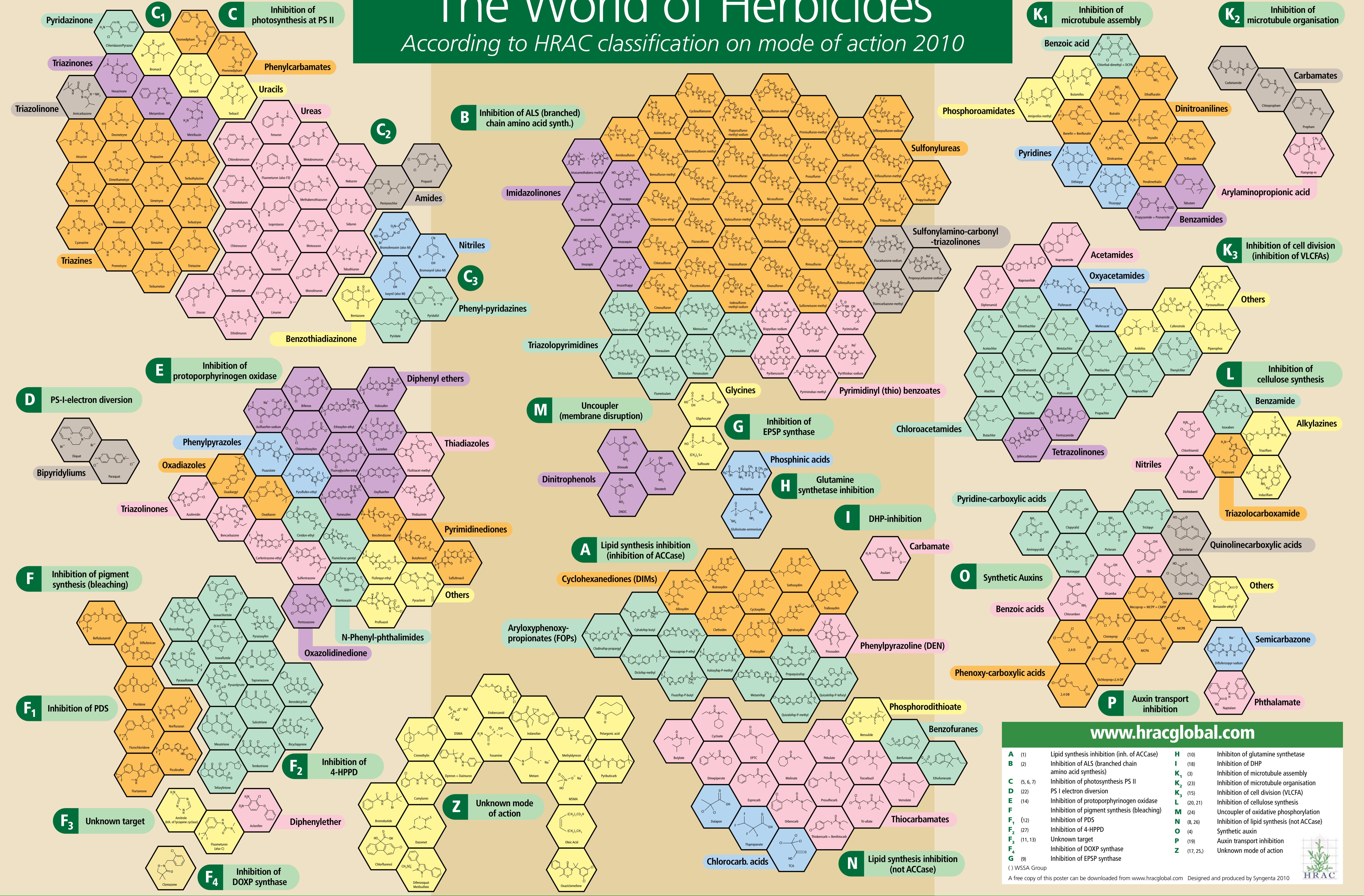


The World of Herbicides

According to HRAC classification on mode of action 2010



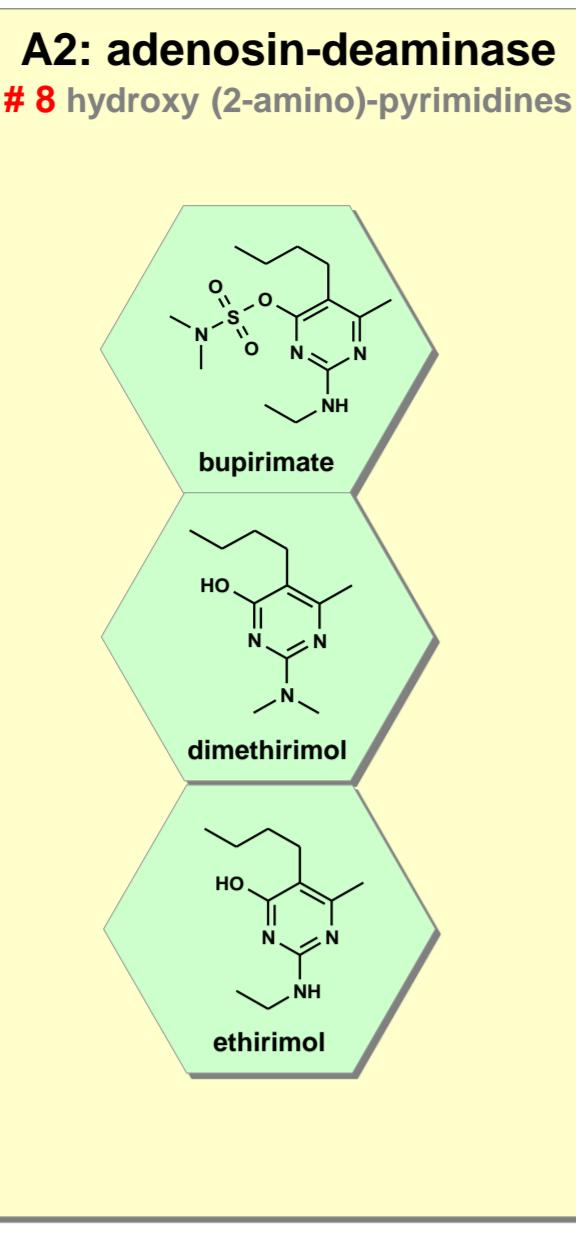
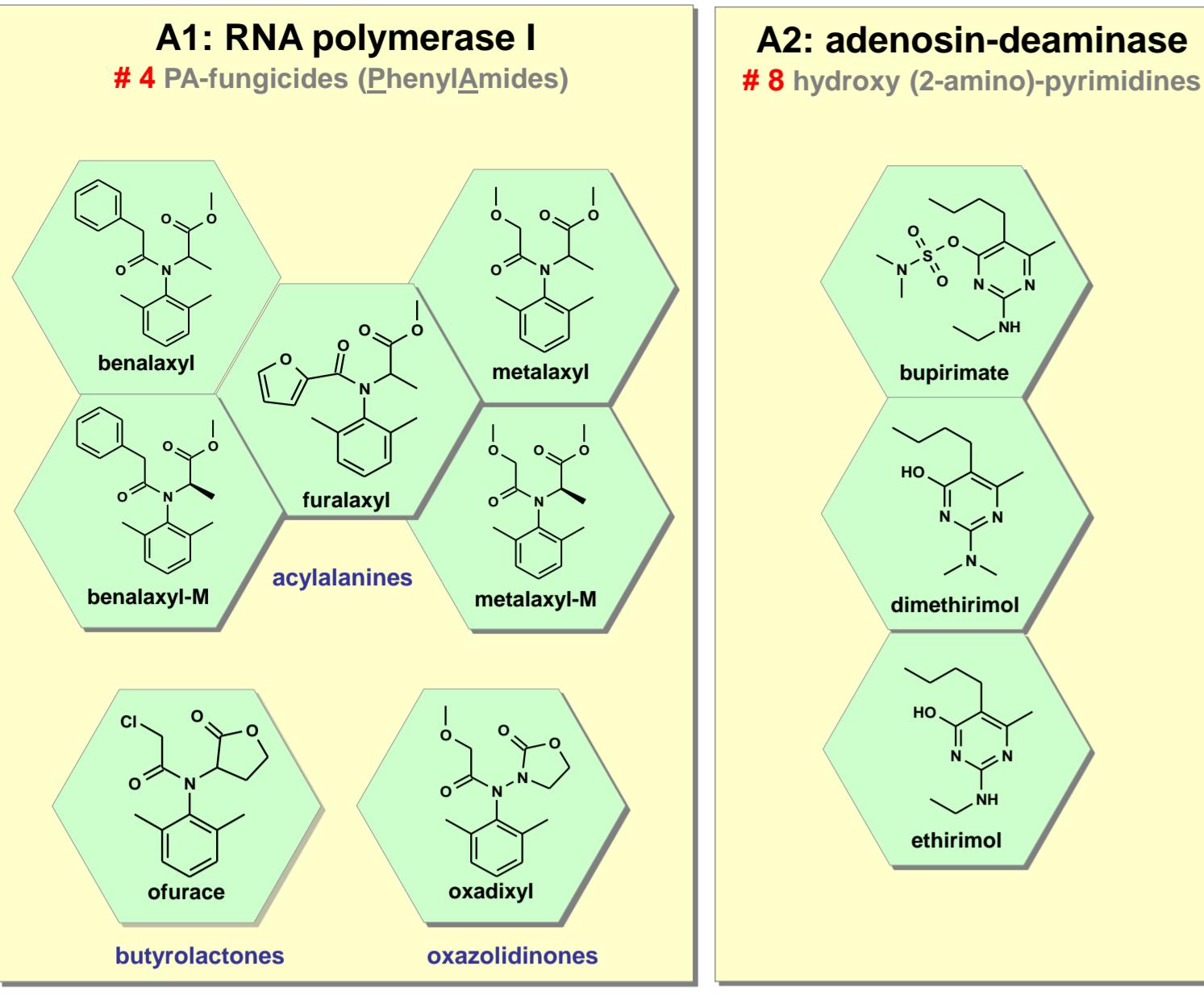
www.hracglobal.com

A	(1)	Lipid synthesis inhibition (inh. of ACCase)	H	(10)	Inhibition of glutamine synthetase
B	(2)	Inhibition of ALS (branched chain amino acid synthesis)	I	(18)	Inhibition of DHP
C	(5, 6, 7)	Inhibition of photosynthesis PS II	K₁	(3)	Inhibition of microtubule assembly
D	(22)	PS I electron diversion	K₂	(23)	Inhibition of microtubule organisation
E	(14)	Inhibition of protoporphyrinogen oxidase	K₃	(15)	Inhibition of cell division (VLCFA)
F		Inhibition of pigment synthesis (bleaching)	L	(20, 21)	Inhibition of cellulose synthesis
F₁	(12)	Inhibition of PDS	M	(24)	Uncoupler of oxidative phosphorylation
F₂	(27)	Inhibition of 4-HPPD	N	(8, 26)	Inhibition of lipid synthesis (not ACCase)
F₃	(11, 13)	Unknown target	O	(4)	Synthetic auxin
F₄		Inhibition of DOXP synthase	P	(19)	Auxin transport inhibition
G	(9)	Inhibition of EPSP synthase	Z	(17, 25,)	Unknown mode of action

A free copy of this poster can be downloaded from www.hracglobal.com Designed and produced by Syngenta 2010



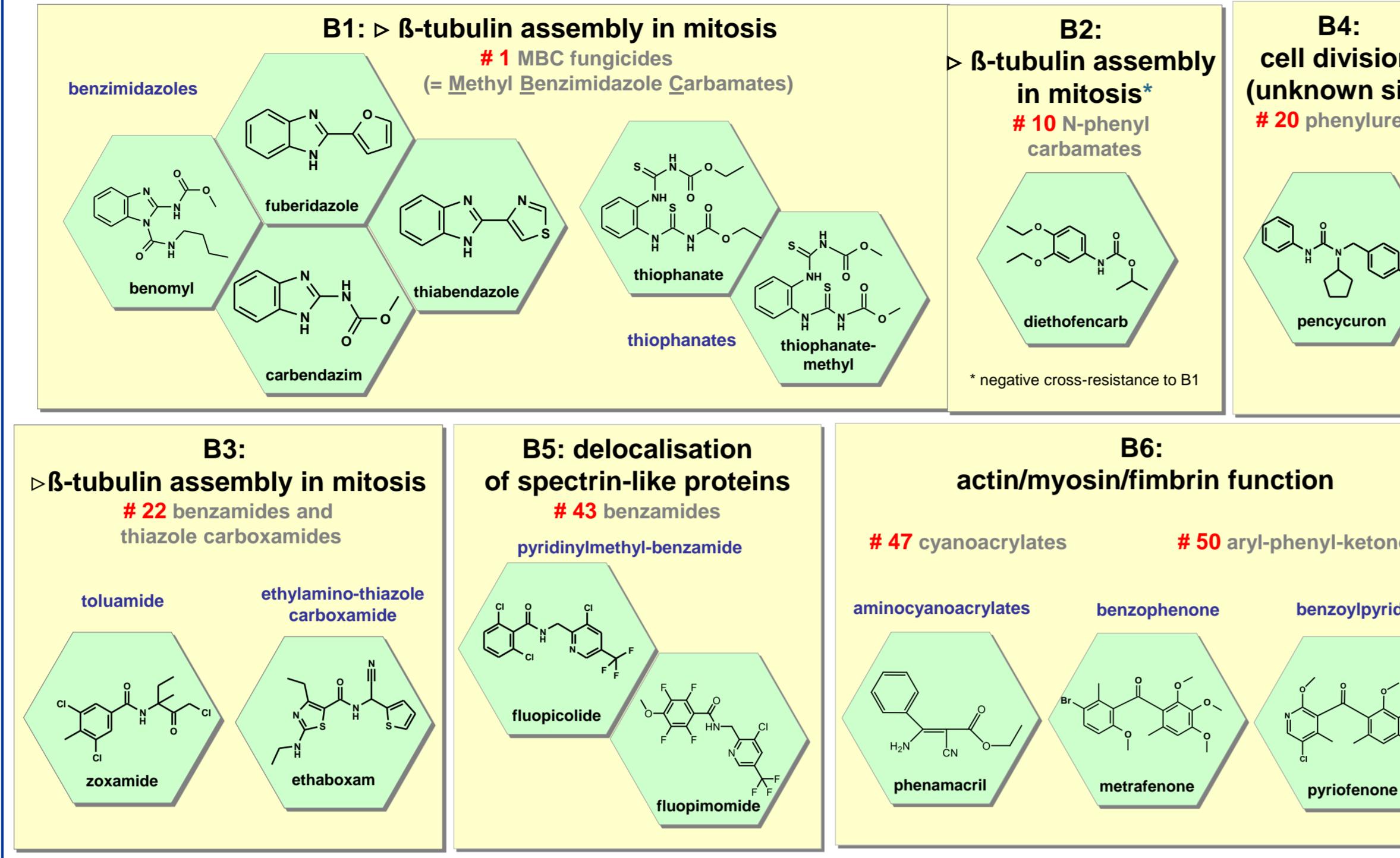
A: Nucleic Acids Metabolism



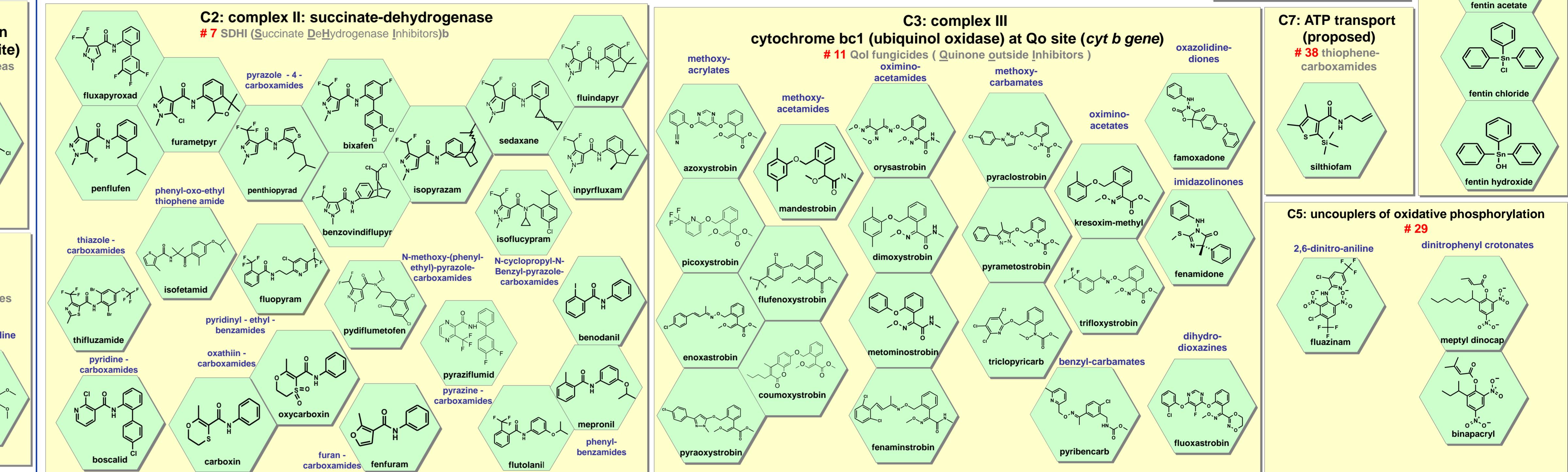
FRAC Classification of Fungicides

Fungal control agents by cross resistance pattern and mode of action 2019 (www.frac.info)

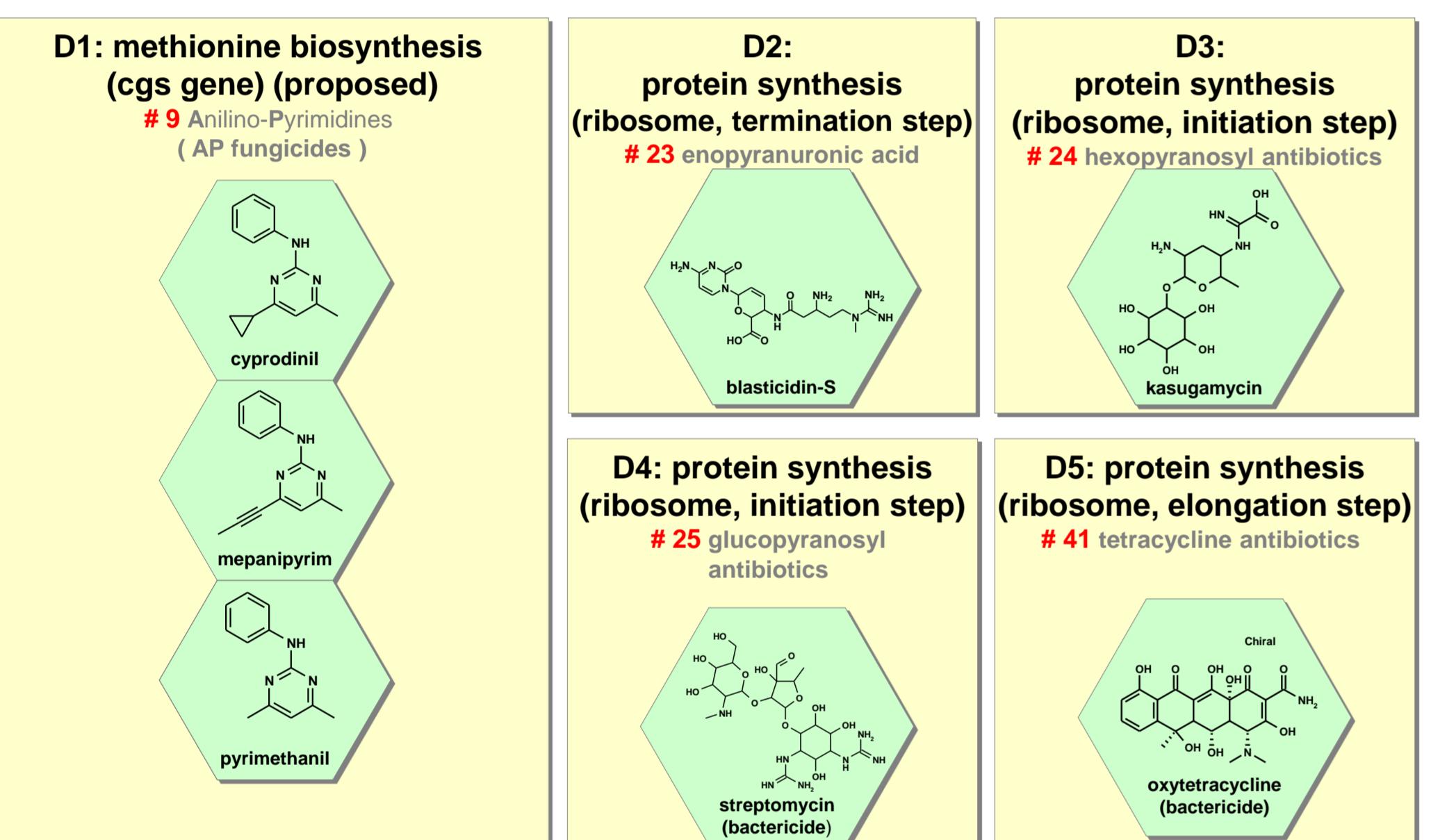
B: Cytoskeleton and Motor Proteins



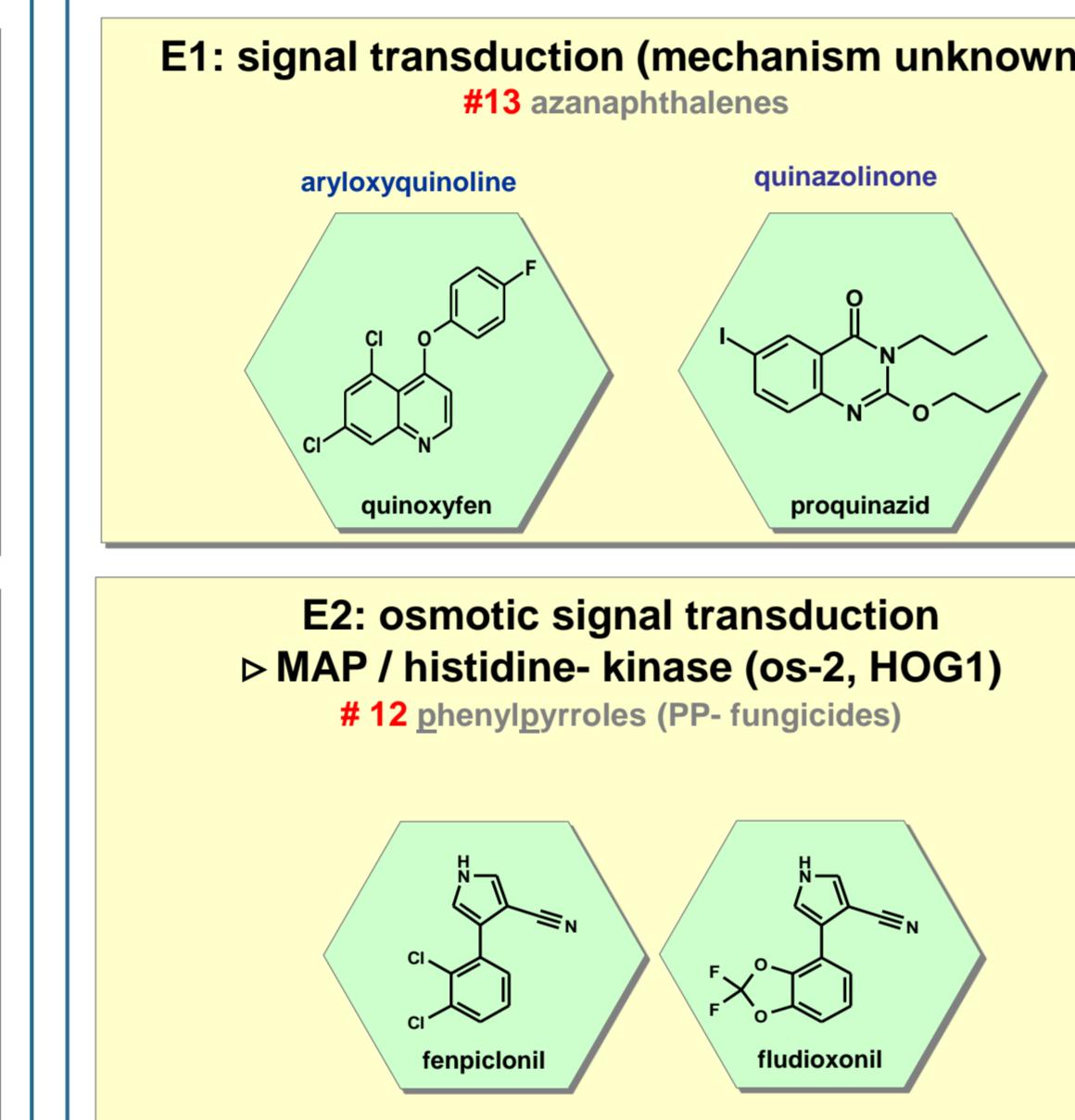
C: Respiration



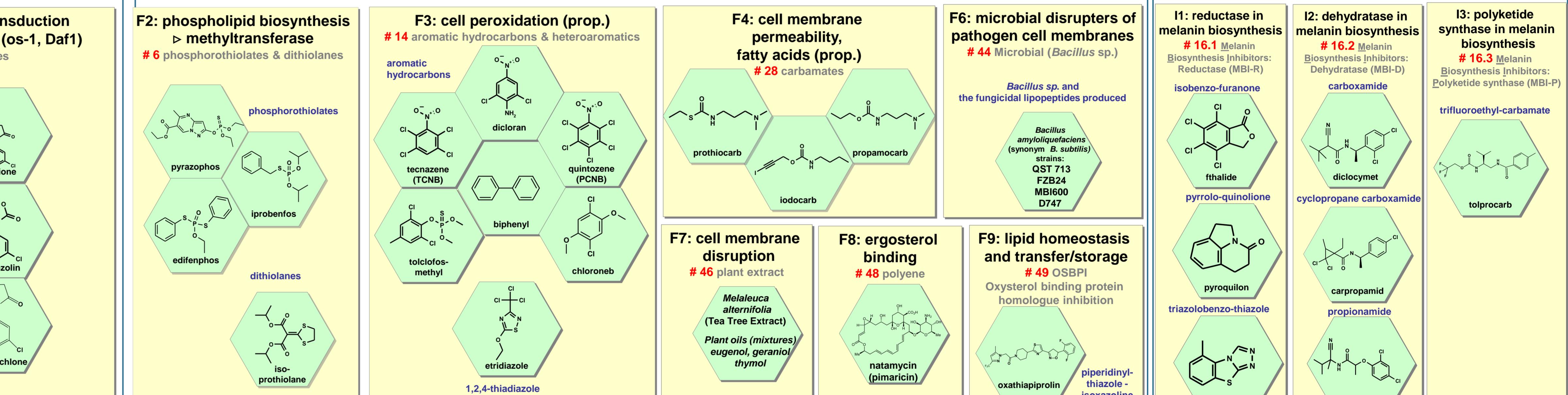
D: Amino Acid and Protein Synthesis



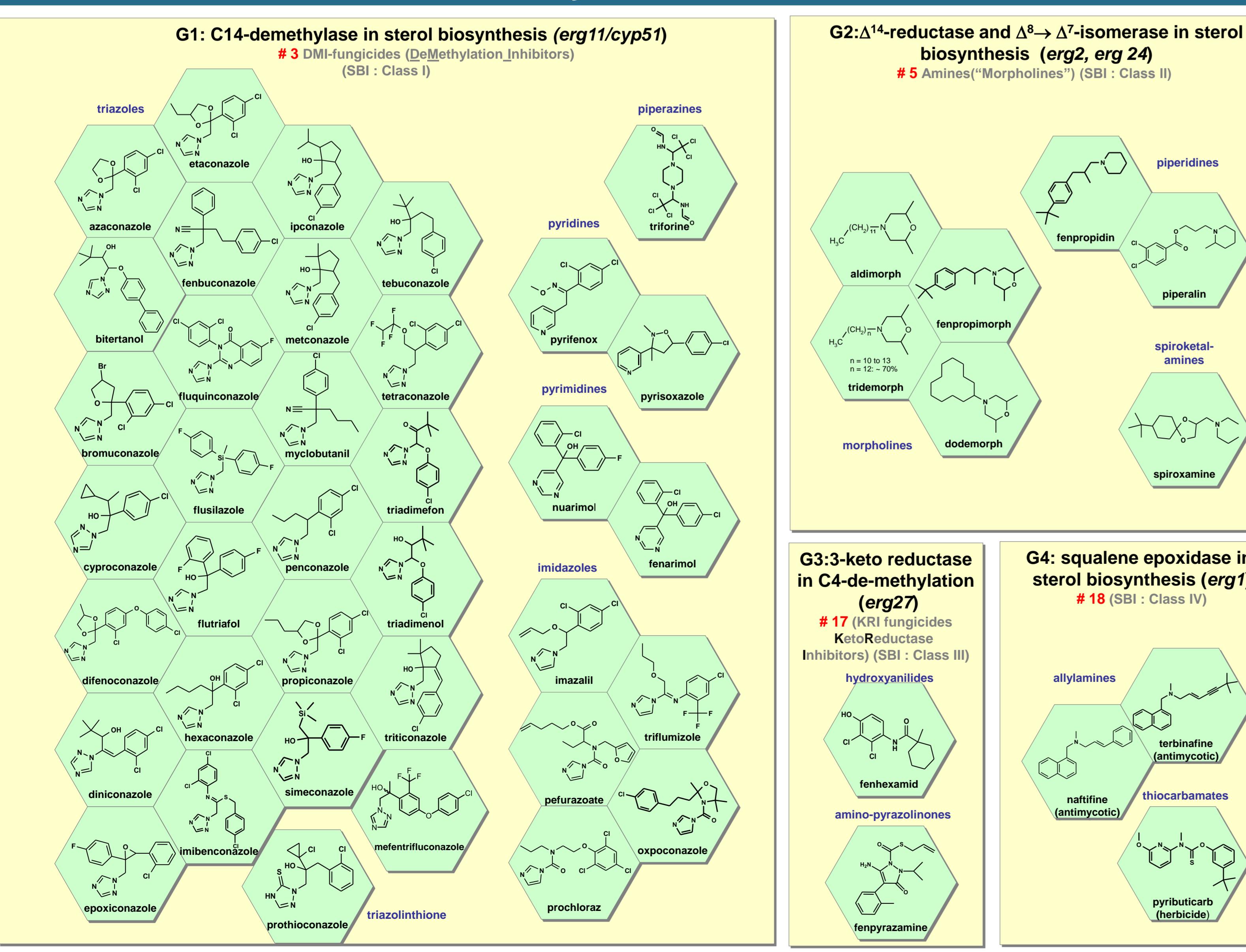
E: Signal Transduction



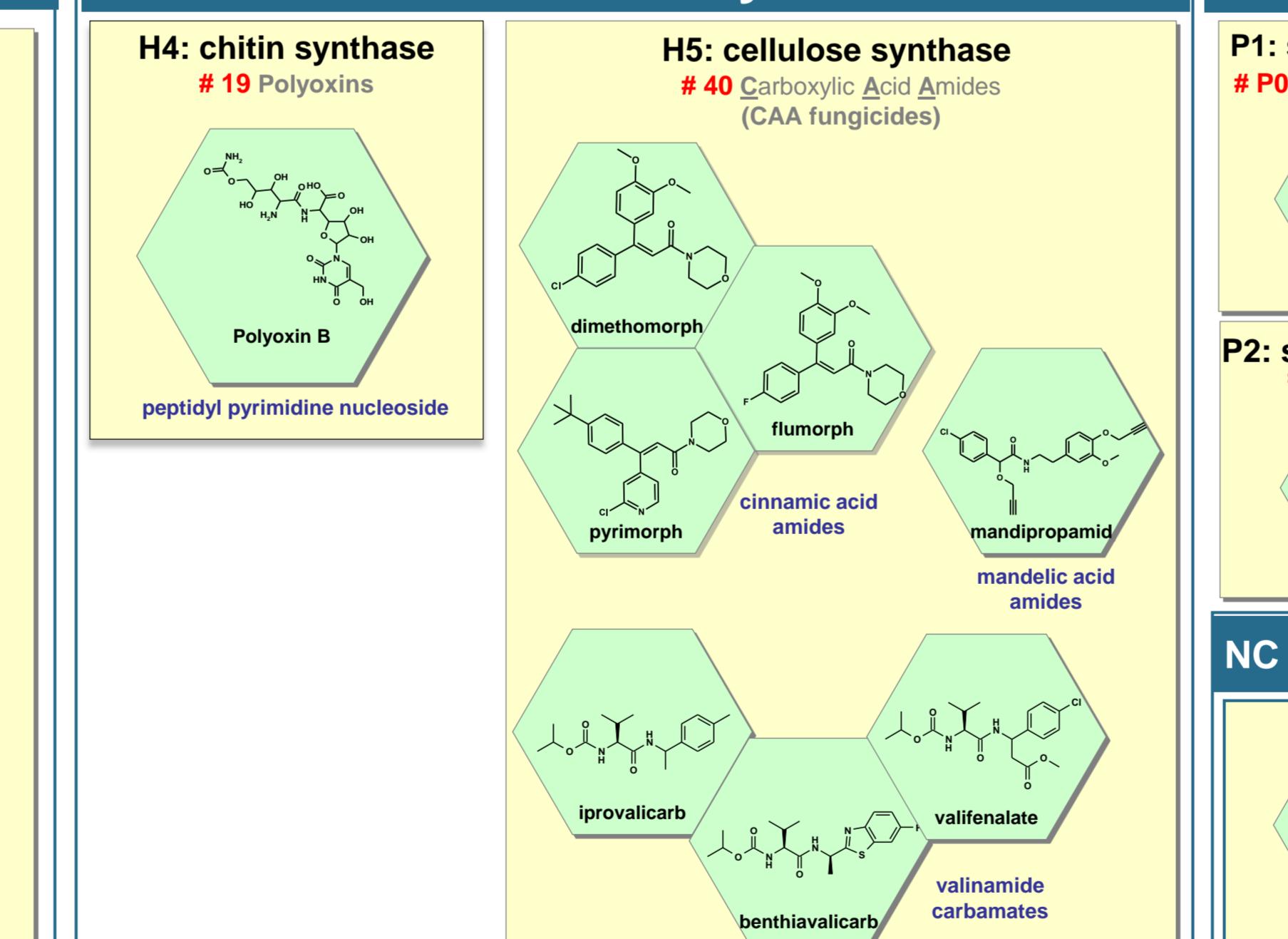
F: Lipid Synthesis or Transport / Membrane Integrity or Function



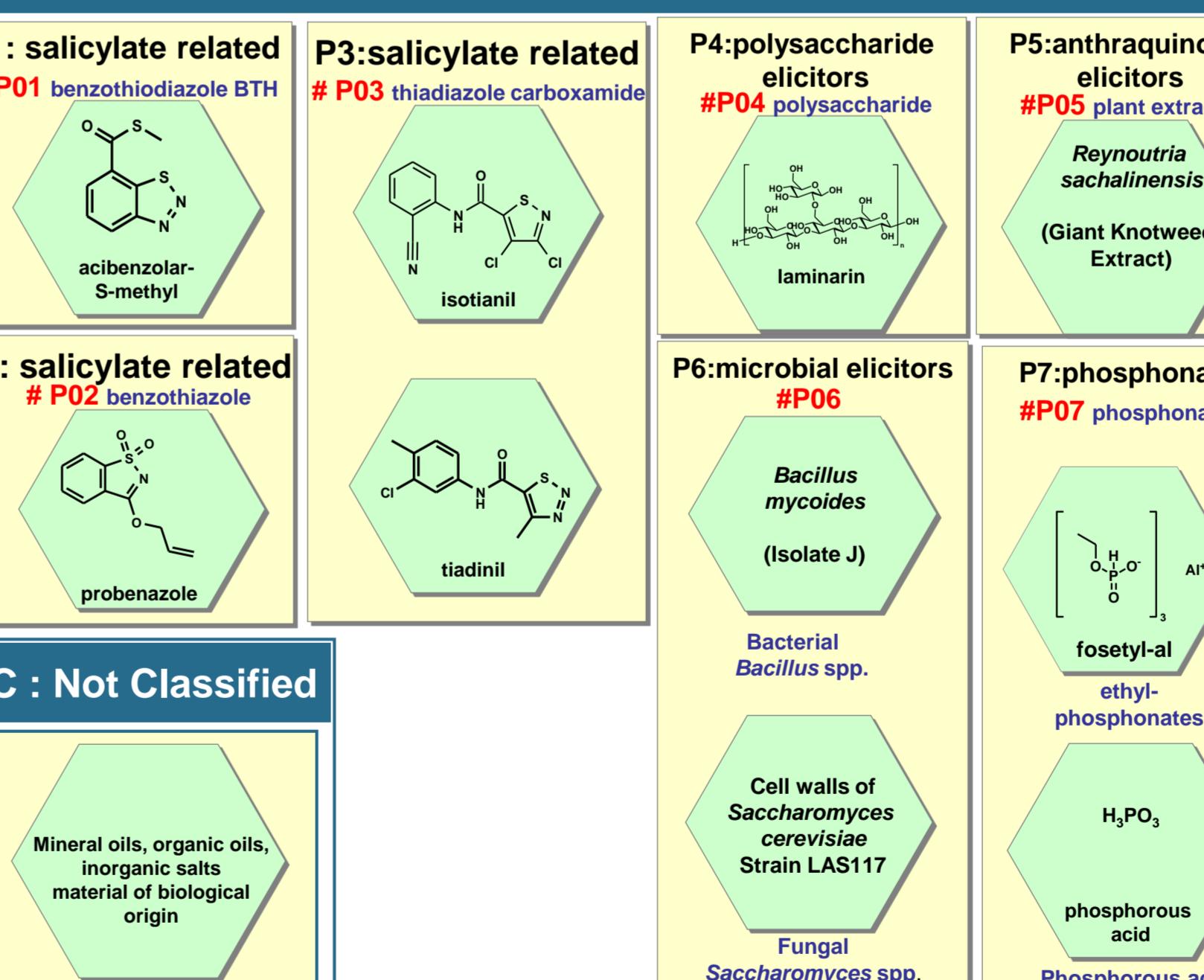
G: Sterol Biosynthesis in Membranes



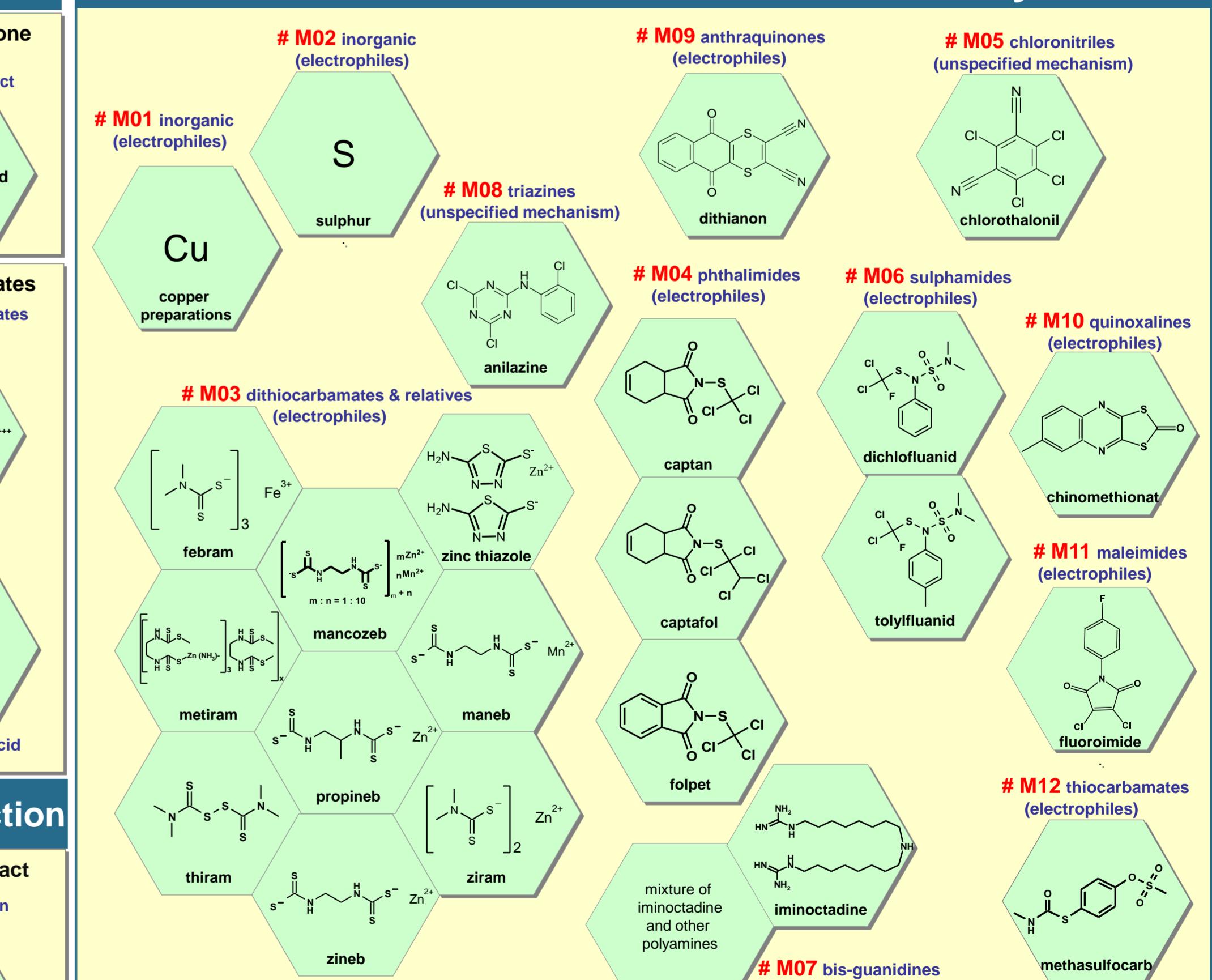
H-Cell Wall Biosynthesis



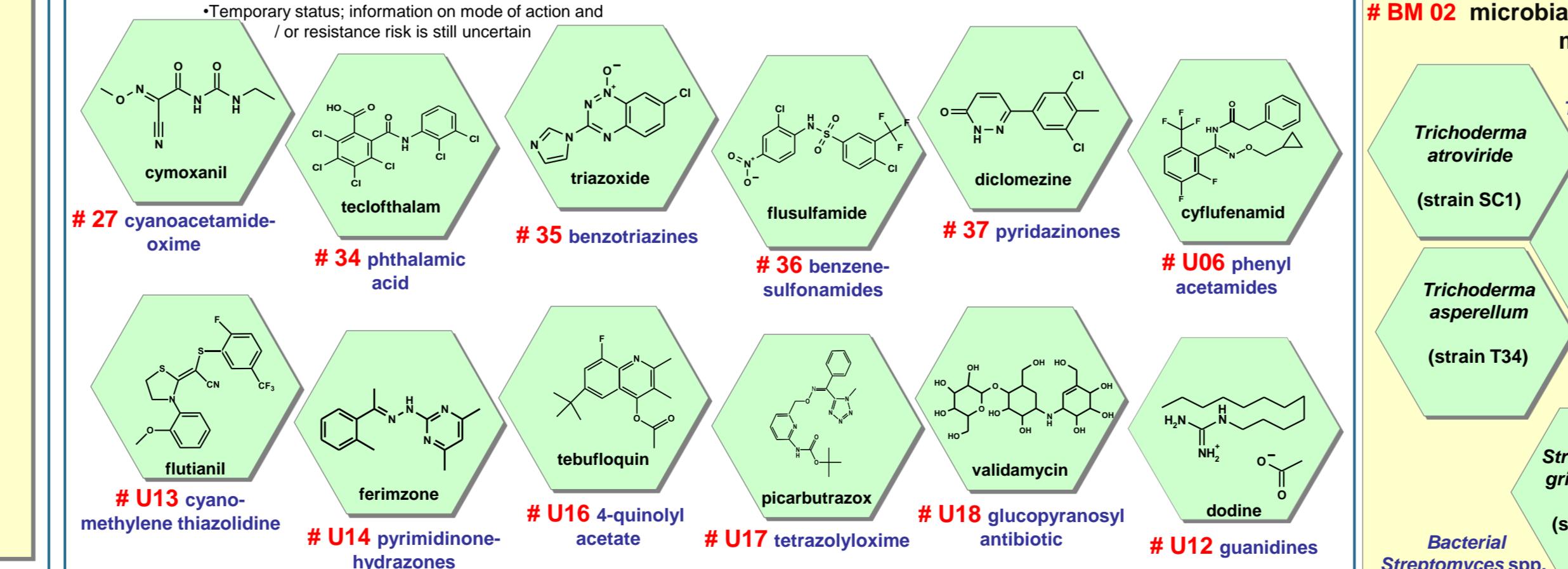
P- Host Plant Defence Induction



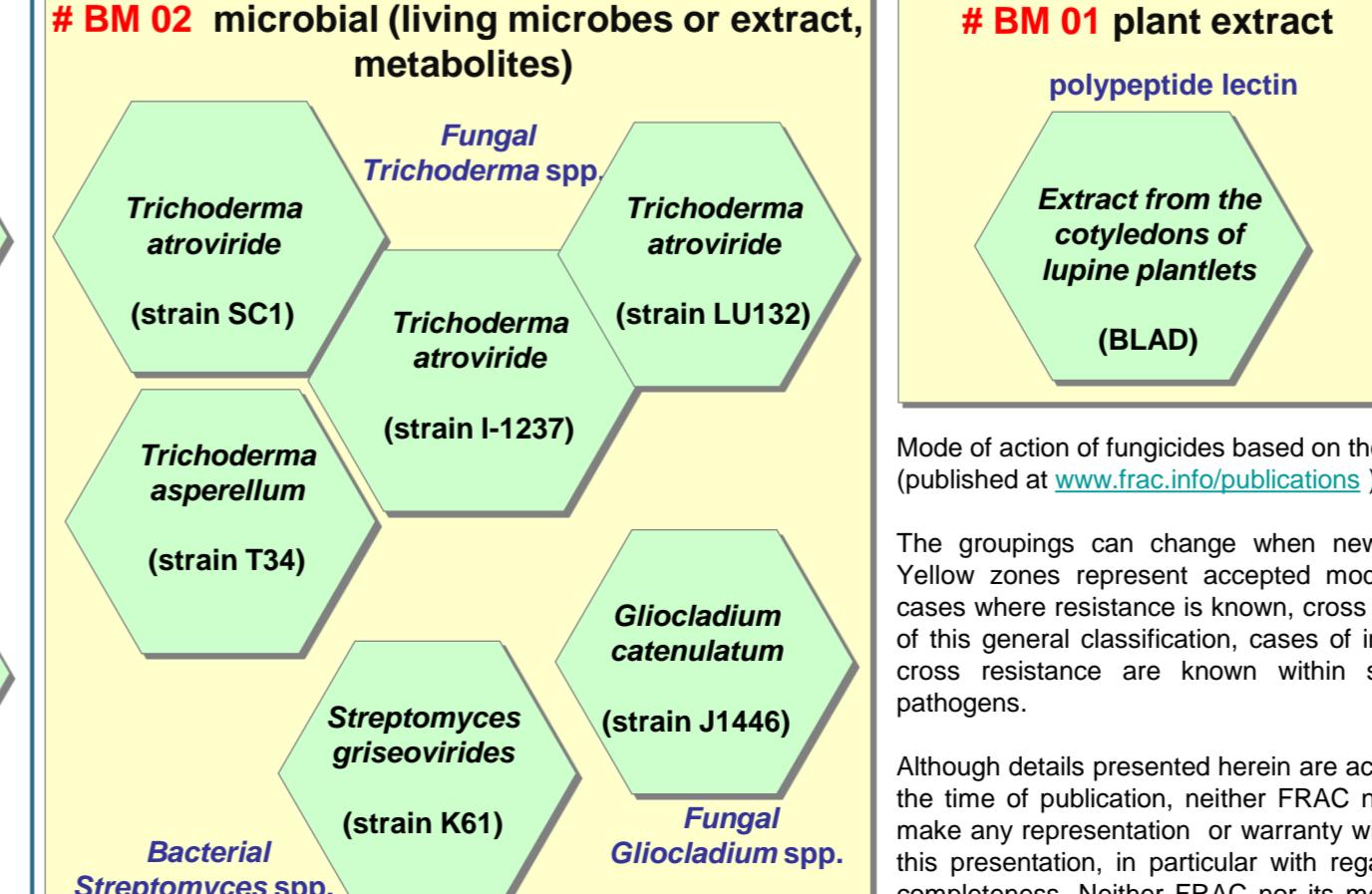
M: Chemicals with Multi-Site Activity



Unknown Mode of Action



BM : Biologicals with Multiple Modes of Action



) Mode of action of fungicides based on the (published at www.frac.info/publications)

The diagram illustrates the FRAC mode of action classification for *Gliocladium catenulatum* (strain J1446). A green hexagon on the left contains the pathogen name and its strain. To its right is a yellow box representing a mode of action group. The text inside the yellow box is as follows:

C2: inhibition of complex II:
▷ **succinate-dehydrogenase**
7 SDHI (Succinate dehydrogenase inhibitors)

Annotations with arrows point to specific parts of the text:

- An arrow points to "SDHI" with the label "sub-group".
- An arrow points to "succinate-dehydrogenase" with the label "target site of action (where known) or putative target site (=prop.)".
- An arrow points to "# 7" with the label "FRAC code no. (#) and group name".
- An arrow points to "thiazole carboxamides" with the label "chemical (sub-) group".

Below the yellow box, the text "thiazole carboxamides" is written in blue.

FRAC
FUNGICIDE RESISTANCE ACTION COMMITTEE

The diagram illustrates the FRAC classification system. At the top, 'C: Respiration' is labeled as the mode of action group. Below it, 'C2: inhibition of complex II:' is labeled as a sub-group. Underneath that, '▷ succinate-dehydrogenase' is labeled as the target site of action (where known) or putative target site (=prop.). To the left of these, '# 7 SDHI (Succinate dehydrogenase inhibitors)' is labeled with its FRAC code no. (#) and group name. At the bottom, 'thiazole carboxamides' is labeled as a chemical (sub-) group.

mode of action group

sub-group

▷ target site of action
(where known) or putative
target site (=prop.)

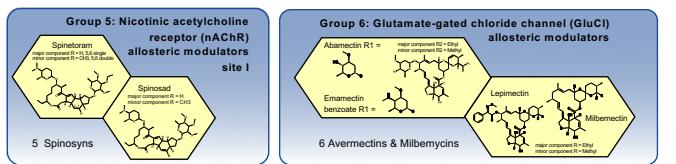
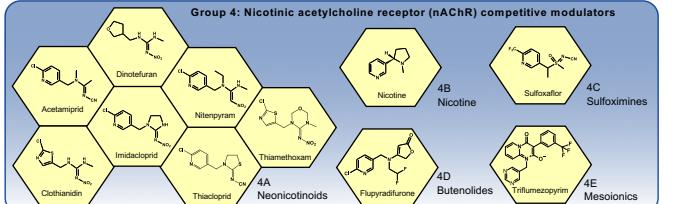
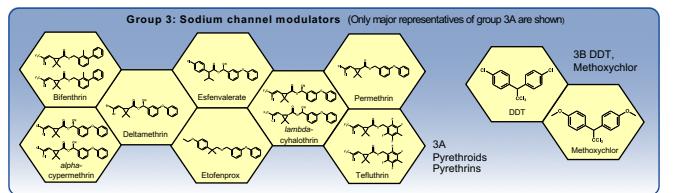
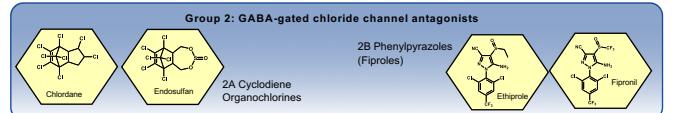
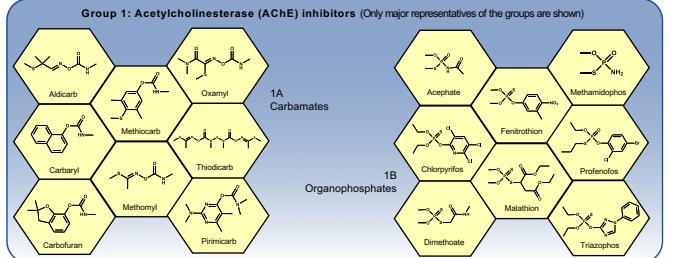
FRAC code no. (#)
and group name

chemical (sub-) group

IRAC

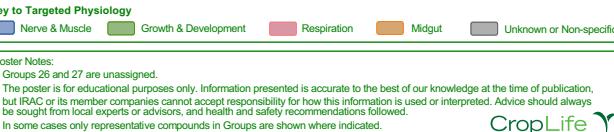
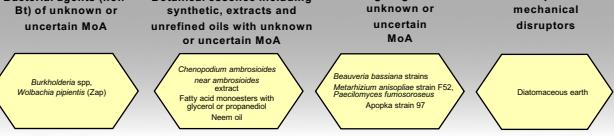
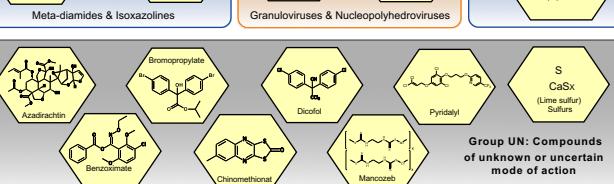
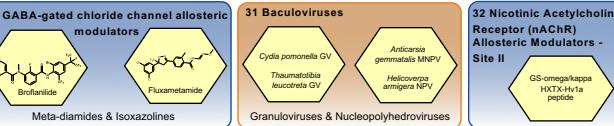
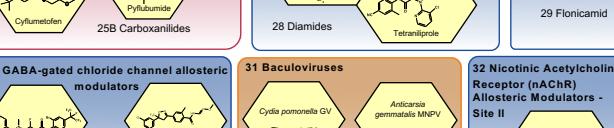
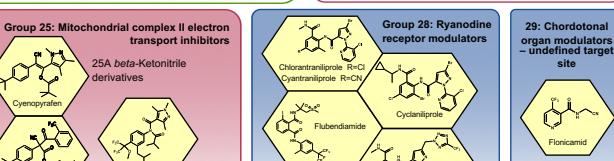
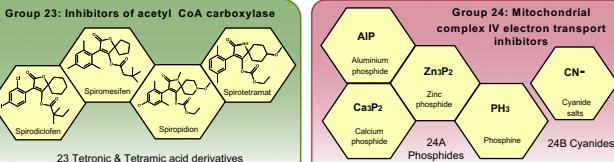
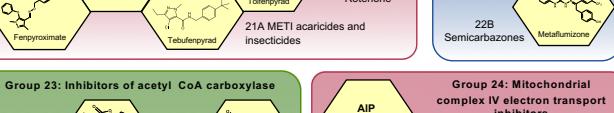
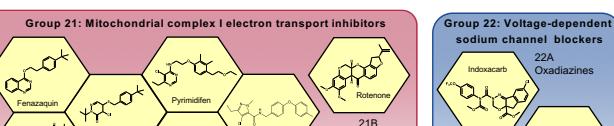
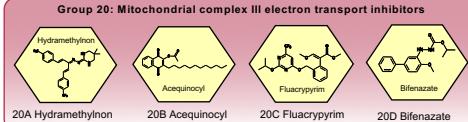
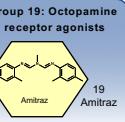
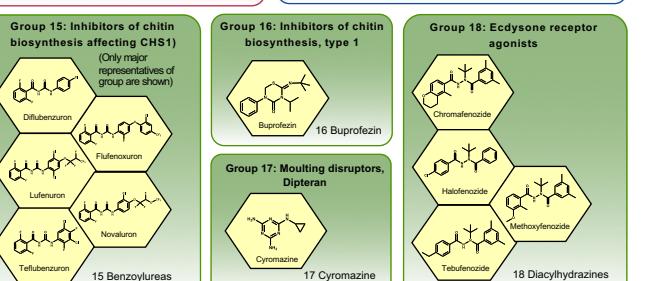
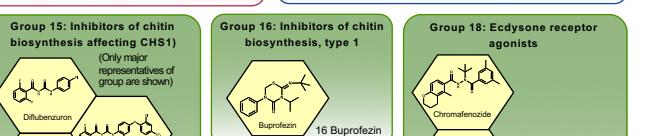
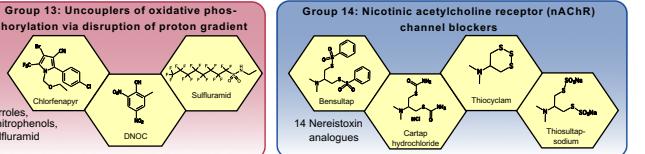
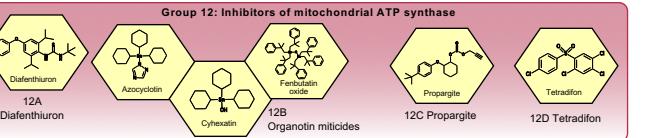
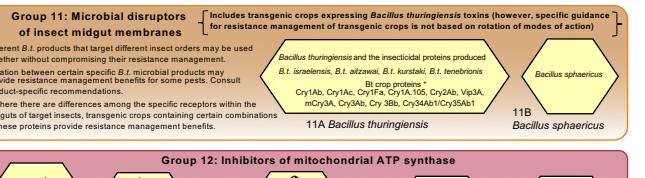
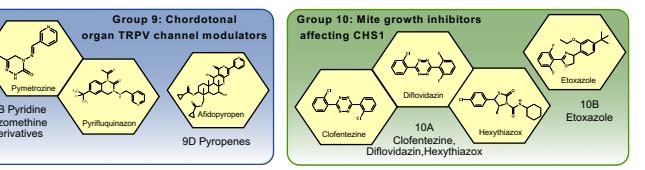
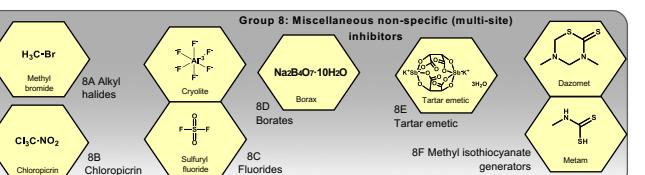
Insecticide Resistance Action Committee

Mode of Action Classification



Use of Groups and Sub-Groups:

- Alternatives, sequences or rotations of compounds between MoA groups reduce selection for target site resistance.
- Applications are arranged into MoA spray windows defined by crop growth stage and pest biology.
- Several sprays of a compound may be possible within each spray window, but successive generations of a pest should not be treated with compounds from the same MoA group.
- Local expert advice should always be followed with regard to spray windows and timing.
- Groups in the classification whose members do not act at a common target site are exempt from the proscription against rotation within the group. These are Group 13 and all the UN groups: UN, UNB, UNE, UNM, UNP & UNV.
- Sub-groups represent distinct structural classes which are believed to have the same mode of action.
- Sub-groups differentiate between compounds that may bind at the same target site but are structurally different enough that risk of resistance cross-resistance is lower than between analogs.
- Cross-resistance potential between groups is higher than between groups, so rotation between sub-groups should be considered only when there are no cross-resistance does not exist, following consultation with local expert advice. These exceptions are not sustainable, and alternative options should be sought.
- Sub-group 3B: DDT is no longer used in agriculture and therefore this is only applicable for the control of insect vectors of human disease, such as mosquitoes, because of a lack of alternatives.
- Sub-group 10A: Hexythiazox is grouped with clofentezine because they exhibit cross-resistance even though they are structurally distinct. Diffovidazin has been added to this group because it is a close analogue of clofentezine and is expected to have the same mode of action.



Key to Targeted Physiology

■ Nerve & Muscle ■ Growth & Development ■ Respiration ■ Midgut ■ Unknown or Non-specific

Poster Notes:

- Groups 26 and 27 are unassigned.
- The poster is for educational purposes only. Information presented is accurate to the best of our knowledge at the time of publication, but IRAC or its member companies cannot accept responsibility for how this information is used or interpreted. Advice should always be sought from local experts or advisors, and health and safety recommendations followed.
- In some cases only representative compounds in Groups are shown where indicated.
- Please visit www.irac-online.org for the complete IRAC classification.