

# Potential Caspian Biomarkers

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RF-Akvamiljø



# Choice of Species to Monitor

- Populations at the ecosystem
  - Ecological important population
  - Economical important populations
  - Not migratory
- Species
  - Different life strategies
  - Sensitive
  - Responsive

# Choice of Biomarkers

- Available instrumentation and expertise
- Cost of training
- Relevant in the species to be monitored
- A suite of biomarkers relevant for the expected pollutants
- Start simple and expand gradually

# Validation of Biomarkers

- Controls
  - Normal variation in unpolluted sites
  - Seasonal variations
  - Life cycle variations
- Positive controls
  - Identify scale of response in the species



# QA and Intercalibration

- Intercalibration exercises should be undertaken for all biomarkers
- SOPs should be produced for all biomarkers

# Biomarkers

- **Core biomarkers**
  - **NRR, ACH, MT, EROD & FAC's**
- **Immune function**
- **Oxidative stress**
- **Genotoxicology**
- **Detoxification**
- **Genomics & Proteomics**
- **Histology**
- **Chemical**





Phase I metabolism  
Cyp 1A P450

Detoxification by conjugation  
(Phase II)

Excretion of metabolites

Non-enzymatic anti-oxidants:  
• Glutathione  
• Vitamin C, E  
•  $\beta$ -Carotene

Neutralization and metabolism

Reactive metabolites

Oxidative stress measurements

Xenobiotics

Radical metabolites

DNA adducts

Adduct measurements

Hydroxy radicals

Protein adducts  
(enzyme inactivation)

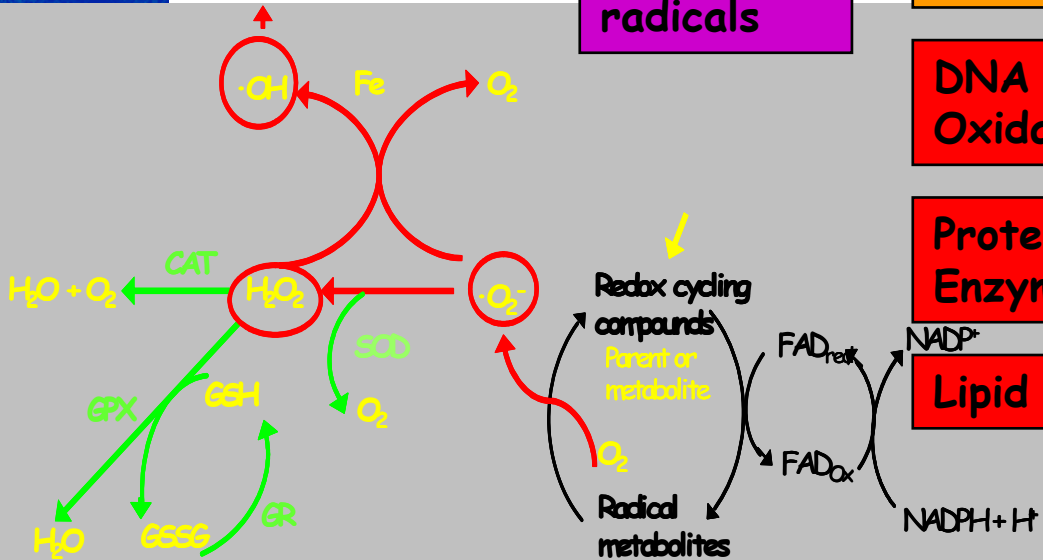
Micronuclei  
Comet assay  
Alkaline unwinding assay

DNA strand breaks  
Oxidation of DNA

Protein oxidation  
Enzyme inactivation

Lipid peroxidation

Accumulation of lipofuscin



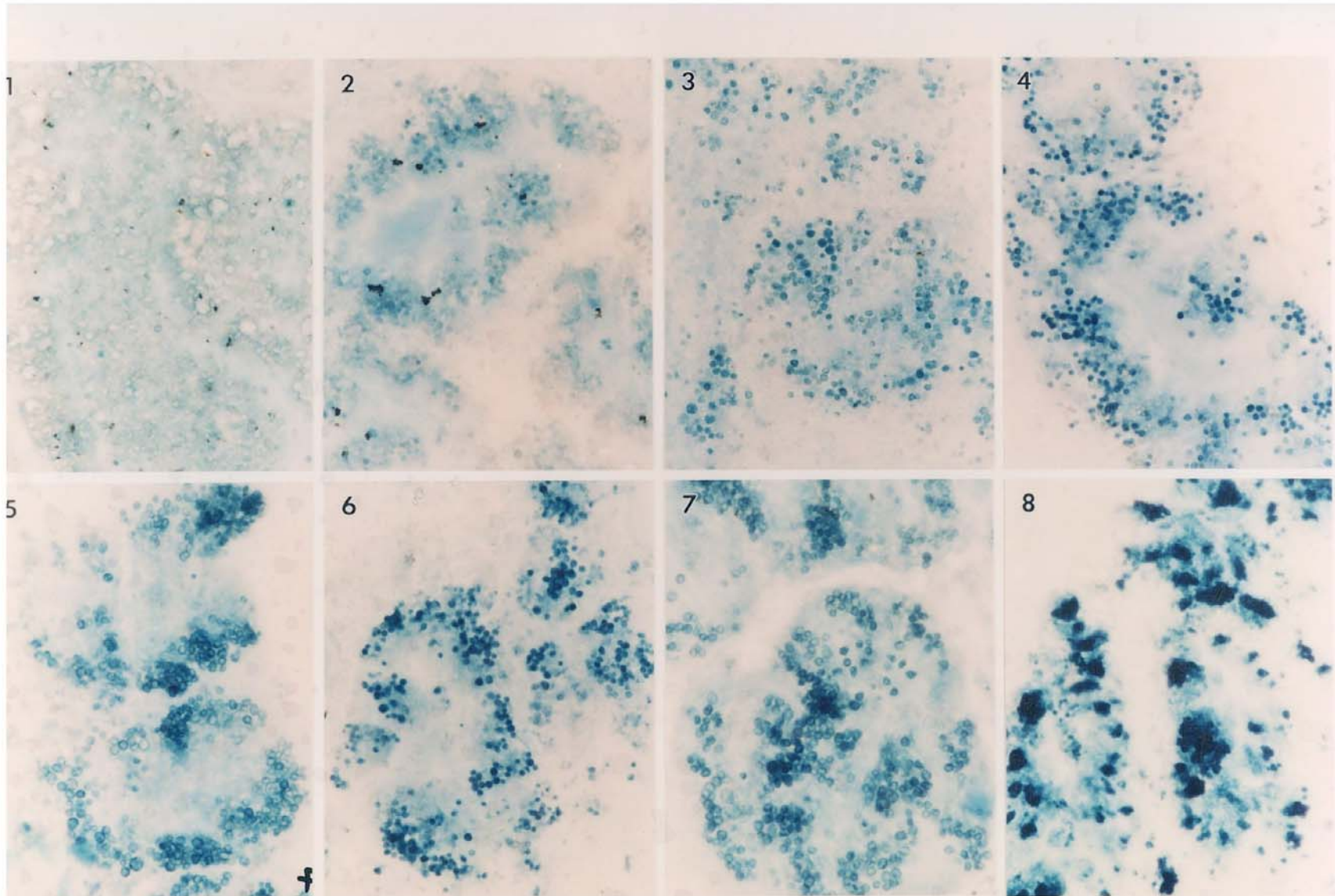
# Biomarkers

- Core biomarkers
- Immune function
- **Oxidative stress**
  - TOSC (Total Oxyradical Scavenging Capacity)
  - Lipid peroxidation
  - GST, Catalase a.o.
- Genotoxicology
- Detoxification
- Genomics & Proteomics
- Histology
- Chemical





# Lipid peroxidation - lipofuscin



# Biomarkers

- Core biomarkers
- Immune function
- Oxidative stress
- **Genotoxicology**
  - **Micronuclei**
  - Alkaline unwinding
  - Comet essay
  - DNA adduct formation
- Detoxification
- Genomics & Proteomics
- Histology
- Chemical



# Biomarkers

- Core biomarkers
- Immune function
- Oxidative stress
- Genotoxicology
- **Detoxification**
  - **Metabolites**
    - **Bile**
    - **Urine**
- Genomics & Proteomics
- Histology
- Chemical



# Biomarkers

- **Core biomarkers**
- **Immune function**
- **Oxidative stress**
- **Genotoxicology**
- **Detoxification**
- **Genomics & Proteomics**
- **Histology**
- **Chemical**
  - **Body burden**
  - **Metabolites**