Stres vysokou teplotou

High temperature stress

Heat stress

M. Barták

OFAR ÚEB PřF MU Brno
Laboratoř fotosyntetických procesů

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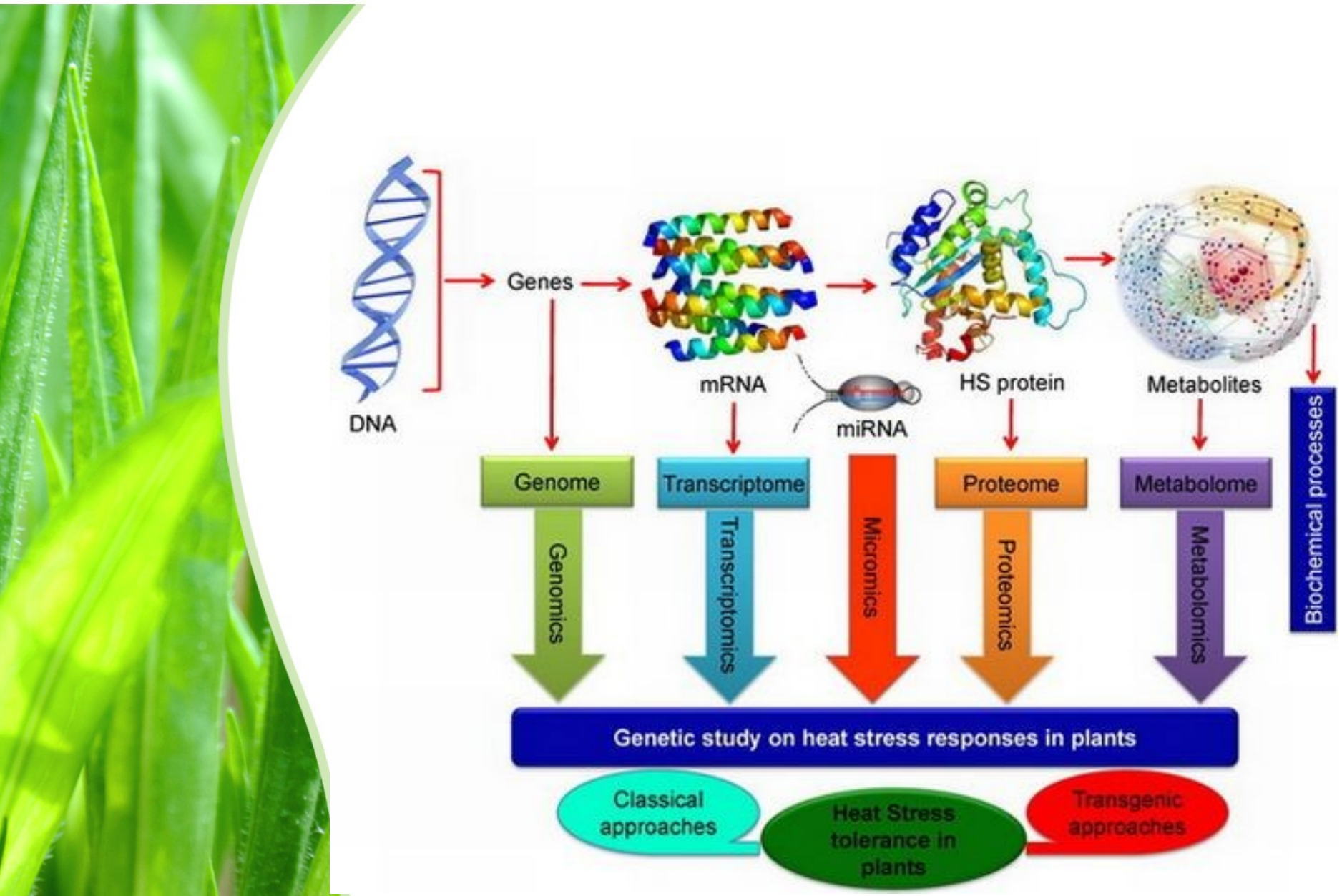
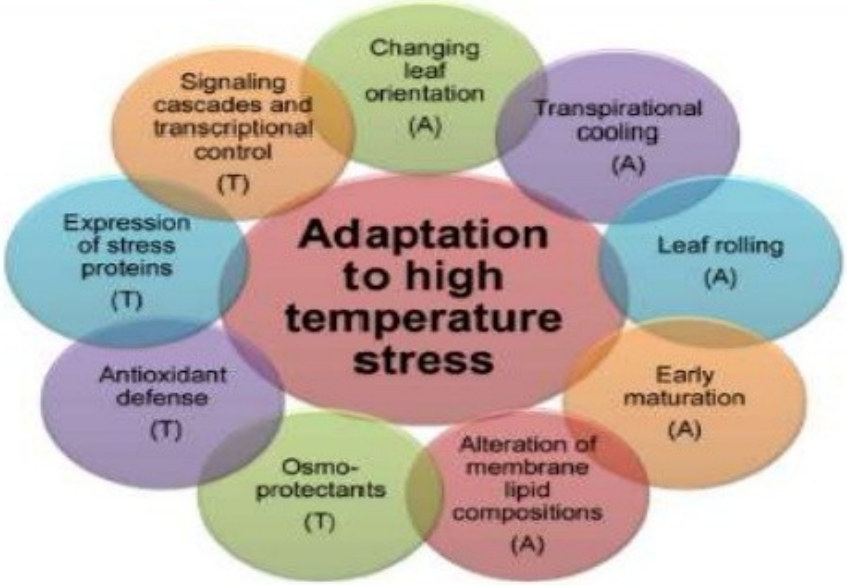
Obecné projevy působení vysoké teploty

Common effects of high tempera

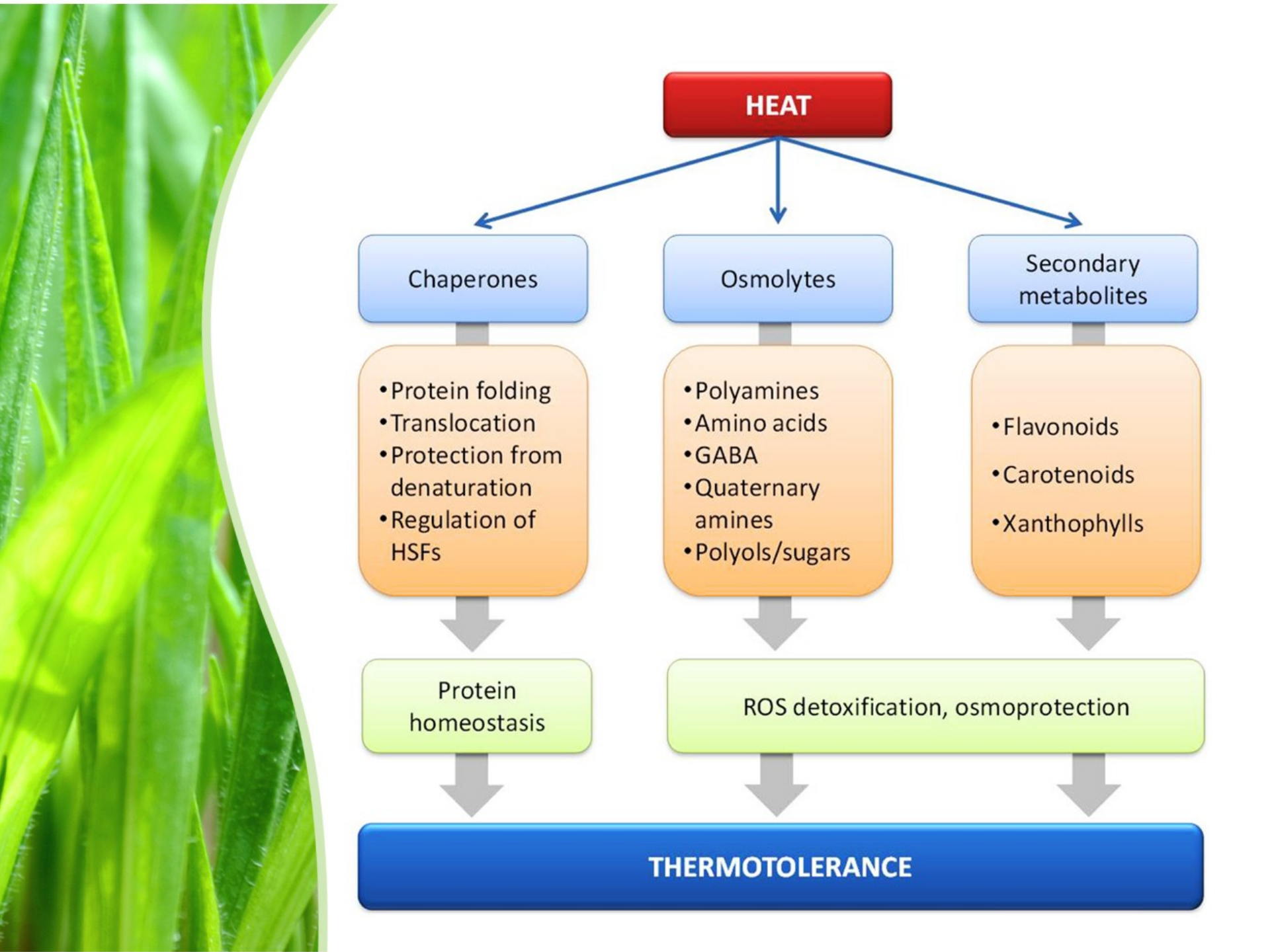

High Temperature
Inhibition of seed germination
Reduction of plant growth
Improper development
Alteration in photosynthe-sis
Alteration in phenology
Alteration in dry matter partitioning
Water loss
Yield reduction
Reduction of crop quality
Oxidative stress

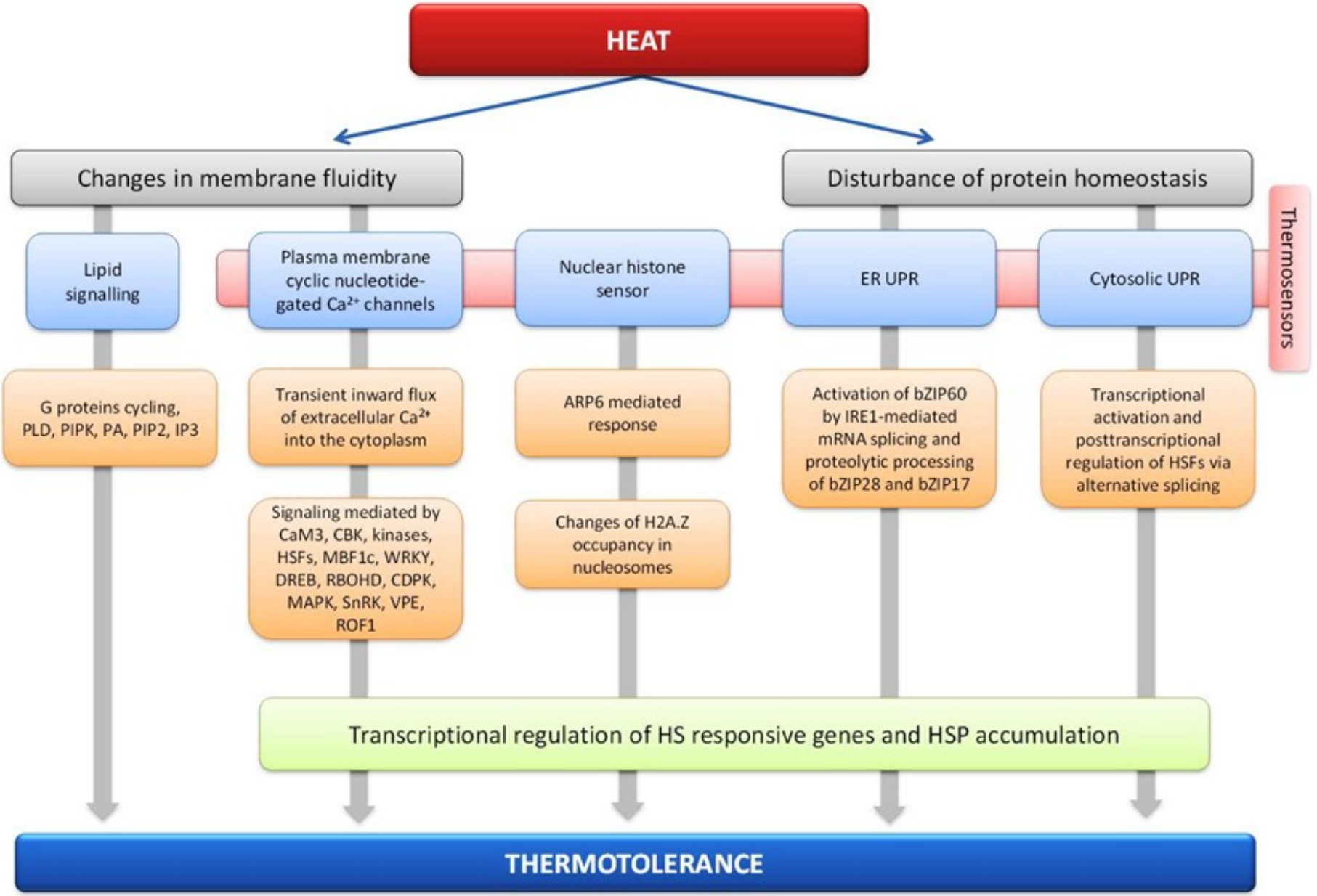

DNA
Genes
mRNA
miRNA
HS protein
Metabolites
Biochemical processes
Genome
Transcriptome
Proteome
Metabolome
Genomics
Transcriptomics
Micromics
Proteomics
Metabolomics
Genetic study on heat stress responses in plants
Classical approaches
Heat Stress tolerance in plants
Transgenic approaches

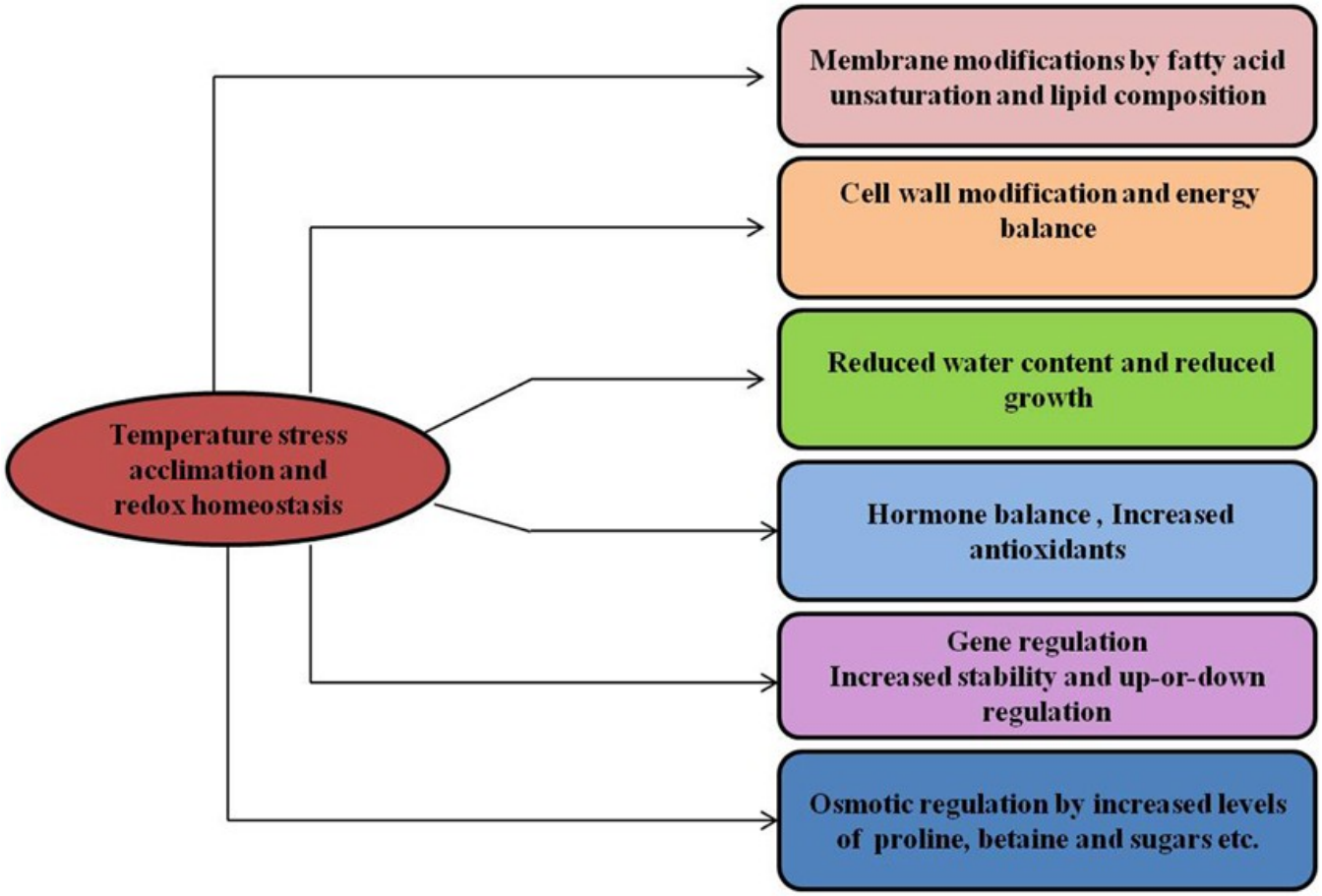
Different adaptation mechanisms of plants to high temperature

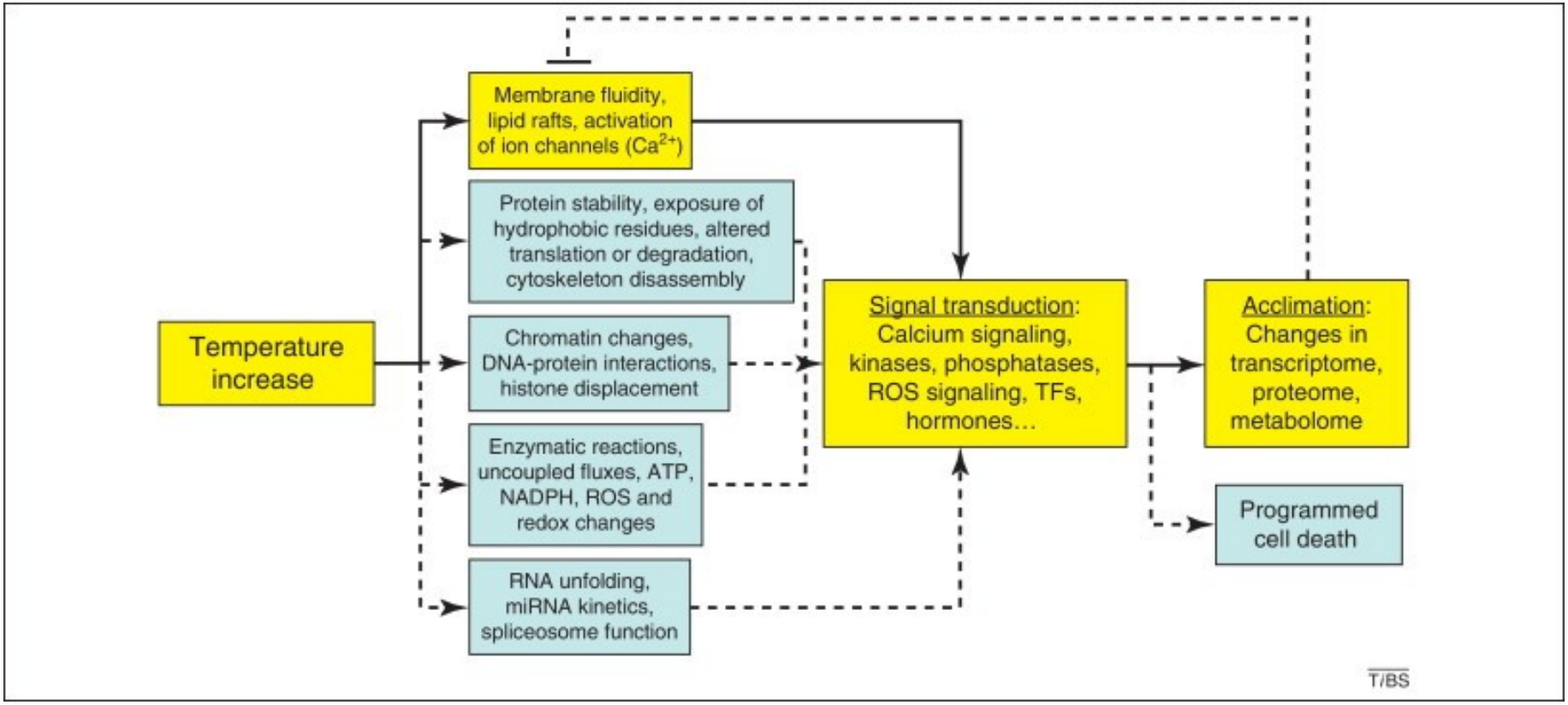


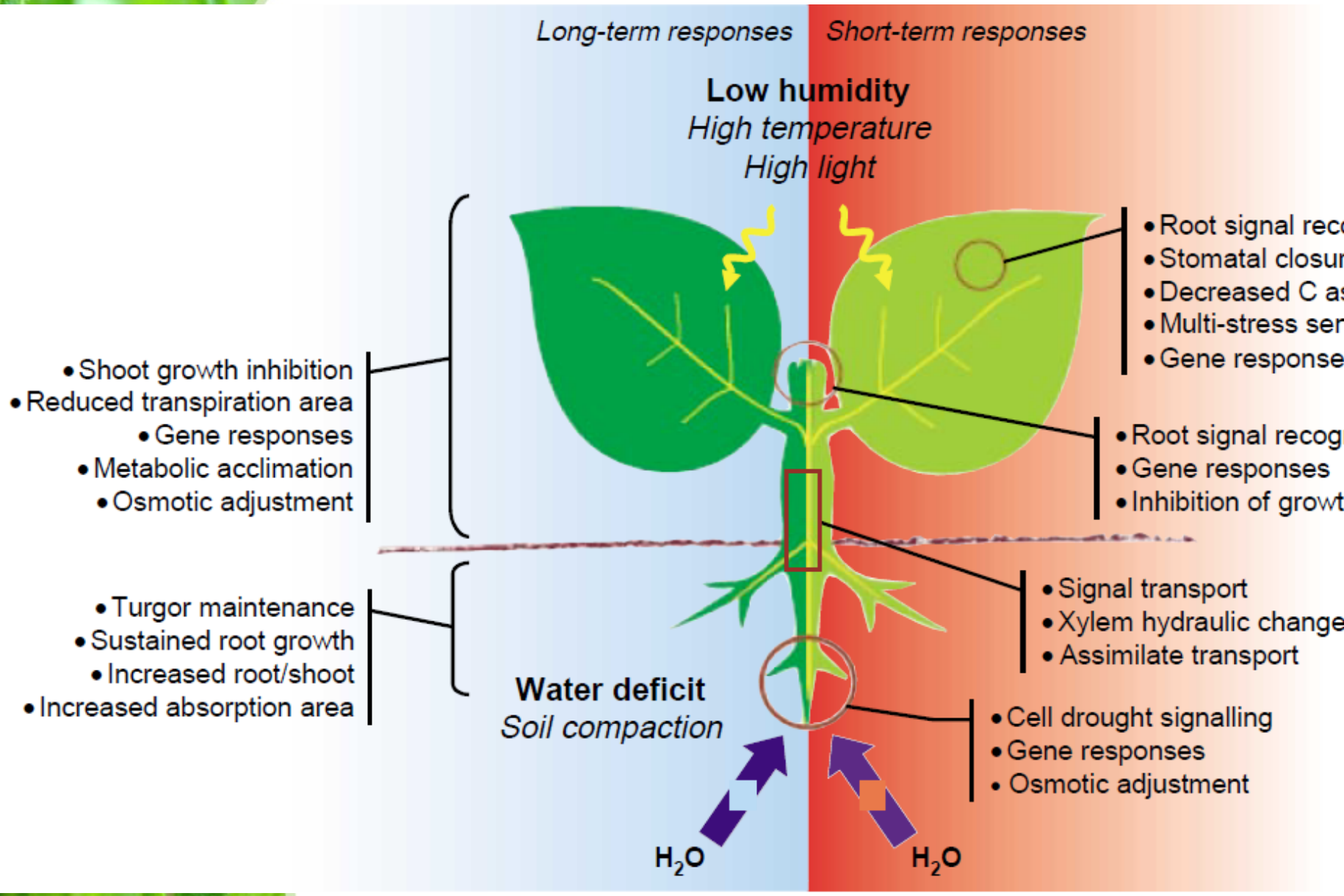
Int. J. Mol. Sci. **2013**,


HEAT
Chaperones
Osmolytes
Secondary metabolites
•Protein folding
•Translocation
•Protection from denaturation
•Regulation of HSFs
•Polyamines
•Amino acids
•GABA
•Quaternary amines
•Polyols/sugars
•Flavonoids
•Carotenoids
•Xanthophylls
Protein homeostasis
ROS detoxification, osmoprotection
THERMOTOLERANCE


HEAT
Changes in membrane fluidity
Disturbance of protein homeostasis
Thermosensors
Lipid signalling
Plasma membrane cyclic nucleotide-gated Ca2+ channels
Nuclear histone sensor
ER UPR
Cytosolic UPR
G proteins cycling, PLD, PIPK, PA, PIP2, IP3
Transient inward flux of extracellular Ca2+ into the cytoplasm
ARP6 mediated response
Activation of bZIP60 by IRE1-mediated mRNA splicing and proteolytic processing of bZIP28 and bZIP17
Transcriptional activation and posttranscriptional regulation of HSFs via alternative splicing
Signaling mediated by CaM3, CBK, kinases, HSFs, MBF1c, WRKY, DREB, RBOHD, CDPK, MAPK, SnRK, VPE, ROF1
Changes of H2A.Z occupancy in nucleosomes
Transcriptional regulation of HS responsive genes and HSP accumulation
THERMOTOLERANCE


Temperature stress acclimation and redox homeostasis
Membrane modifications by fatty acid unsaturation and lipid composition
Cell wall modification and energy balance
Reduced water content and reduced growth
Hormone balance , Increased antioxidants
Gene regulation
Increased stability and up-or-down regulation
Osmotic regulation by increased levels of proline, betaine and sugars etc.


Membrane fluidity, lipid rafts, activation of ion channels (Ca^{2+})
Protein stability, exposure of hydrophobic residues, altered translation or degradation, cytoskeleton disassembly
Chromatin changes, DNA-protein interactions, histone displacement
Enzymatic reactions, uncoupled fluxes, ATP, NADPH, ROS and redox changes
RNA unfolding, miRNA kinetics, spliceosome function
Temperature increase
Signal transduction: Calcium signaling, kinases, phosphatases, ROS signaling, TFs, hormones…
Acclimation: Changes in transcriptome, proteome, metabolome
Programmed cell death
TiBS


Long-term responses
Short-term responses
Low humidity
High temperature
High light
• Shoot growth inhibition
• Reduced transpiration area
• Gene responses
• Metabolic acclimation
• Osmotic adjustment
• Turgor maintenance
• Sustained root growth
• Increased root/shoot
• Increased absorption area
Water deficit
Soil compaction
H2O
H2O
• Root signal rec
• Stomatal closur
• Decreased C as
• Multi-stress ser
• Gene response
• Root signal recog
• Gene responses
• Inhibition of growt
• Signal transport
• Xylem hydraulic change
• Assimilate transport
• Cell drought signalling
• Gene responses
• Osmotic adjustment