

Introduction to Forensic Chemistry

Chapter 1



**Enrique "Kiki" Camarena (1948–1985),
U.S. DEA agent. (AP Photo)**

Chapter 1 Opener
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All about mystery
and detail

Guilty will leave
traces behind and
take fragments
with him

Carpet fibers, pet hair
blood, gunshot residue
Are all matter

SEASON FIVE

TONY SHALHOUB
MONK

the real
ocd.



psych

A NEW ORIGINAL SERIES
JULY 7, FRIDAYS 10/9C

fake psychic. real detectives.

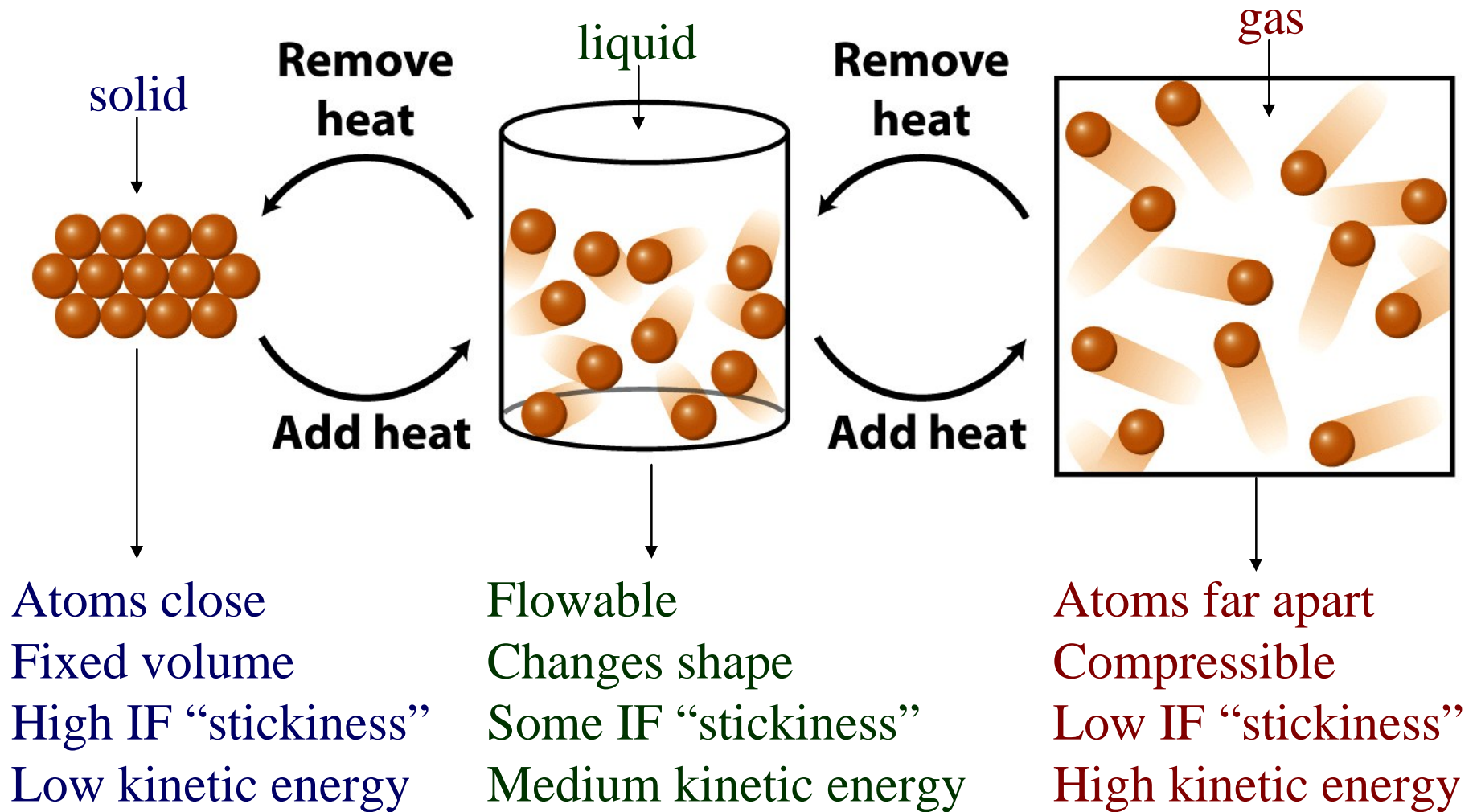


characters welcome.
USA
network

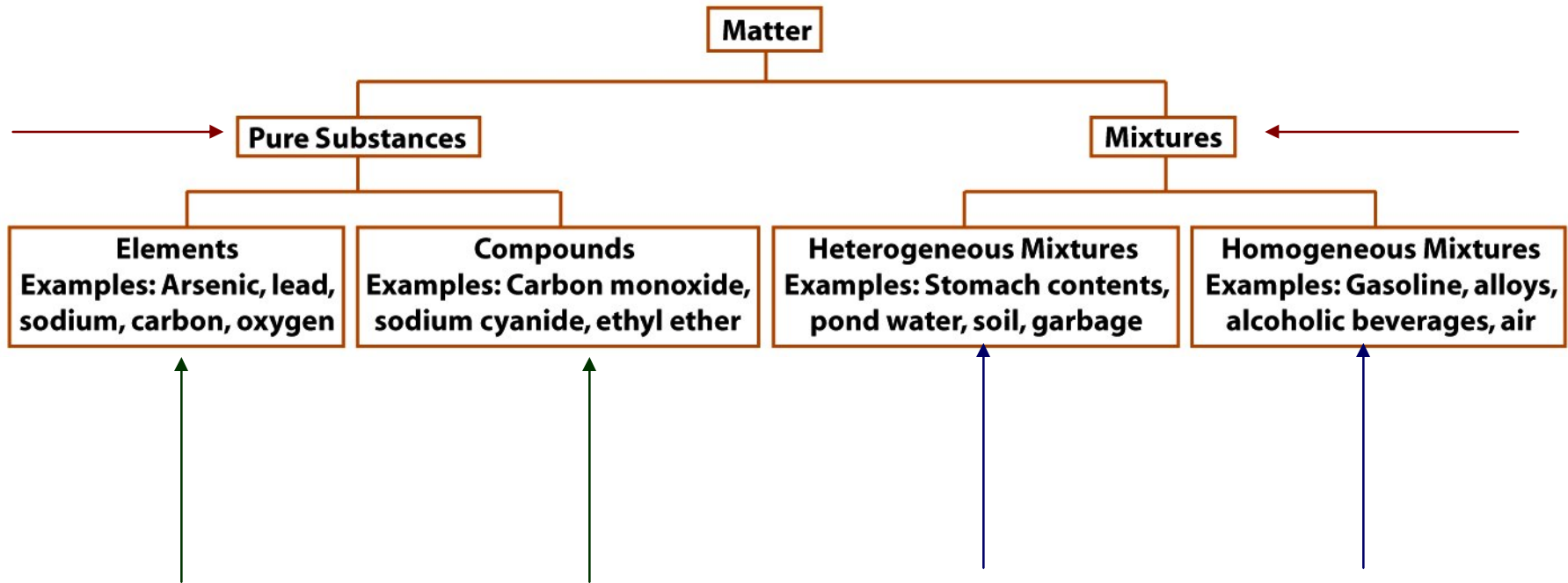


usa-network.com

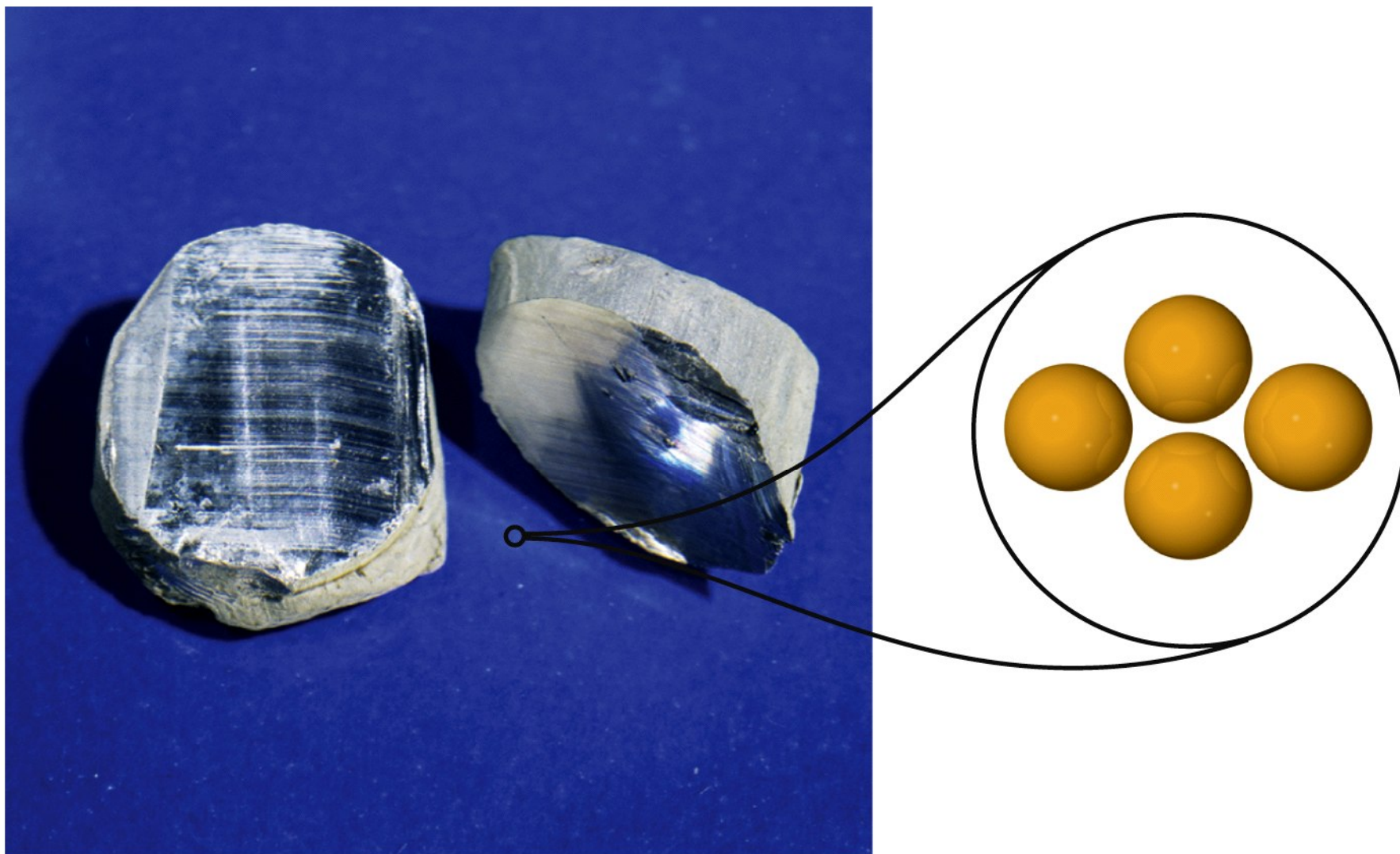
States of Matter



Types of Matter

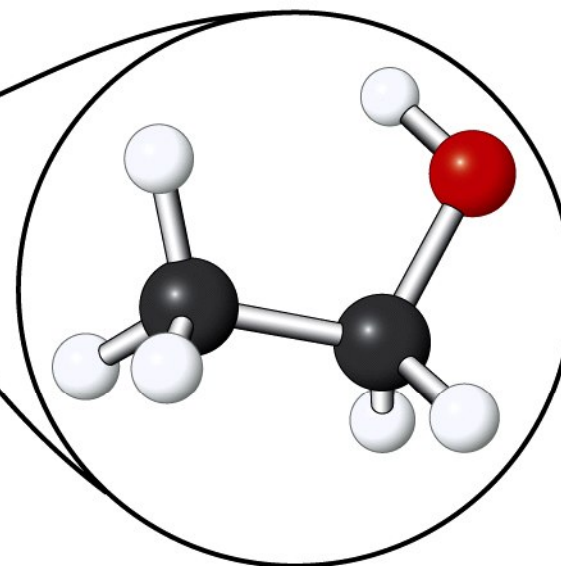


Sodium



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Ethanol



Homogeneous Mixtures



Figure 1-2a
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Metal Alloys

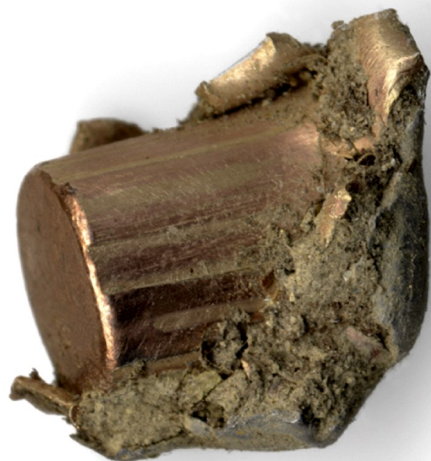


Figure 1-2c
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Bullet



Figure 1-2b
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Lighter Fluid



Figure 1-2d
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Healthy Booze???

Tannins are antioxidant molecules
found in grape skin and seeds

Called Oligomeric Proanthocyanidins
or OPC's

- Help repair collagen and elastin
 - Maintain blood vessels
 - Prevent wrinkles
- 20X more powerful than Vit C and 50X than Vit E
- Decrease histamine production



Allergies and Antihistamines

The substances that cause an allergic reaction are called allergens or antigens

They bind to white blood cells called B-lymphocytes

B-cells make Antibodies (Ab) against the allergen

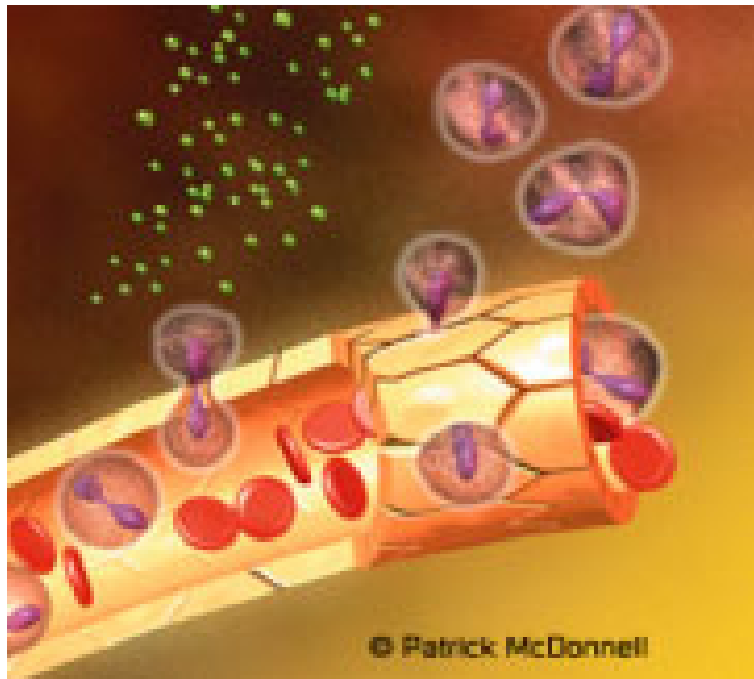
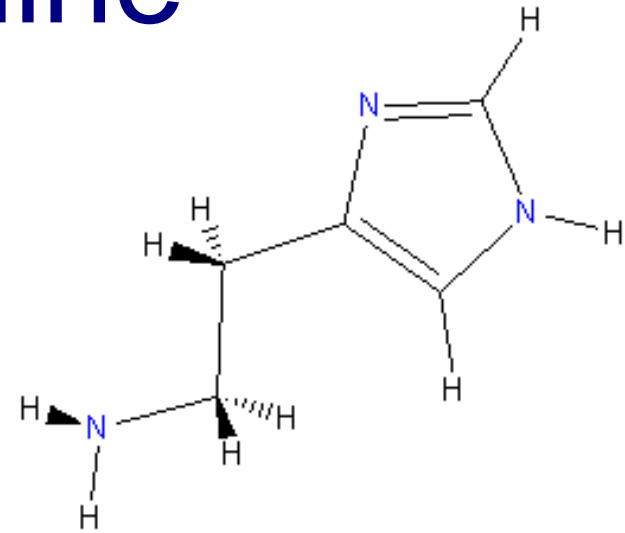
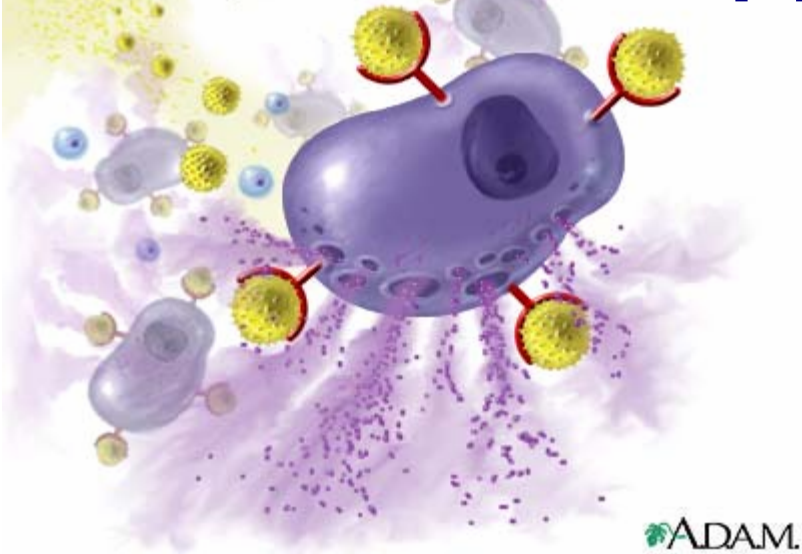


The Ab bind to mast cells and become receptors for the allergens

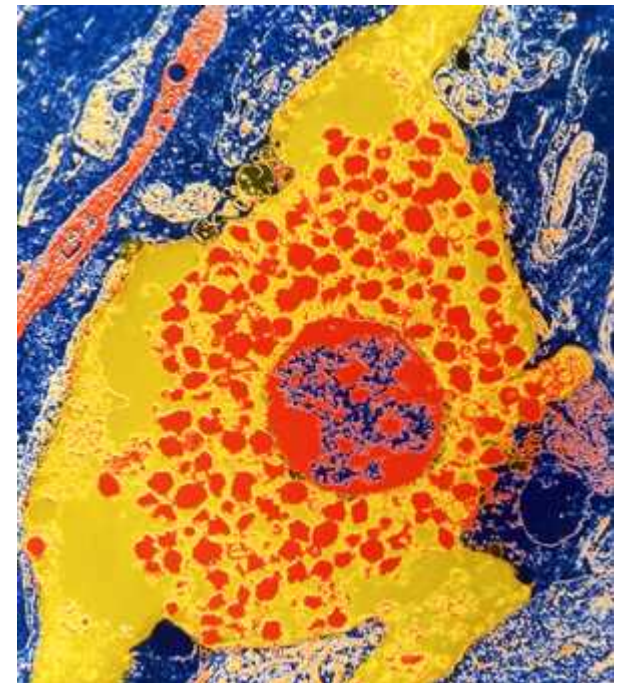
Next time the allergen enters the body, they bind to the Ab bound to the mast cell and cause histamine to be released.

Histamine

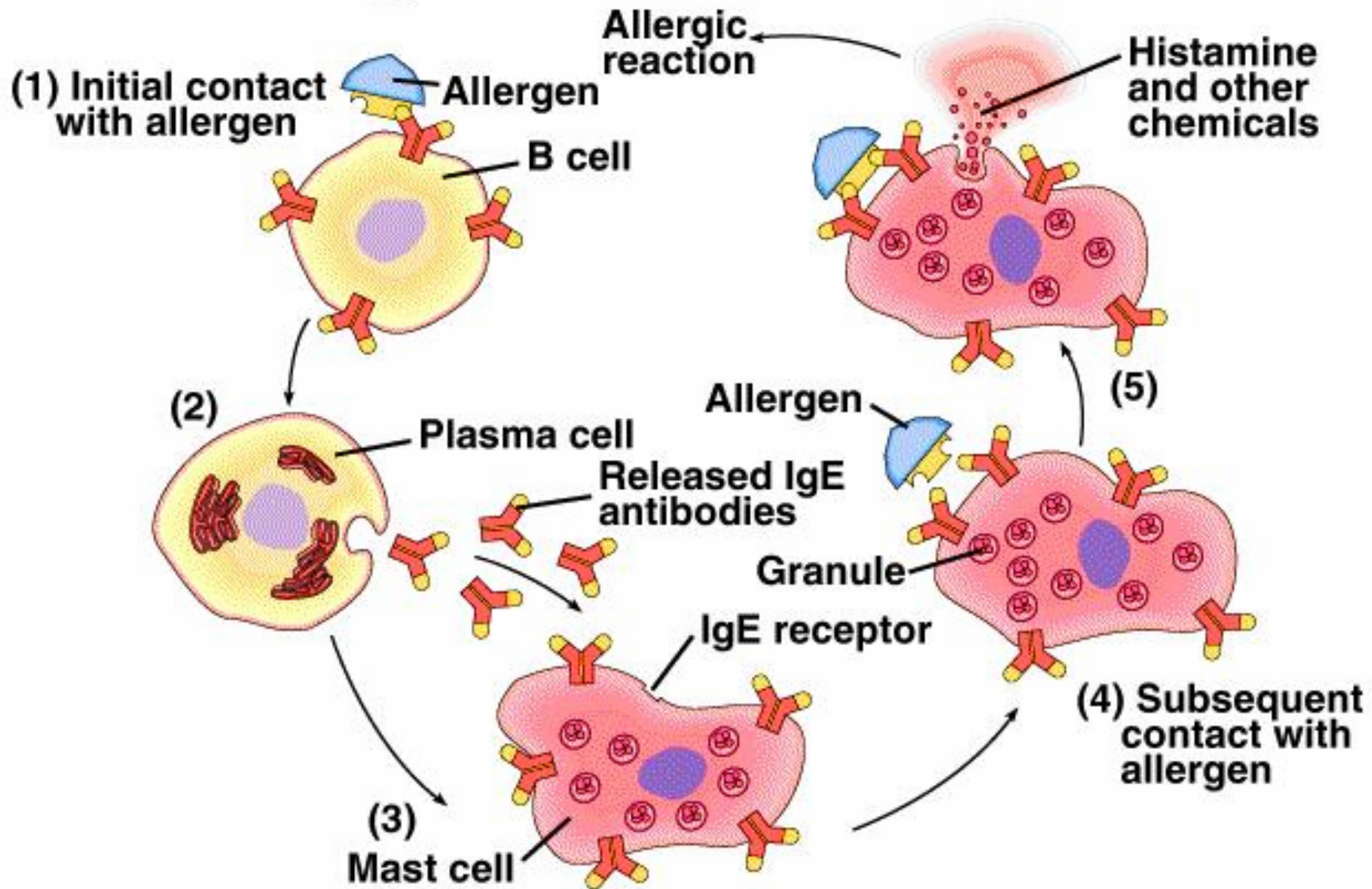
Mast cells release histamines when the allergen is encountered



Mast Cell
with histamine
granules



An Allergic Reaction — Overview



Allergy

Antihistamine

OPC's Cont.

Fight smoke, alcohol, chemical damage

~~ Free Radicals

Internal sunscreen

Cross blood-brain barrier

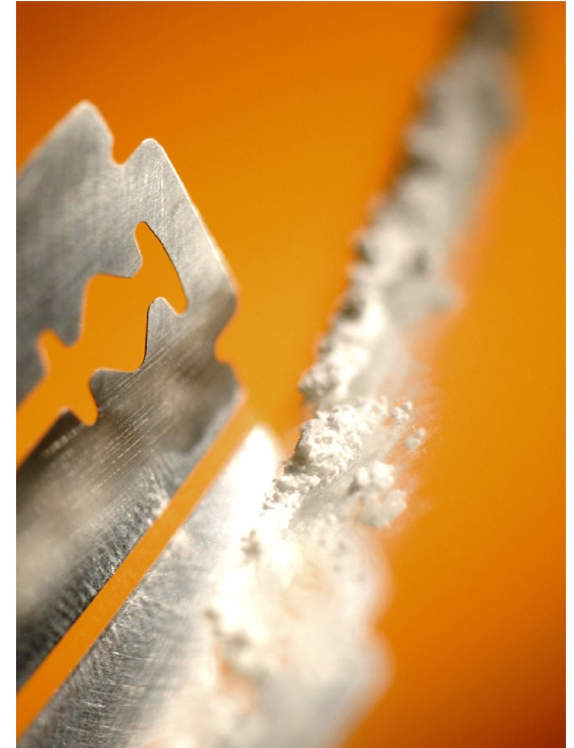
Explains French paradox





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Coca leaves



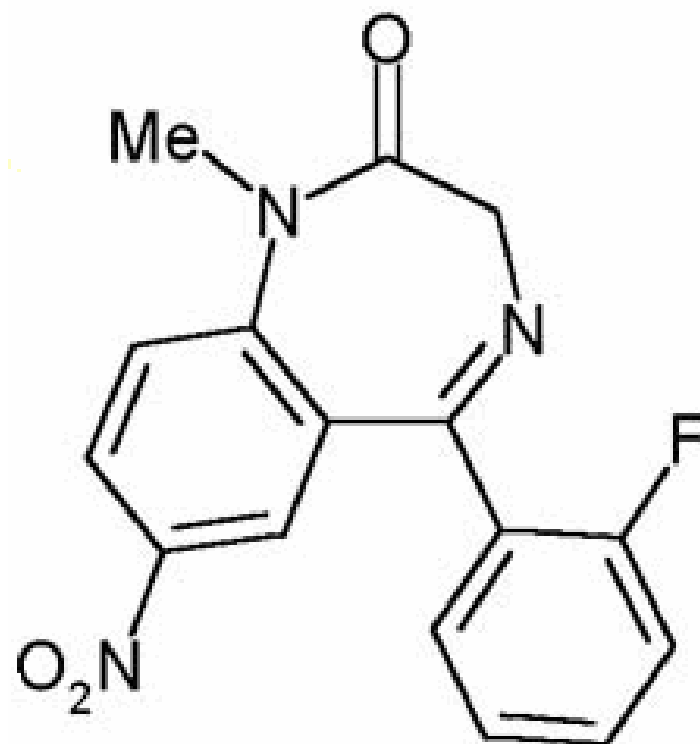
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cocaine





Rohypnol



Rohypnol tablets are white and are single or cross-scored on one side with "ROCHE" and "1" or "2" encircled on the other.

(Graphics courtesy of the U.S Dept. of Justice)

Heterogeneous Mixtures



Figure 1-3a
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Figure 1-3b
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Figure 1-3c
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Figure 1-3d
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1										18																																			
1 H 1.0079	2										13 B 10.811	14 C 12.011	15 N 14.007	16 O 15.999	17 F 18.998	2 He 4.003																													
3 Li 6.941	4 Be 9.012											5 B 10.811	6 C 12.011	7 N 14.007	8 O 15.999	9 F 18.998	10 Ne 20.180																												
11 Na 22.990	12 Mg 24.305	3	4	5	6	7	8	9	10	11	12	13 Al 26.982	14 Si 28.086	15 P 30.974	16 S 32.065	17 Cl 35.453	18 Ar 39.948																												
19 K 39.098	20 Ca 40.078	21 Sc 44.956	22 Ti 47.867	23 V 50.942	24 Cr 51.996	25 Mn 54.938	26 Fe 55.845	27 Co 58.933	28 Ni 58.693	29 Cu 63.546	30 Zn 65.409	31 Ga 69.723	32 Ge 72.64	33 As 74.922	34 Se 78.96	35 Br 79.904	36 Kr 83.798																												
37 Rb 85.468	38 Sr 87.62	39 Y 88.906	40 Zr 91.224	41 Nb 92.906	42 Mo 95.94	43 Tc (98)	44 Ru 101.07	45 Rh 102.906	46 Pd 106.42	47 Ag 107.868	48 Cd 112.411	49 In 114.818	50 Sn 118.710	51 Sb 121.760	52 Te 127.60	53 I 126.905	54 Xe 131.293																												
55 Cs 132.905	56 Ba 137.327	57 La 138.906	72 Hf 178.49	73 Ta 180.948	74 W 183.84	75 Re 186.207	76 Os 190.23	77 Ir 192.217	78 Pt 195.078	79 Au 196.967	80 Hg 200.59	81 Tl 204.383	82 Pb 207.2	83 Bi 208.980	84 Po (209)	85 At (210)	86 Rn (222)																												
87 Fr (223)	88 Ra (226)	89 Ac (227)	104 Rf (261)	105 Db (262)	106 Sg (266)	107 Bh (264)	108 Hs (277)	109 Mt (268)	110 Ds (271)	111 Rg (272)																																			
<table border="1"> <tr> <td>58 Ce 140.116</td> <td>59 Pr 140.908</td> <td>60 Nd 144.24</td> <td>61 Pm (145)</td> <td>62 Sm 150.36</td> <td>63 Eu 151.964</td> <td>64 Gd 157.25</td> <td>65 Tb 158.925</td> <td>66 Dy 162.500</td> <td>67 Ho 164.930</td> <td>68 Er 167.259</td> <td>69 Tm 168.934</td> <td>70 Yb 173.04</td> <td>71 Lu 174.967</td> </tr> <tr> <td>90 Th 232.038</td> <td>91 Pa 231.036</td> <td>92 U 238.029</td> <td>93 Np (237)</td> <td>94 Pu (244)</td> <td>95 Am (243)</td> <td>96 Cm (247)</td> <td>97 Bk (247)</td> <td>98 Cf (251)</td> <td>99 Es (252)</td> <td>100 Fm (257)</td> <td>101 Md (258)</td> <td>102 No (259)</td> <td>103 Lr (262)</td> </tr> </table>																		58 Ce 140.116	59 Pr 140.908	60 Nd 144.24	61 Pm (145)	62 Sm 150.36	63 Eu 151.964	64 Gd 157.25	65 Tb 158.925	66 Dy 162.500	67 Ho 164.930	68 Er 167.259	69 Tm 168.934	70 Yb 173.04	71 Lu 174.967	90 Th 232.038	91 Pa 231.036	92 U 238.029	93 Np (237)	94 Pu (244)	95 Am (243)	96 Cm (247)	97 Bk (247)	98 Cf (251)	99 Es (252)	100 Fm (257)	101 Md (258)	102 No (259)	103 Lr (262)
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Dmitri Mendeleev (1837–1907)

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Table 1.1 Mendeleev's Predictions and Actual Values

Property	Eka-aluminum Predictions	Actual Properties of Gallium	Eka-silicon Predictions	Actual Properties of Germanium
Atomic mass (amu)	About 68	69.7	About 72	72.6
Melting point (°C)	Low	29.8	—	—
Density (g/cm ³)	5.9	5.94	5.5	5.47
Oxide formula	X ₂ O ₃	Ga ₂ O ₃	XO ₂	GeO ₂
Chloride formula	XCl ₃	GaCl ₃	XCl ₄	GeCl ₄
Discovered (year)		1886		1875

Table 1-1
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Table 1.2 Atomic Symbols and Names

Ac	Actinium	Gd	Gadolinium	Po	Polonium
→ Ag	Silver	→ Ge	Germanium	Pr	Praseodymium
→ Al	Aluminum	→ H	Hydrogen	→ Pt	Platinum
Am	Americium	→ He	Helium	Pu	Plutonium
→ Ar	Argon	Hf	Hafnium	Ra	Radium
→ As	Arsenic	→ Hg	Mercury	→ Rb	Rubidium
At	Astatine	Ho	Holmium	Re	Rhenium
→ Au	Gold	Hs	Hassium	Rf	Rutherfordium
→ B	Boron	→ I	Iodine	Rg	Roentgenium
→ Ba	Barium	In	Indium	Rh	Rhodium
→ Be	Beryllium	Ir	Iridium	Rn	Radon
Bh	Bohrium	→ K	Potassium	Ru	Ruthenium
Bi	Bismuth	→ Kr	Krypton	→ S	Sulfur
Bk	Berkelium	La	Lanthanum	Sb	Antimony
→ Br	Bromine	→ Li	Lithium	Sc	Scandium
→ C	Carbon	Lr	Lawrencium	Se	Selenium
→ Ca	Calcium	Lu	Lutetium	Sg	Seaborgium
→ Cd	Cadmium	Md	Mendelevium	→ Si	Silicon
Ce	Cerium	→ Mg	Magnesium	Sm	Samarium
Cf	Californium	→ Mn	Manganese	→ Sn	Tin
→ Cl	Chlorine	Mo	Molybdenum	Sr	Strontium
Cm	Curium	Mt	Meitnerium	Ta	Tantalum
→ Co	Cobalt	→ N	Nitrogen	Tb	Terbium
→ Cr	Chromium	→ Na	Sodium	Tc	Technetium
→ Cs	Cesium	Nb	Niobium	Te	Tellurium
→ Cu	Copper	Nd	Neodymium	Th	Thorium
Db	Dubnium	→ Ne	Neon	Ti	Titanium
Ds	Darmstadtium	→ Ni	Nickel	Tl	Thallium
Dy	Dysprosium	No	Nobelium	Tm	Thulium
Er	Erbium	Np	Neptunium	→ U	Uranium
Es	Einsteinium	→ O	Oxygen	V	Vanadium
Eu	Europium	Os	Osmium	W	Tungsten
→ F	Fluorine	→ P	Phosphorus	→ Xe	Xenon
→ Fe	Iron	Pa	Protactinium	Y	Yttrium
Fm	Fermium	Pb	Lead	Yb	Ytterbium
Fr	Francium	Pd	Palladium	→ Zn	Zinc
→ Ga	Gallium	Pm	Promethium	Zr	Zirconium

Table 1-2
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											<div style="display: flex; flex-direction: column; align-items: center;"> <div style="display: flex; justify-content: space-around; width: 100%;"> ■ Metalloids</div> <div style="display: flex; justify-content: space-around; width: 100%;"> ■ Nonmetals</div> <div style="display: flex; justify-content: space-around; width: 100%;"> ■ Metals</div> </div>																			
1 H											2 He																			
3 Li	4 Be											5 B	6 C	7 N	8 O	9 F	10 Ne													
11 Na	12 Mg											13 Al	14 Si	15 P	16 S	17 Cl	18 Ar													
19 K	20 Ca	21 Sc	22 Ti	23 V	24 Cr	25 Mn	26 Fe	27 Co	28 Ni	29 Cu	30 Zn	31 Ga	32 Ge	33 As	34 Se	35 Br	36 Kr													
37 Rb	38 Sr	39 Y	40 Zr	41 Nb	42 Mo	43 Tc	44 Ru	45 Rh	46 Pd	47 Ag	48 Cd	49 In	50 Sn	51 Sb	52 Te	53 I	54 Xe													
55 Cs	56 Ba	57 La	72 Hf	73 Ta	74 W	75 Re	76 Os	77 Ir	78 Pt	79 Au	80 Hg	81 Tl	82 Pb	83 Bi	84 Po	85 At	86 Rn													
87 Fr	88 Ra	89 Ac	104 Rf	105 Db	106 Sg	107 Bh	108 Hs	109 Mt	110 Ds	111 Rg																				
																	58 Ce	59 Pr	60 Nd	61 Pm	62 Sm	63 Eu	64 Gd	65 Tb	66 Dy	67 Ho	68 Er	69 Tm	70 Yb	71 Lu
																	90 Th	91 Pa	92 U	93 Np	94 Pu	95 Am	96 Cm	97 Bk	98 Cf	99 Es	100 Fm	101 Md	102 No	103 Lr

Figure 1-6
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Serendipity

ser·en·dip·i·ty /ˈsɛrənˈdɪpəti/ [ser-uhn-dip-i-tee]

–noun

1. an aptitude for making desirable discoveries by accident.

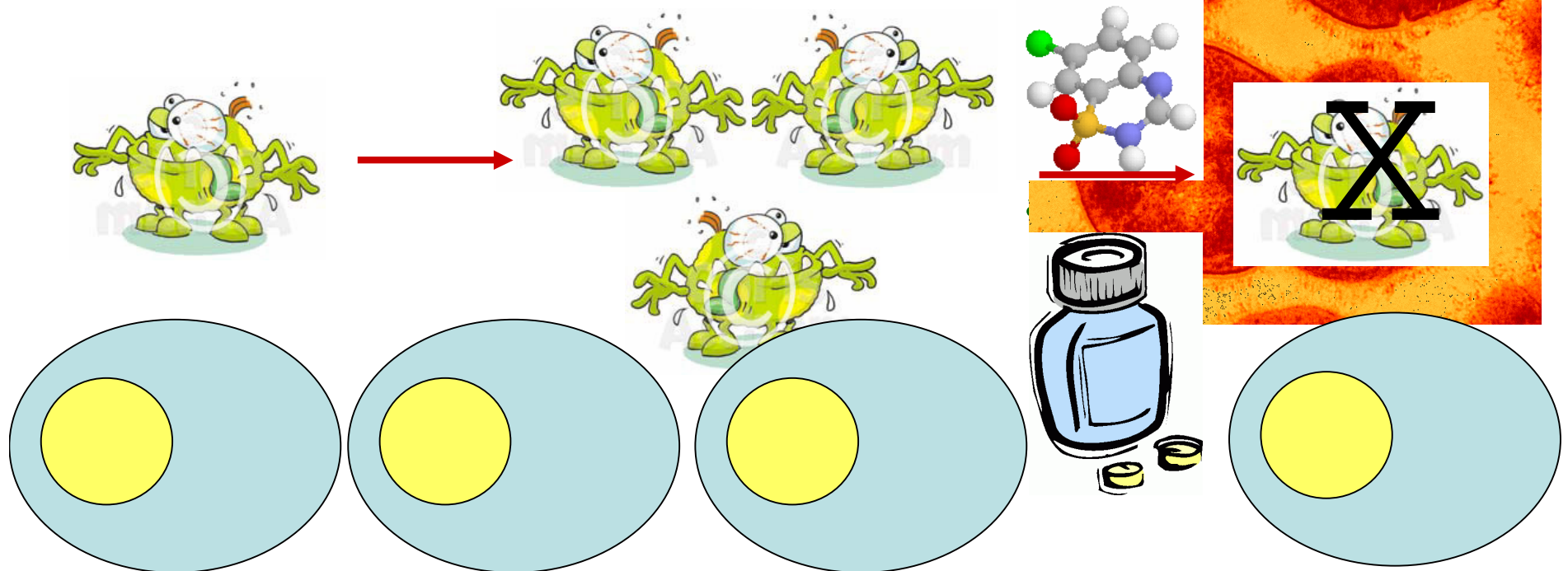
Invaders like bacteria make us

Bacteria make us sick by
invading
and growing in our tissues

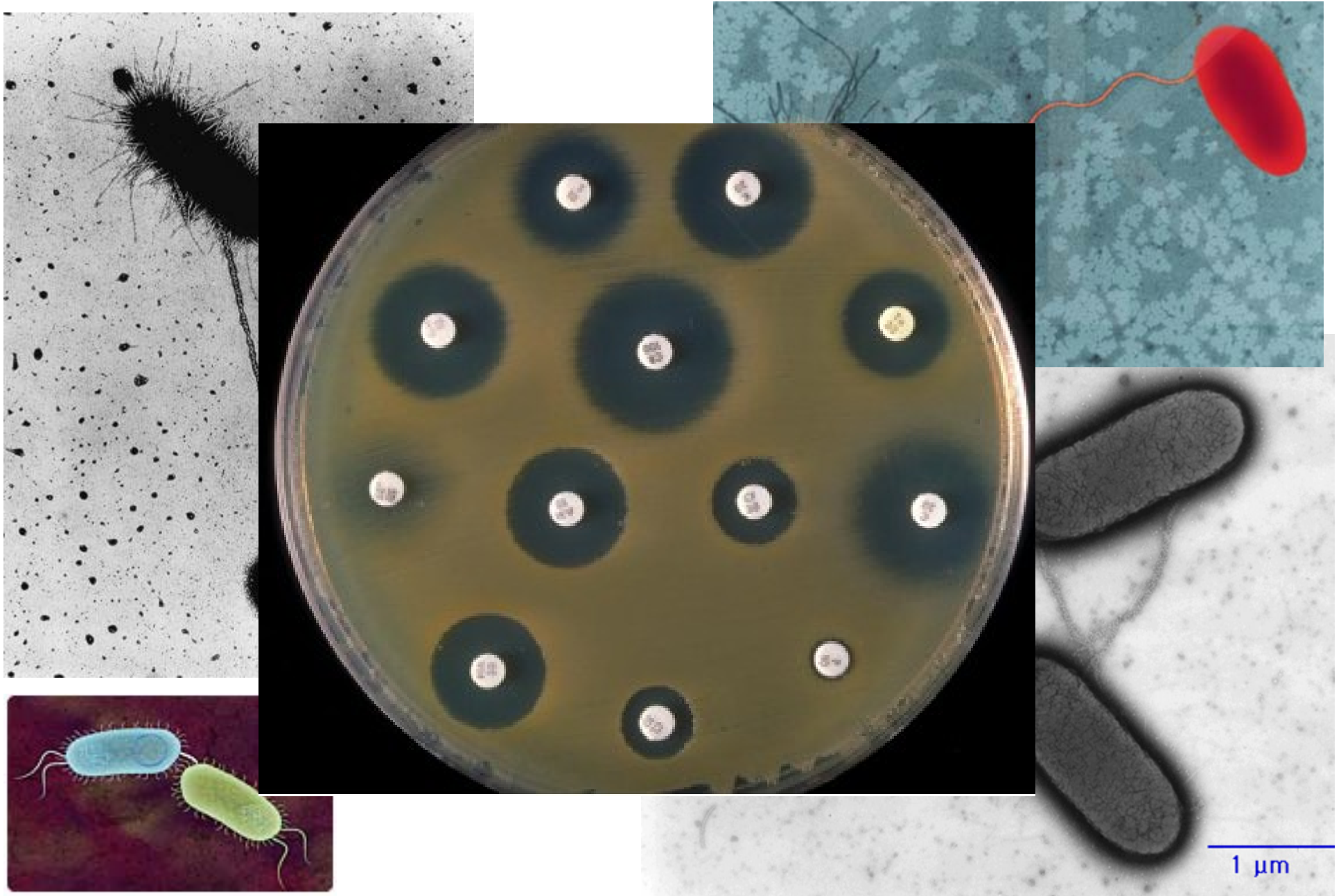


especially noses, throats, stomachs

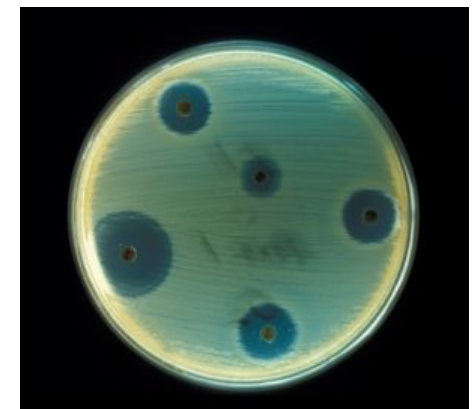
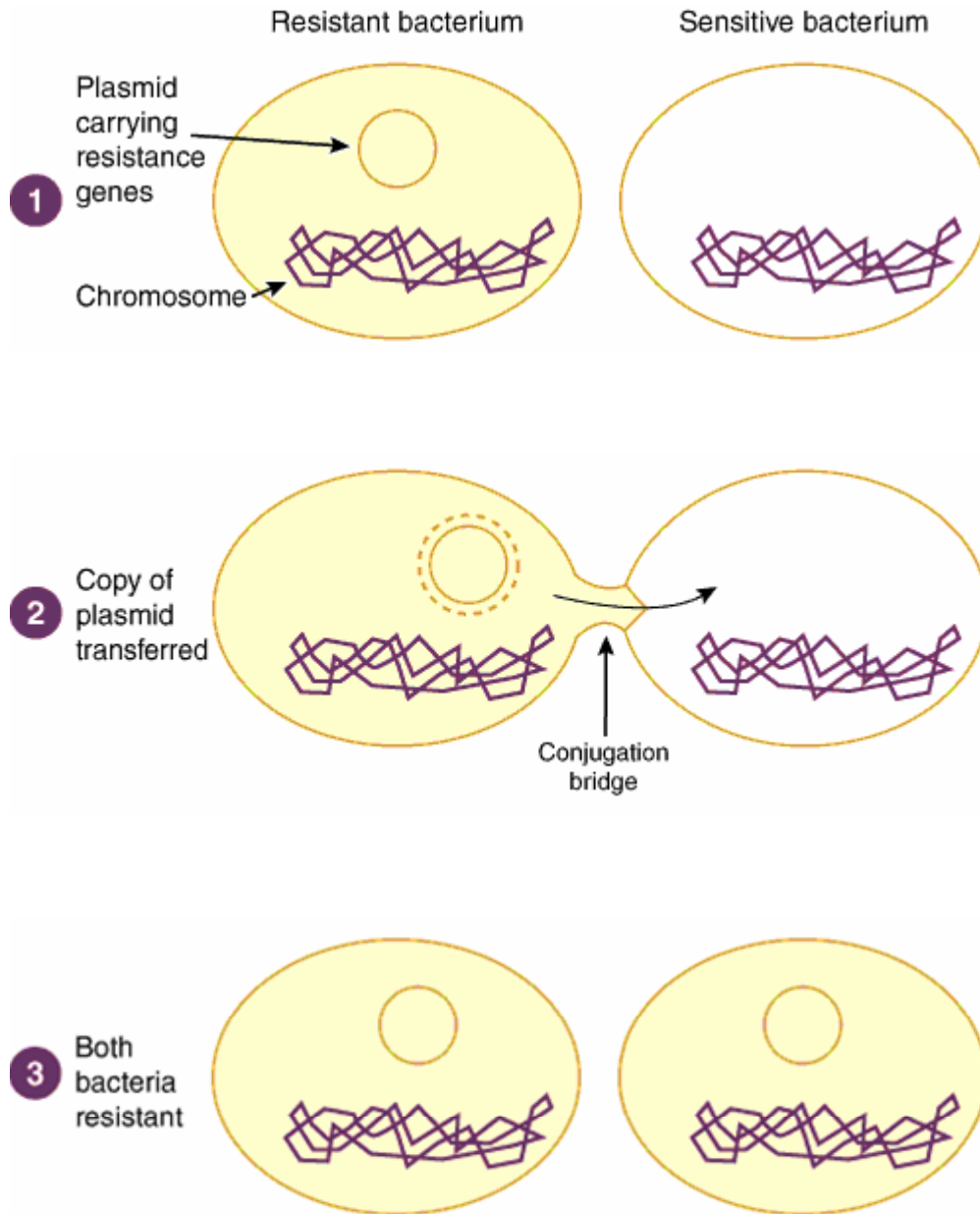
Dead bacteria



Bacteria are SMART and crafty

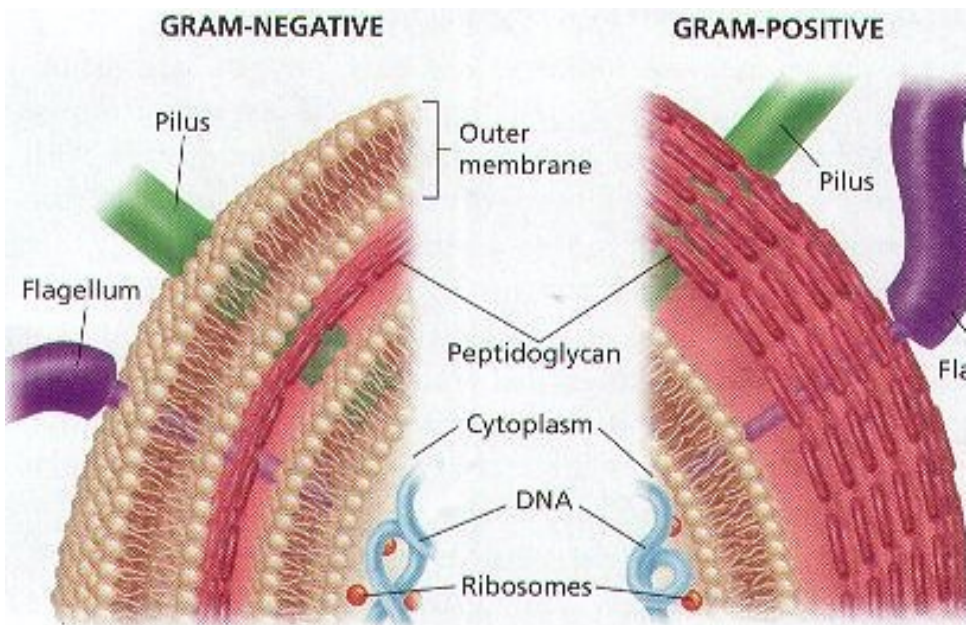
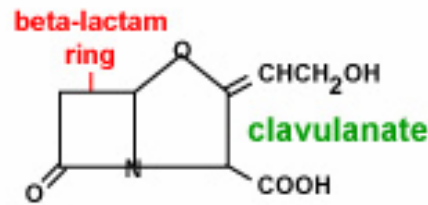
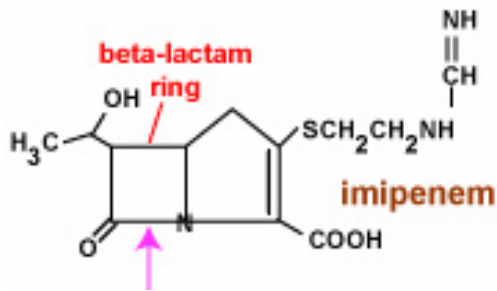
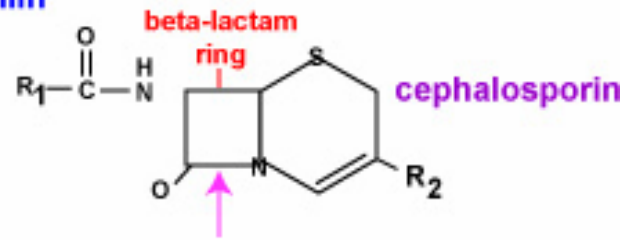
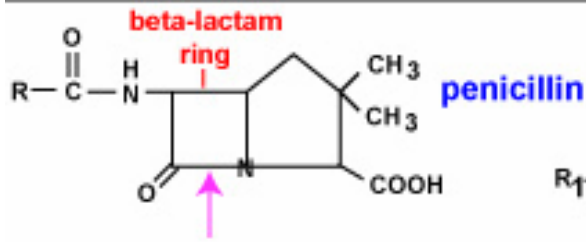


Bacterial Conjugation

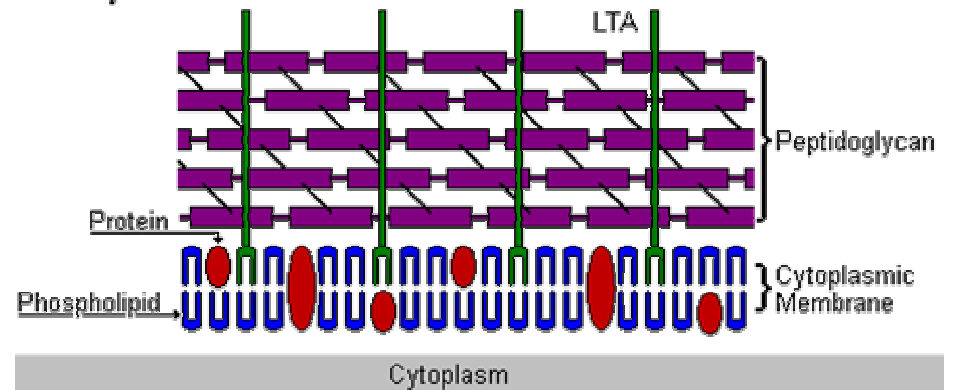


β -lactam Antibiotics

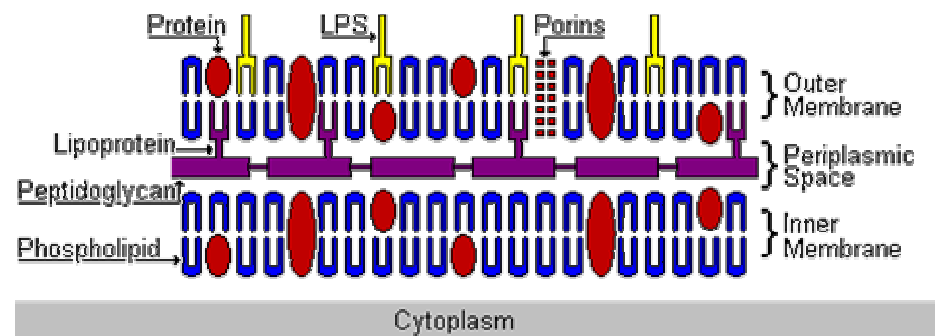
Prevent cell wall synthesis



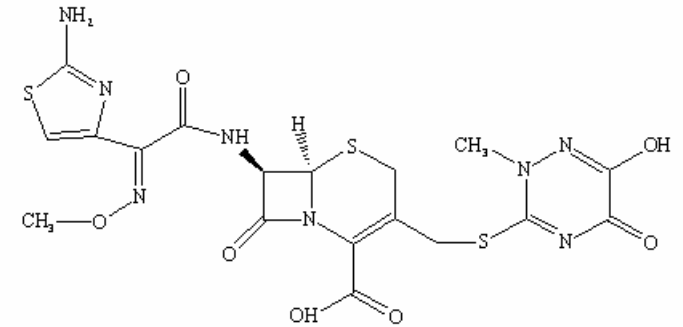
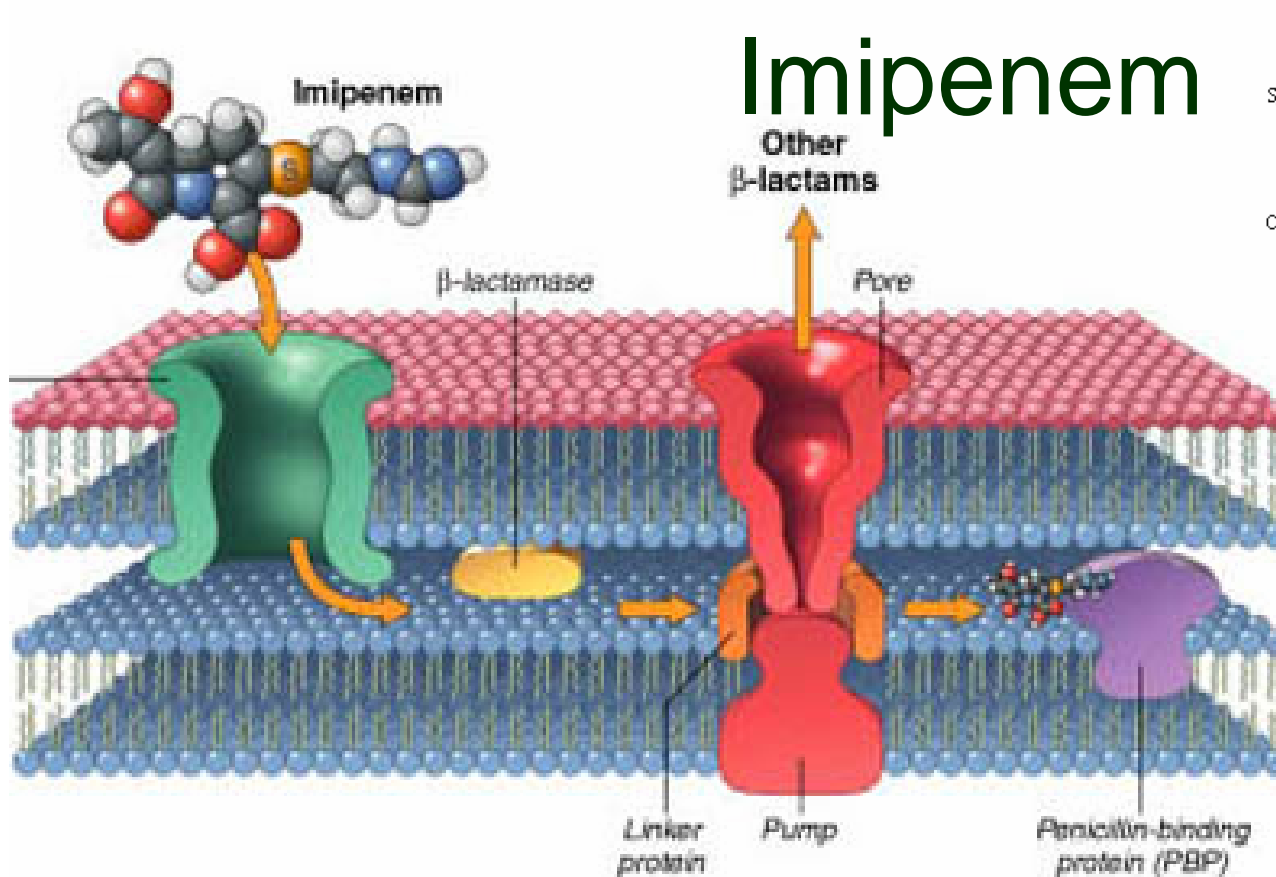
Gram-positive Cell Wall



Gram-negative Cell Wall



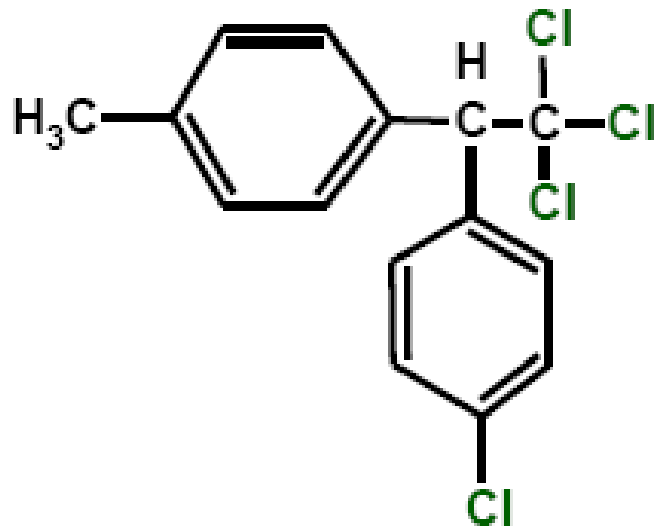
Imipenem



This antibiotic

- (1) bypasses the enzyme that cleaves antibiotics,
- (2) inhibits this enzyme
- and (3) avoids the pump that pumps them out

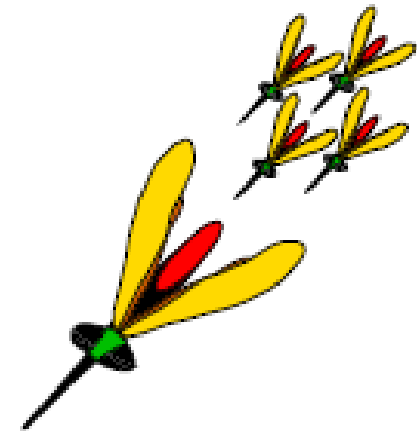
dichlorodiphenyl trichloroethane (DDT)



Non-biodegradable pesticide
Neurotoxin ~ causes paralysis, convulsions and death

Widely used from 1940's until 1972

- sprayed on crops
- delousing agent for people
- in and on homes to kill mosquitos



Worked well until insect resistance forced higher doses

Biological Magnification

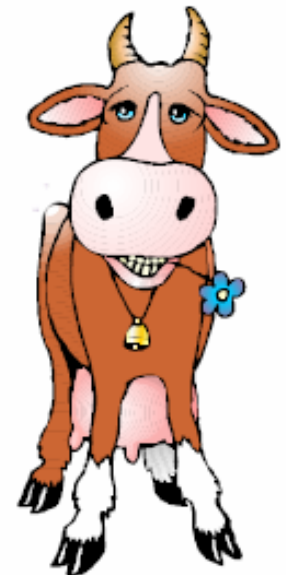
(1) DDT interfered with Ca^{2+} metabolism of birds

- shells too thin to support chick development
- fewer birds
- MORE INSECTS!!



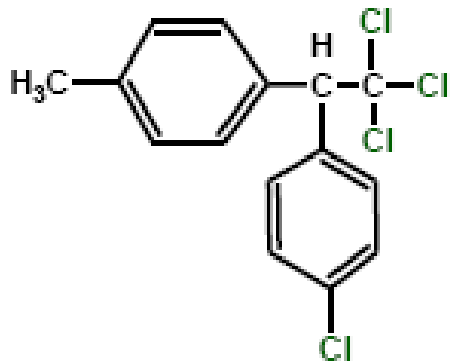
(2) DDT is insoluble in water but soluble in non-polar solvents

- Stored in fat instead of excreted in urine
- Cow eats grass, you eat cow



Biological Magnification: Borneo 1955

Malaria



DDT

killed other insects



lizards ate insects

Biological Magnification: Borneo 1955

cats ate lizards



cats died



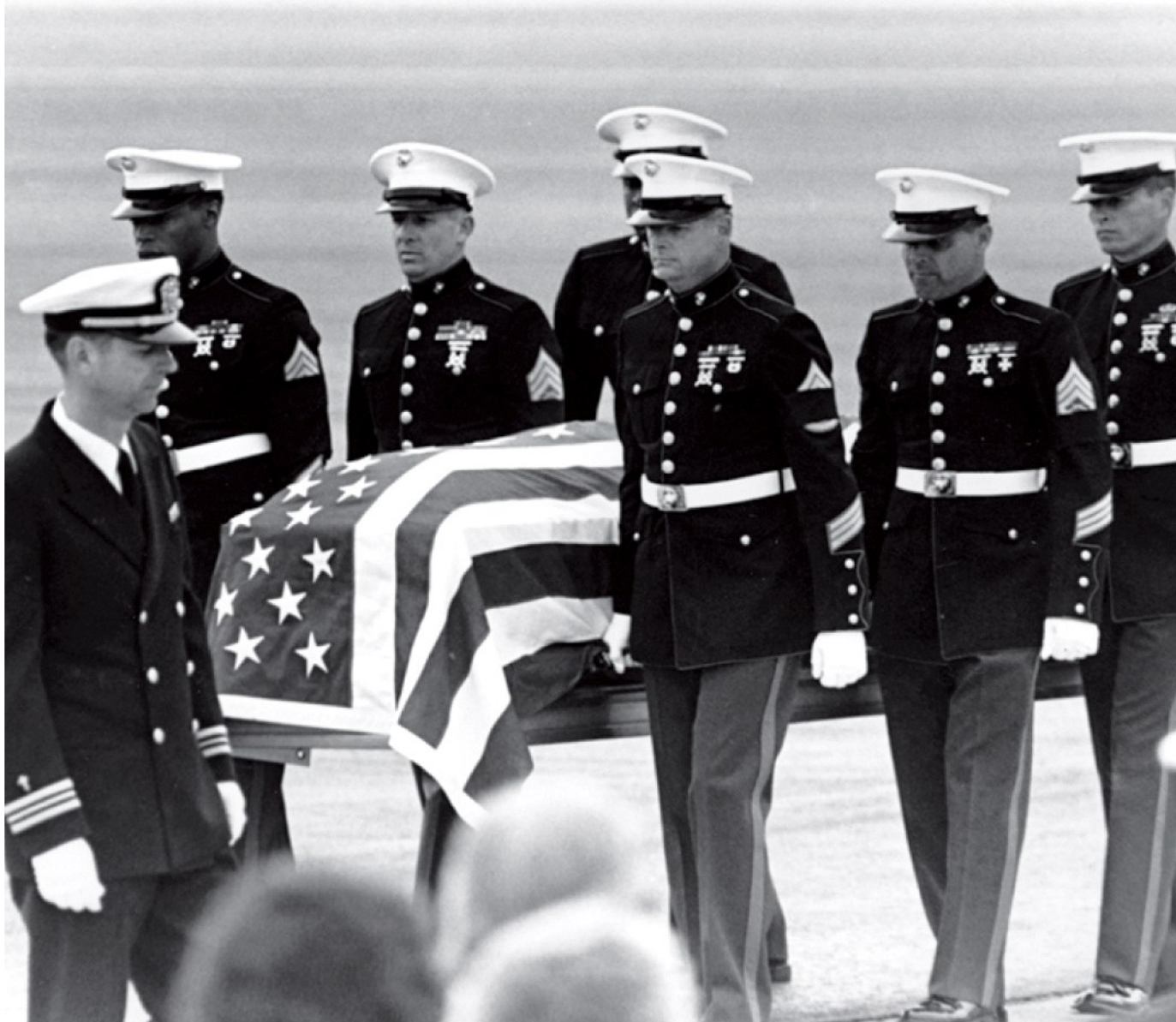
increase in mice and rats



Bubonic Plague

Traded malaria for bubonic plague





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NOVEMBER 7, 1988

The Differences
That Matter

\$2.00

TIME

DEATH OF A NARC

U.S. drug agent
"Kiki" Camarena's
mission was to
hunt down Mexico's
drug barons. This
is the story of how
they got him.

