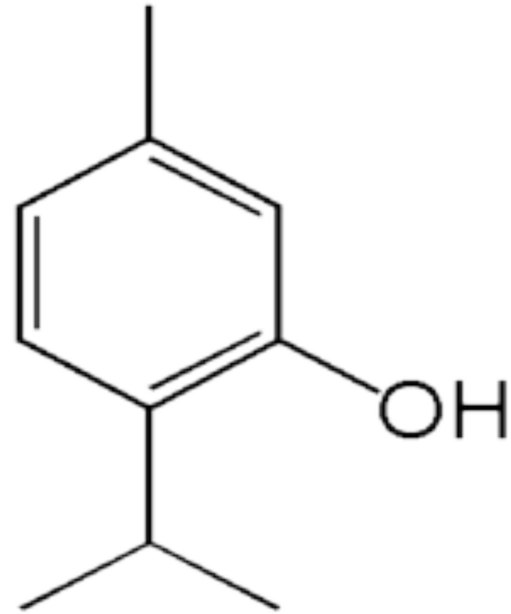


camphor

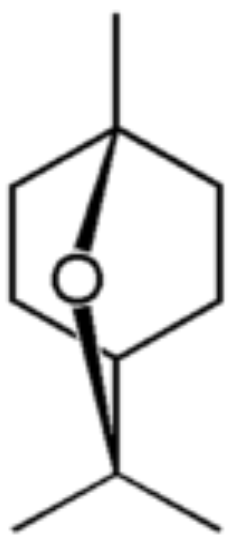
turpenoids 2



menthol

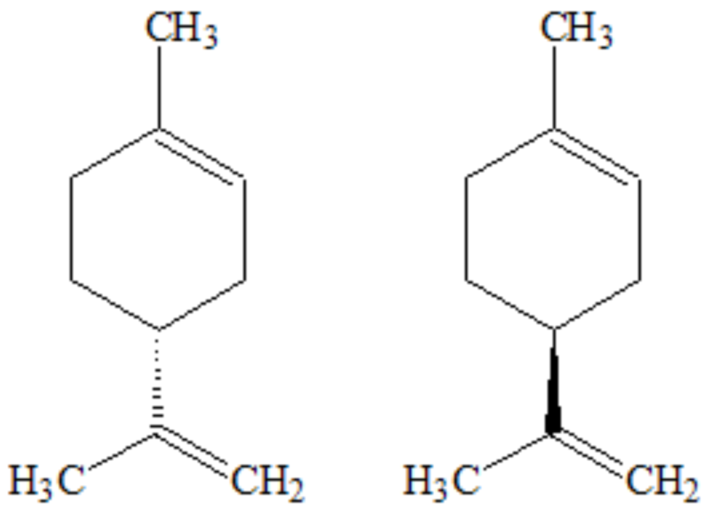


thymol



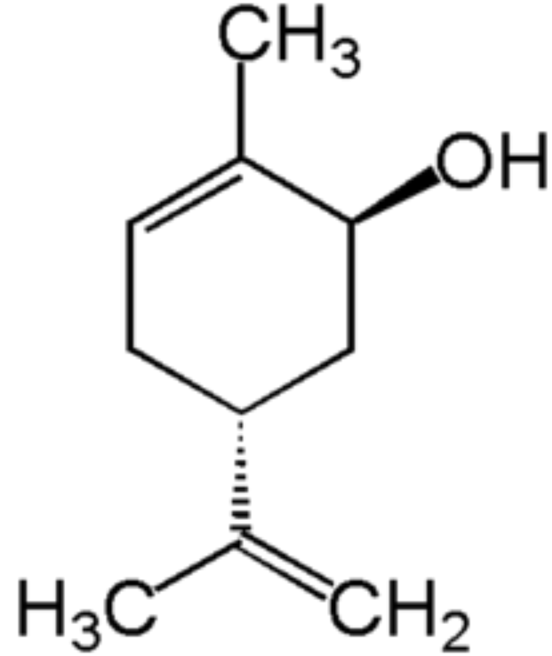
eucalyptol

limonene

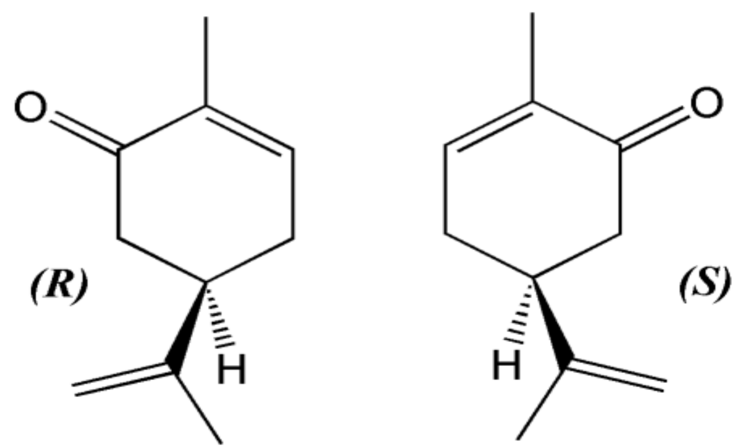


(R) (S)

orange citrus



carveol- ~spearmint



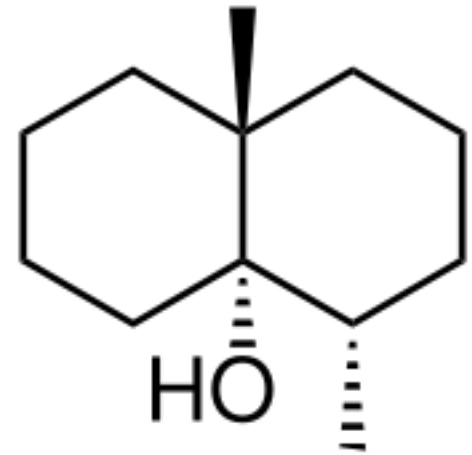
carvone R=spearmint S=caraway

ferric chloride

hydrochloric acid smell

Earthy smells

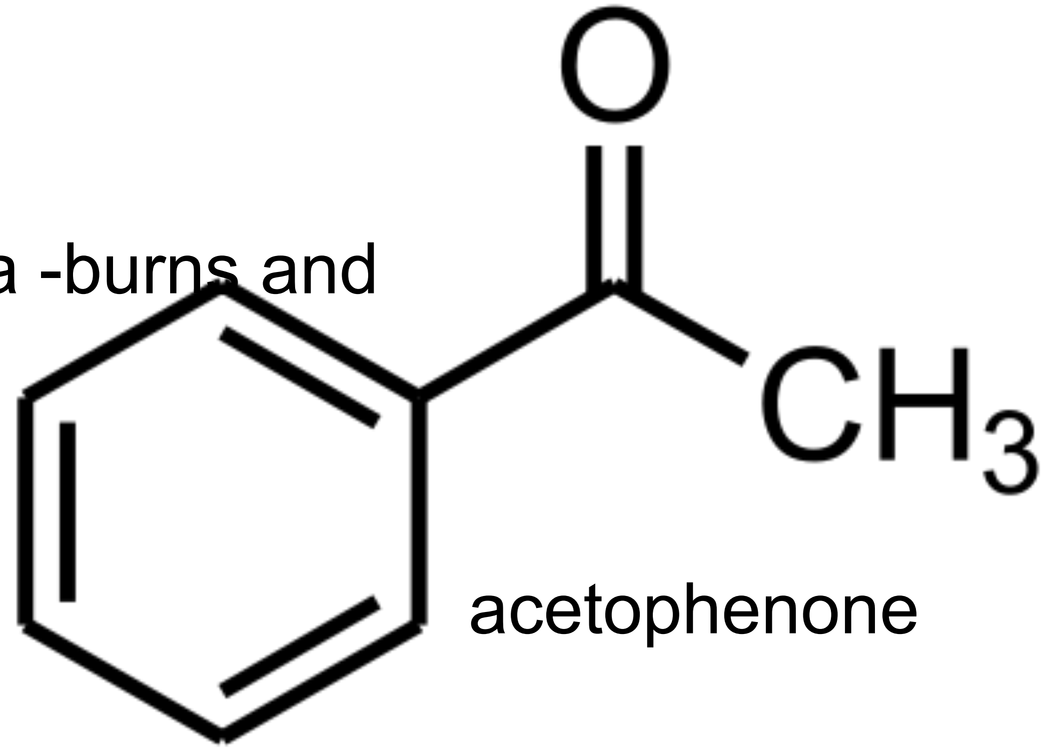
actinomycetes bacteria such as streptomyces



geosmin

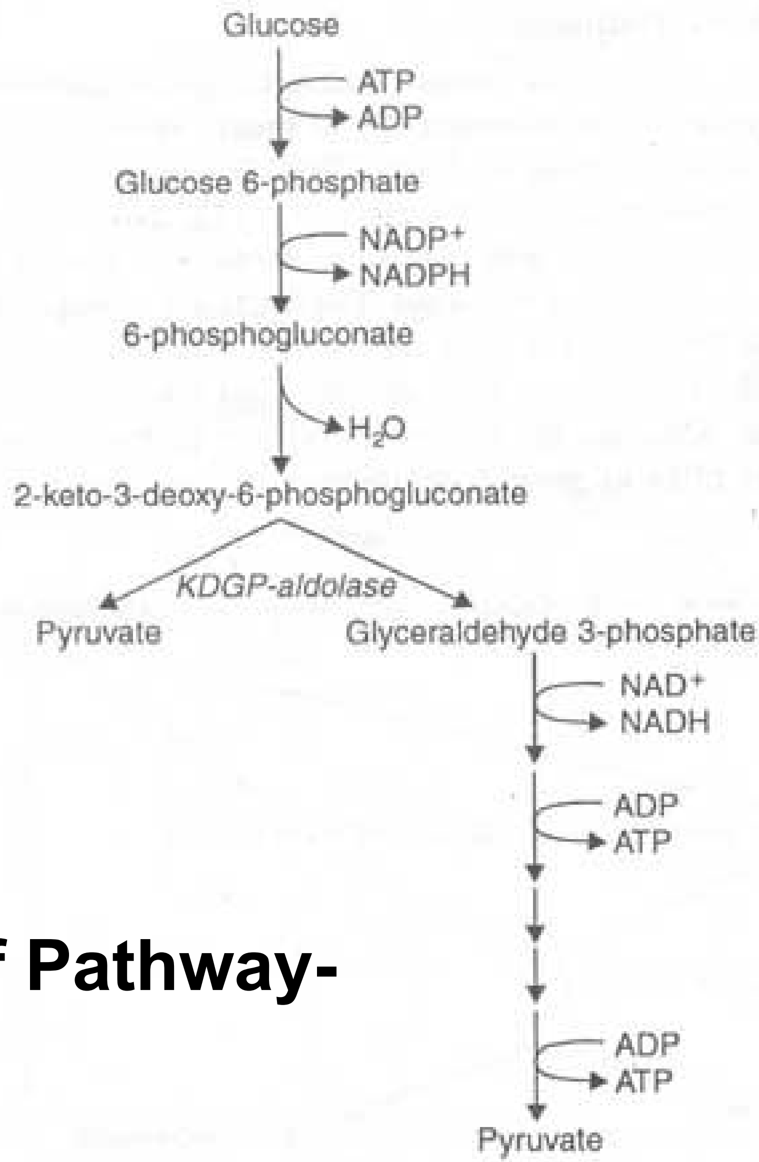
acetophenone -sweetish smell

Pseudomonas aeruginosa -burns and diabetic wounds
masa corn flour -tortillas
Mexican freetailed bat



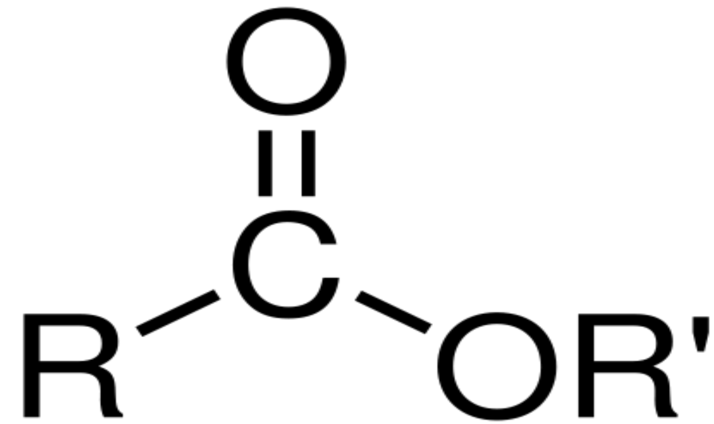
acetophenone

pseudomonas/cornybacteria and stinky socks
Entner–Doudoroff pathway



Entner-Doudoroff Pathway-pseudomonads

The ester



Proteins, fats and carbohydrates all joined with ester links

aspirin -ester of salcyclic acid and acetic acid. Old aspirin decays and smells of acetic acid (vinegar) especially in humid environments

cocaine and methyl benzoate- cocaine decays as aspirin does (both esters) releasing methyl benzoate instead of acetic acid

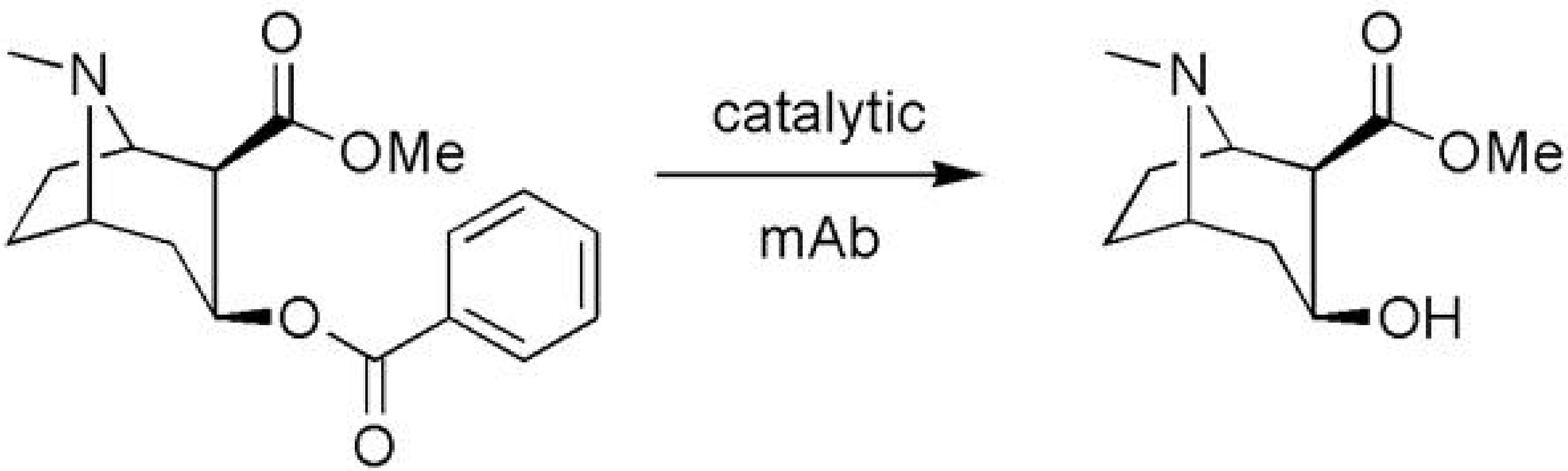
acid hydrolysis vs base hydrolysis -acids or bases may destroy ester bonds

When a base is used the process is often called saponification- soap making

adipocere-grave wax -Free fatty acids released by bacterial decay will combine with metallic minerals (Na, K, Ca, Mg) in soil to form a sort of soap or soap scum. The free fatty acids smell horrible along with the shorter VFA's. Adipocere often occurs when corpse is buried in moist alkaline soil. Moisture is the most important factor needed for adipocere formation

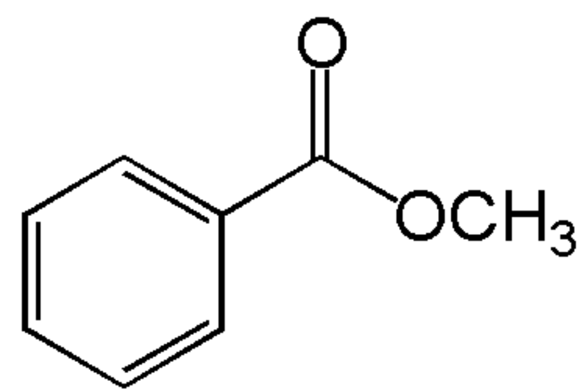
Cocaine decay

methyl ecgonine



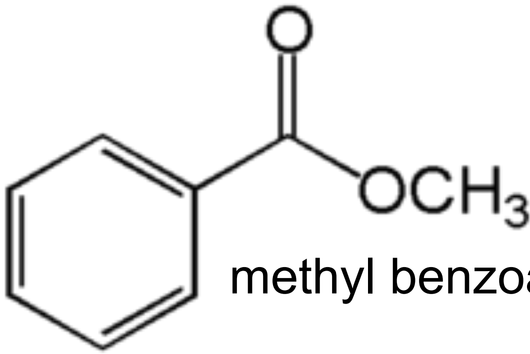
Cocaine

police dog smells the methyl benzoate. Trained with methyl benzoate

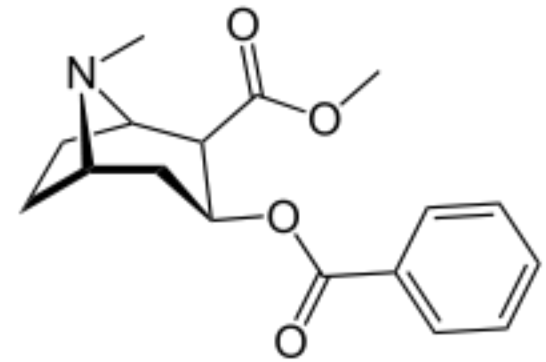


methyl benzoate

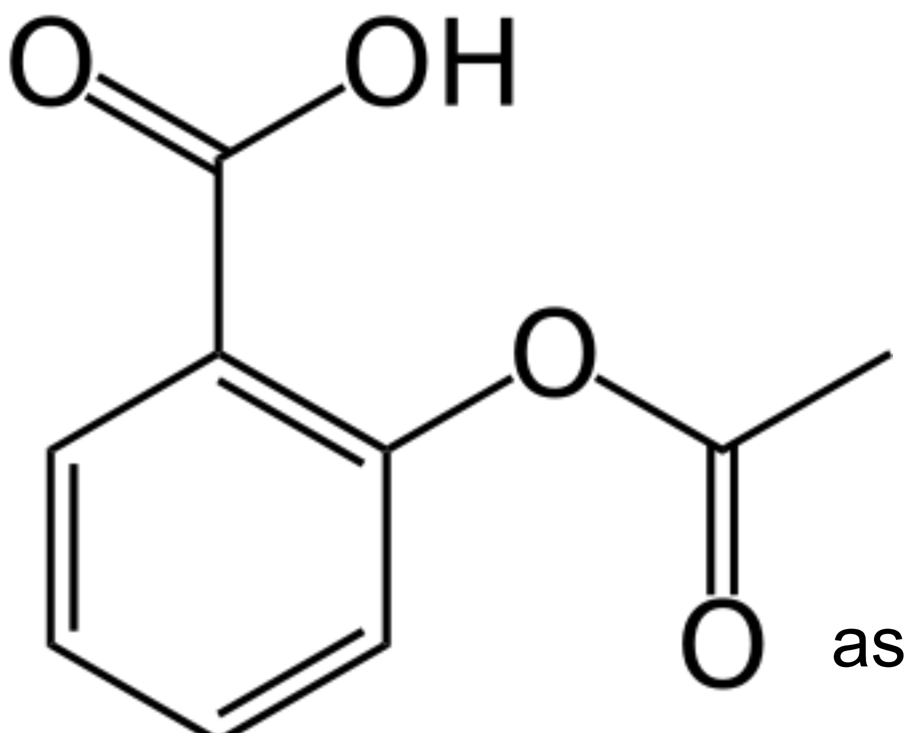
cocaine/methyl benzoate



methyl benzoate



cocaine



asprin

Parasitol Today. 1996 Apr;12(4):159-61.

Limburger cheese as an attractant for the malaria mosquito Anopheles gambiae s.s.

Knols BG, De Jong R.
Department of Entomology, Wageningen Agricultural University, PO Box 8031, 6700 EH, Wageningen, The Netherlands. Bart.Knols@Medew.Ento

In the process of bloodfeeding, female Anopheles can transmit malaria parasites to humans. At night, while searching for blood, these insects respond to visual, physical and chemical properties of humans. Current research concentrates on the identification of kairomones, which guide mosquitoes to humans. Earlier observations on the biting behaviour of Anopheles gambiae s.s. on humans have now resulted in the discovery of a remarkable attractant for this important malaria vector, and it is thought that this will accelerate the development of odour-baited traps for malaria mosquito surveillance and control in sub-Saharan Africa, as discussed here by Bart Knols and Ruurd De Jong.

PMID: 15275226 [PubMed]

J Vector Ecol. 1998 Dec;23(2):186-94.

Olfactory responses and field attraction of mosquitoes to volatiles from Limburger cheese and human foot odor.

Kline DL.
USDA, ARS, Gainesville, FL 32604, USA.

Olfactory responses of female Aedes aegypti (Linnaeus) to various odor stimuli were studied in a dual-port olfactometer. Responses (i.e., the percent of ca. 75 available female mosquitoes in flight chamber entering each olfactometer port) were studied toward clean conditioned air (control), human foot skin emanations (collected on socks by wearing them for three days), human hand, and Limburger cheese. Mean percent response was greatest to the human hand (80.1%), followed by the human worn sock (66.1%), Limburger cheese (6.4%), and control (< 0.1%). In field studies the worn sock alone attracted very few mosquitoes but a synergistic response occurred to the sock + carbon dioxide baited traps for most species of mosquitoes in six genera (Aedes, Anopheles, Coquillettidia, Culex, Culiseta, and Psorophora). This synergistic effect persisted even when the socks were exposed to environmental conditions for eight consecutive days. Limburger cheese alone did not attract mosquitoes to traps compared to unbaited traps, and there appeared to be a slight repellent effect for most mosquito species when used in combination with carbon dioxide.

PMID: 9879074 [PubMed - indexed for MEDLINE]

J Appl Bacteriol. 1988 Jul;65(1):61-8.

A comparative study of the cutaneous microflora of normal feet with low and high levels of odour.

Marshall J, Holland KT, Gribbon EM.
Department of Microbiology, University of Leeds, UK.

A comparison of the cutaneous microflora found on normal feet with varying levels of odour has been made. High population densities of staphylococci and aerobic coryneform bacteria predispose to foot odour. There was no association between odour and the carriage on feet of any particular micro-organism, including brevibacteria. All organisms isolated were screened for exoenzyme activity. Only staphylococci produced lipase (78% of the staphylococci), whereas 97% of micrococci, 68% of aerobic coryneform bacteria, 25% of staphylococci and 94% of propionibacteria produced proteinase. The ability to degrade callous was exhibited by 47% of micrococci, 24% of aerobic coryneforms and 17% of the staphylococci. Feet with high odour had significantly higher population densities of micro-organisms with the ability to produce these exoenzymes than feet with low odour. No association was observed between foot odour and the carriage of micro-organisms capable of producing methanethiol. A hypothesis for the role of micro-organisms in the production of foot odour is proposed.

PMID: 3145263 [PubMed - indexed for MEDLINE]

Int J Cosmet Sci. 1990 Oct;12(5):197-207.
The skin microflora and the formation of human axillary odour.
Rennie PJ, Gower DB, Holland KT, Mallet AI, Watkins WJ.
Procter & Gamble Health and Beauty Care Division, Egham, Surrey TW20 9NW, UK.
Synopsis We have examined the relationship between human axillary skin microflora and underarm odour (UAO), in particular, the ability of cutaneous bacteria to transform steroids. A study was made of bacterial population density and odour intensity of the axillae of 34 normal male subjects. There was a statistically significant association between population density of aerobic coryneform bacteria and UAO intensity. No associations could be found between population densities of staphylococci, micrococci or propionibacteria and UAO intensity. An in vitro model for formation of UAO was developed, and used to test individual bacterial isolates. Only aerobic coryneforms could produce axillary odour in vitro, most notably C. xerosis. Many aerobic coryneforms could transform testosterone, the principal metabolites being 5alpha- and 5beta-DHT, androstenedione, and 5alpha- and 5beta-androstanedione. UAO positive coryneforms were more metabolically active than UAO negative bacteria. Micrococci also transformed testosterone to androstenedione, whilst staphylococci and propionibacteria could not metabolize it. A hypothesis for the role of aerobic coryneforms in the formation of human axillary odour is discussed.
PMID: 19291030 [PubMed - in process]

Int J Cosmet Sci. 2003 Jun;25(3):137-45.

Characterization of the microflora of the human axilla.

Taylor D, Daulby A, Grimshaw S, James G, Mercer J, Vaziri S.
Unilever Research & Development Port Sunlight, Wirral, U.K.

It is widely accepted that axillary malodour is attributable to the microbial biotransformation of odourless, natural secretions into volatile odorous products. Consequently, there is a need to understand the microbial ecology of the axilla in order that deodorant products, which control microbial action in this region, can be developed in the appropriate manner. A detailed characterization of the axillary microflora of a group of human volunteers has been performed. The axillary microflora is composed of four principal groups of bacteria (staphylococci, aerobic coryneforms, micrococci and propionibacteria), and the yeast genus Malassezia. Results indicated that the axillary microflora was dominated by either staphylococcal or aerobic coryneform species. Comparisons between axillary bacterial numbers and levels of axillary odour demonstrated the greatest association between odour levels and the presence of aerobic coryneforms in the under-arm. As the taxonomy of cutaneous aerobic coryneforms is poorly understood, a further study was conducted to characterize selected axillary aerobic coryneform isolates. Using the molecular technique of 16S rDNA sequencing, selected genomic sequences of a number of axillary aerobic coryneform isolates were obtained. Comparisons with sequence databases indicated the likely presence of a range of Corynebacterium species on axillary skin, although the majority of isolates were most similar to either Corynebacterium G-2 CDC G5840 or C. mucifaciens DMMZ 2278. Although for a panel of individuals differences in the carriage of Corynebacterium species were noted, similar species were carried by a number of panellists. All isolates examined in this limited evaluation failed to demonstrate the capability to metabolize long-chain fatty acids (LCFAs) to shorter chain, more volatile products. The application of this modern molecular phylogenetic technique has increased understanding of the diversity of aerobic coryneform carriage in the axilla, and on human skin. The application of this technique in other studies to assess the ethnic differences in cutaneous bacterial ecology, or the effects on the microflora of specific product use, will assist in the future development of novel deodorant systems.

Int J Cosmet Sci. 2004 Jun;26(3):149-56.

Generation of volatile fatty acids by axillary bacteria.

James AG, Hyliands D, Johnston H.
Unilever R&D Colworth, Colworth House, Sharnbrook, Bedford MK44 1LQ, U.K.

It is generally accepted that short-chain (C(2)-C(5)) volatile fatty acids (VFAs) are among the causal molecules of axillary malodour. It is also widely acknowledged that malodour generation is attributable to the biotransformation of odourless natural secretions, into volatile odorous products, by axillary bacteria. However, little information is available on the biochemical origins of VFAs on axillary skin. In these studies, assay systems were developed to investigate the generation of VFAs from substrates readily available to the bacteria resident on axillary skin. Propionibacteria and staphylococci were shown to ferment glycerol and lactic acid to the short-chain (C(2)-C(3)) VFAs, acetic and propionic acid. Furthermore, staphylococci are capable of converting branched aliphatic amino acids, such as leucine, to highly odorous short-chain (C(4)-C(5)) methyl-branched VFAs, such as isovaleric acid, which are traditionally associated with the acidic note of axillary malodour. However, in vitro kinetic data indicates that these pathways contribute less to axillary VFA levels, than fatty acid biotransformations by a recently defined sub-group of the Corynebacterium genus, corynebacteria (A). The results of these studies provide new understanding on the biochemical origins of VFA-based axillary malodour which, in turn, should lead to the development of novel deodorant systems.

PMID: 18494871 [PubMed - in process]

J Steroid Biochem Mol Biol. 2003 Oct;87(1):105-10.
Microbial pathways leading to steroidal malodour in the axilla.
Austin C, Ellis J.
Unilever R&D Colworth, Sharnbrook, Bedfordshire MK44 1LQ, UK. corrine.austin@unilever.com
Odorous steroids, specifically the 16-androstenes, 5alpha-androstenol and 5alpha-androstenone, are widely accepted as being contributors to underarm odour, but the precursors and pathways to these odorous steroids were unclear. This study demonstrated that the axillary microflora could only generate odorous 16-androstenes from precursors that already contain the C16 double bond, such as 5,16-androstadien-3-ol and 4,16-androstadien-3-one. In incubations containing 5,16-androstadien-3-ol, mixed populations of Corynebacterium spp., isolated from the axilla, could generate many different 16-androstene metabolites, several of which were odorous. Isolation of individual Corynebacterium strains, followed by pure culture incubations with 5,16-androstadien-3-ol, revealed organisms capable of efficient, rapid reactions. However, no single isolate could carry out a full complement of the observed biotransformations. 16-Androstene metabolites were identified by gas chromatography-mass spectrometry (GC-MS), either by comparison with known standards, or by prediction from molecular ion and fragmentation patterns. Based on detection of these metabolites, a metabolic map for axillary corynebacterial 16-androstene biotransformations was proposed, detailing potential enzyme activities. In summary, the formerly implicated 4,16-androstadien-3-one, 5alpha-androstenone and 5alpha-androstenol were detected, along with previously unreported hydroxy- and keto-substituted 16-androstenes, 16-androstatrienones and 16-androstatrienols. Additionally, many other metabolites with steroidal fragmentation patterns were present, but have remained unidentified.A key observation was that very low prevalences of microorganisms capable of biotransforming 16-androstenes were present on skin. For example, from a panel of 21 individuals, only 4 of 18 mixed populations of corynebacteria, and only 4 of 45 Corynebacterium isolates, could biotransform 5,16-androstadien-3-ol. This study has increased understanding of the metabolic pathways involved in steroidal malodour formation, and has demonstrated that the biotransformations are more complex than previously anticipated. However, it is clear that further research is required, both to assess the level of contribution of 16-androstenes to underarm odour, and to further elucidate the pathways and odour molecules formed by corynebacteria.

Disinfect vs odor removal

quaternary ammonium compounds-kill bacteria
bleach-kill bacteria AND oxidize chemicals-also bleach is an alkaline solution
activated charcoal -absorbs molecules with its fantastic surface area cavities

peroxide -oxidizes compounds kills bacteria (weakly) in ther process
oxy-products -sodium percarbonate (release peroxide)and sodium carbonate (alkaline)-peroxide componant oxidizes. the alkaline componant will neutralize stinky acids

triethylene glycol -Oust, Ozium, Febreeze-kills airborne bacteria only

the gas mask- little more that a simple filter with activated charcoal -the same activated charcoal used in aquariums.

the black colored "charcoal filter" pads for litter box vents do not contain enough activated charcoal to be useful.

also baking soda (alkaline) in the ammonia rich (alkaline as well) will do little to neutralize kitty urine odor. You need an acid. To bad many acids stink.

quaternary ammonium compounds

most common is benzalkonium chloride
dimethyl benzyl ammonium chloride
commonly found in Lysol spray (with alcohol) or most other disinfectant spray cleaners

activated charcoal

wood heated (charred) in the absense of oxygen
used made in a metal container with a small hole to allow gases to escape.

Cavities left after charring are ideal to capture large molecules.

the gas mask

Very simple canister filled with activated charcoal and a simple particle filter.

One way valve

Sometime sodium thiosulfate added to absorb chlorine gas. -rare

Gas Mask II

sniff examples

thioglycolate-Nair- Hydrogen sulfide smell
trimethylamine- Fishy
amyl acetate-ester "Banana oil"
ethyl acetate-ester
acetone
Dettol/Lysol -phenol odor
Chloroseptic-phenol odor
Windex -2-butoxyethanol
acetic acid
garlic -pleasant thiol smell
methyl salicylate-ester wintergreen odor

camphophenique -camphor and Phenol

eucalyptus oil

ferric chloride- HCl gas
Durian -thiol/fecal odor

fish oil -amine fishy

bleach

Sodium Hypochlorite- sodium salt of hypochlorous acid. bleach is at an alkaline pH which will neutralize many stinky acids regardless of its "bleaching power"

If bleach pH shifts towards acid chlorine gas tends to evolve from solution peroxide

oxy-products

sodium percarbonate and sodium carbonate

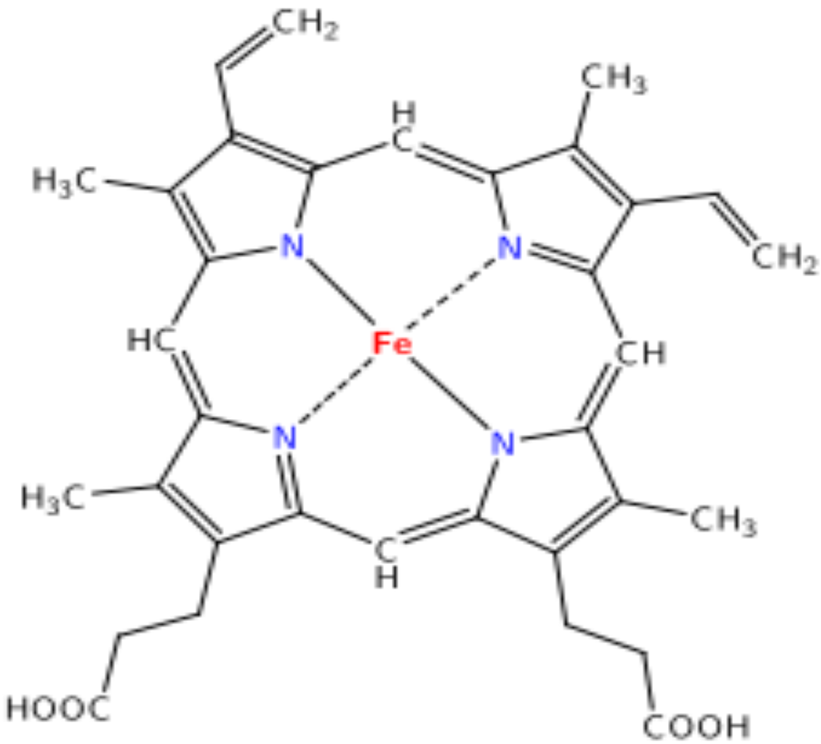
triethylene glycol -Oust, Ozium, Febreeze

kills bacteria in the air.
Often additional quaternary ammonium compound added to kill bacteria /disinfect surfaces - dimethyl benzyl ammonium chloride

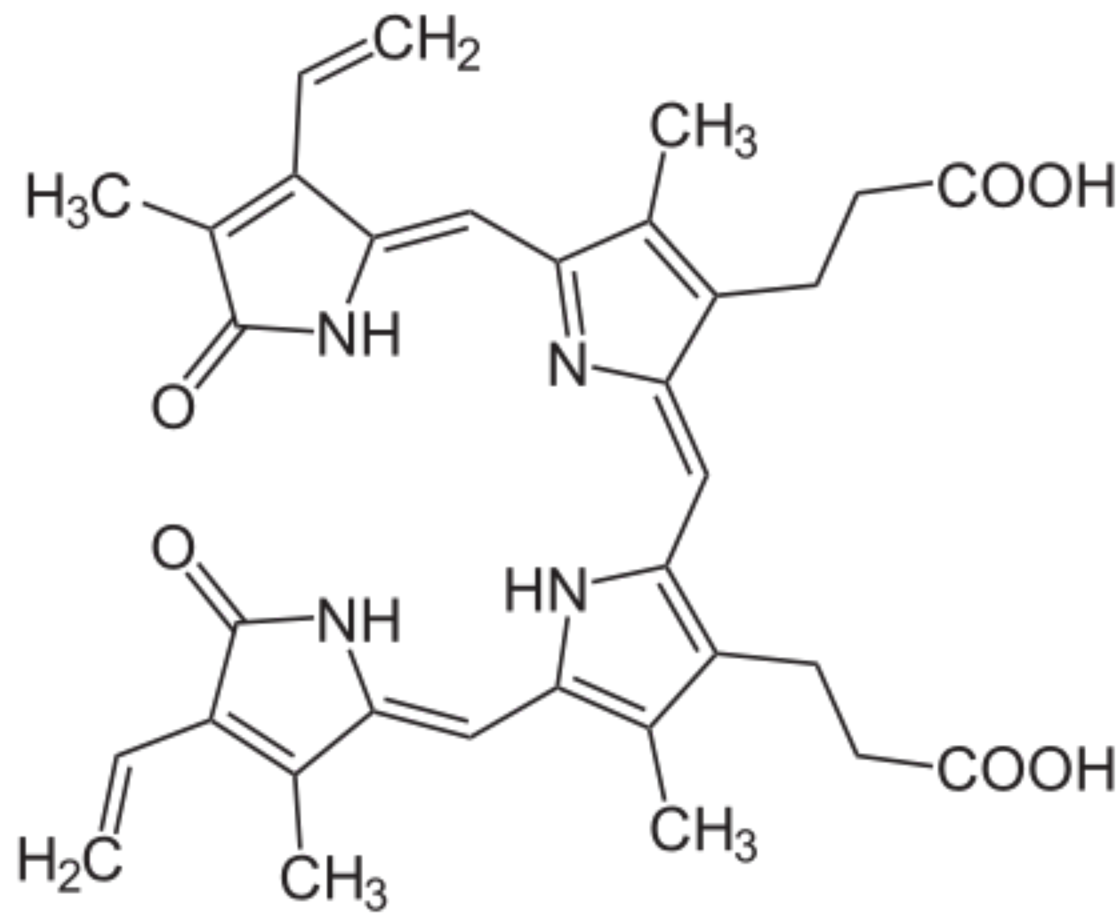
The ester and bile

bile synthesis and metabolism
contribution of color to feces
organic pics of bile salts

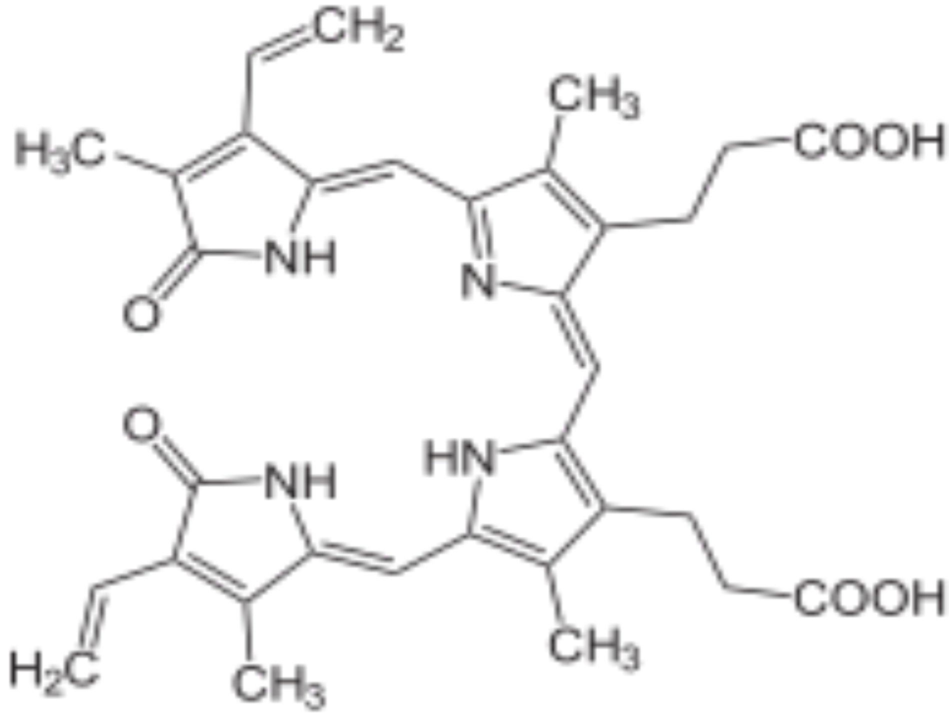
bile



hemoglobin- red

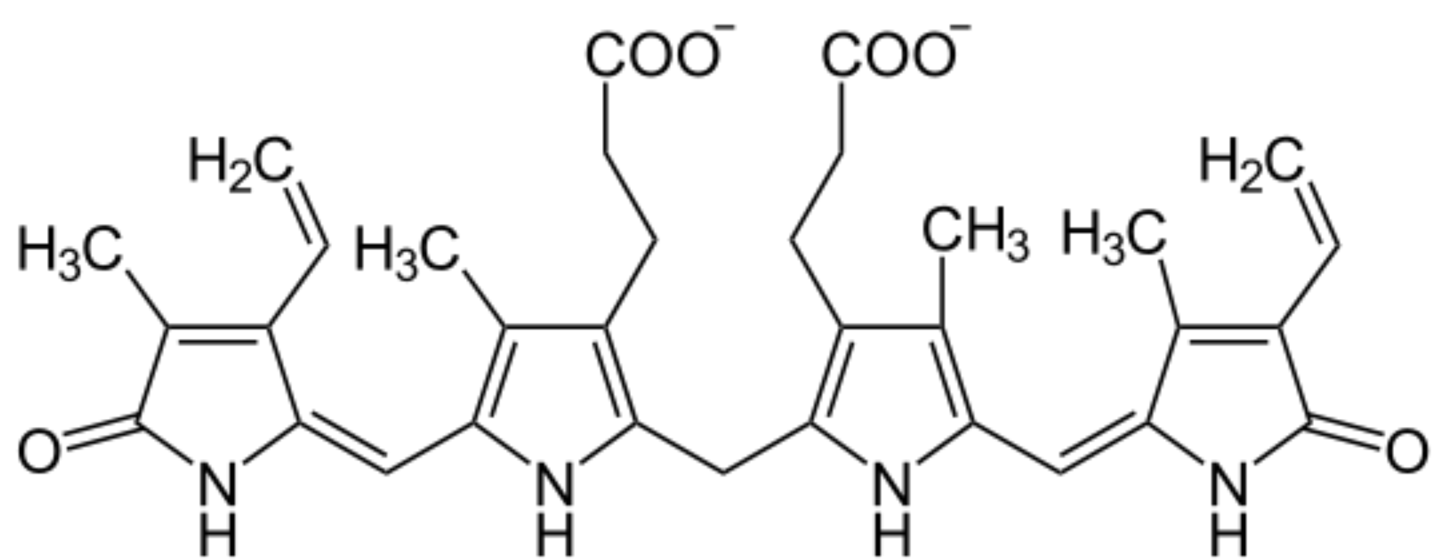


biliverdun -green



biliverdin -green

bilirubin -yellow



SIGMA-ALDRICH®

Home | Products | Order Center | Custom Products | Support | MSDS | All | Search | Advanced Search

Home->Site Search | Print

Product Results (11) | Technical Documents (1) | Site Content (1) | Analytical Application (0) | Genes (0) | Substructure Search

Search Filters

Products for sale in: US Help

Language: English (change) Help

Search: training scent

Product Category
- Analytical/Chromatography (10)
- Labware (1)

Brand
- Fluka (8)
- Sigma (3)

Physical Form
- Powder (3)
- Solution (1)

All | Search

Search Matches

Product Name (9) CAS Number (0) Molecular Formula (0) Genes (0)

Product Number (0) MDL Number (0) Product Category (10)

Search within these results Help

11 Matches Found For **training scent** 1

Sort By: Relevancy

compare Select up to 4 items to compare

View All Group Details / Close All Group Details

Sigma Pseudo™ Corpse Scent (4)

P4304	Formulation I (Fluka)	MSDS	pricing
P3929	Formulation II (Fluka)	MSDS	pricing
PSCI	Corpse Scent Kit (Fluka)	MSDS	pricing
P7184	drowned victim scent (Fluka)	MSDS	pricing

Sigma Pseudo™ Narcotic Scent Cocaine formulation (2)

P2423	powder (Fluka)	MSDS	pricing
P7681	solution (Sigma)	MSDS	pricing

Sigma Pseudo™ Narcotic Scent Heroin formulation (1)

P2548	powder (Fluka)	MSDS	pricing

Sigma Pseudo™ Narcotic Scent LSD formulation (1)

P1334	powder (Fluka)	MSDS	pricing

Sigma Pseudo™ Narcotic Scent Marijuana formulation (1)

Technical Documents (1)
- Winter2001 (983 KB)

Site Content (1)
- TesserACT - It Has to do with Smell

Search Survey

Did you find what you were searching for?

Yes No

How can we improve your search experience?

Submit

Done

Fluka (6)
Sigma (3)

Physical Form
Powder (3)
Solution (1)

Sigma Pseudo™ Corpse Scent (4)

☐	P4304	Formulation I (Fluka)	MSDS	pricing
☐	P3929	Formulation II (Fluka)	MSDS	pricing
☐	PSCI	Corpse Scent Kit (Fluka)	MSDS	pricing
☐	P7184	drowned victim scent (Fluka)	MSDS	pricing

Sigma Pseudo™ Narcotic Scent Cocaine formulation (2)

☐	P2423	powder (Fluka)	MSDS	pricing
☐	P7681	solution (Sigma)	MSDS	pricing

Sigma Pseudo™ Narcotic Scent Heroin formulation (1)

☐	P2548	powder (Fluka)	MSDS	pricing

Sigma Pseudo™ Narcotic Scent LSD formulation (1)

☐	P1334	powder (Fluka)	MSDS	pricing

Sigma Pseudo™ Narcotic Scent Marijuana formulation (1)

☐	P7309	(Fluka)	MSDS	pricing

Sigma Pseudo™ Distressed Body Scent , Trauma and Fear Formulation (1)

☐	P1310	canine training (Sigma)	MSDS	pricing

Cadaver Dog Handbook: Forensic Training and Tactics for the Recovery of Human Remains (1)

☐	Z700266	(Sigma)	pricing

1

☐Yes ☐No

How can we improve your search experience?

Submit

SIGMA-ALDRICH®

Site Use Terms | Terms and Conditions of Sale | Privacy | Contact Us | Site Map

Done

☐	P1334	powder (Fluka)	MSDS	pricing

Sigma Pseudo™ Narcotic Scent Marijuana formulation (1)

Done

11 Matches Found For **training scent**

1

Sort By : Relevancy

compare Select up to 4 items to compare

View All Group Details / Close All Group Details

Sigma Pseudo™ Corpse Scent (4)

P4304	Formulation I (Fluka)	MSDS	pricing
P3929	Formulation II (Fluka)	MSDS	pricing
PSCI	Corpse Scent Kit (Fluka)	MSDS	pricing
P7184	drowned victim scent (Fluka)	MSDS	pricing

Sigma Pseudo™ Narcotic Scent Cocaine formulation (2)

P2423	powder (Fluka)	MSDS	pricing
P7681	solution (Sigma)	MSDS	pricing

Sigma Pseudo™ Narcotic Scent Heroin formulation (1)

P2548	powder (Fluka)	MSDS	pricing

☐	P7681	solution (Sigma)	MSDS	pricing

Sigma Pseudo™ Narcotic Scent Heroin formulation (1)

☐	P2548	powder (Fluka)	MSDS	pricing

Sigma Pseudo™ Narcotic Scent LSD formulation (1)

☐	P1334	powder (Fluka)	MSDS	pricing

Sigma Pseudo™ Narcotic Scent Marijuana formulation (1)

☐	P7309	(Fluka)	MSDS	pricing

Sigma Pseudo™ Distressed Body Scent , Trauma and Fear Formulation (1)

☐	P1310	canine training (Sigma)	MSDS	pricing

Cadaver Dog Handbook: Forensic Training and Tactics for the Recovery of Human Remains (1)

☐	Z700266	(Sigma)		pricing