Faculty of Agricultural and Nutritional Science

Christian-Albrechts-University Kiel
Institute of Animal Breeding and Husbandry

Sperm mitochondrial gene-dependent activity mediate the stress capacity in young and old Holstein bulls

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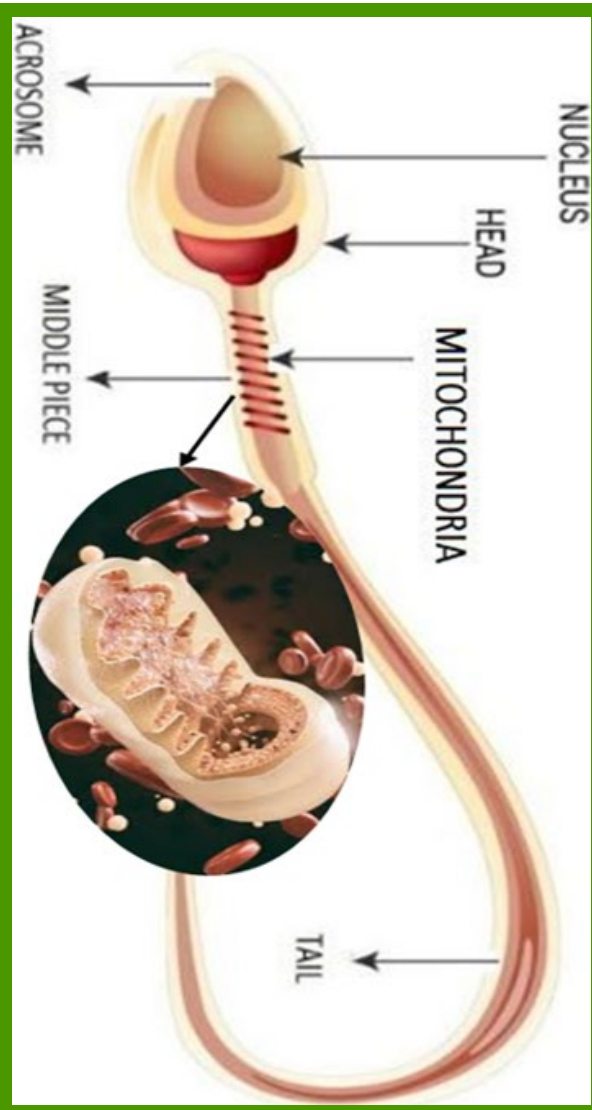
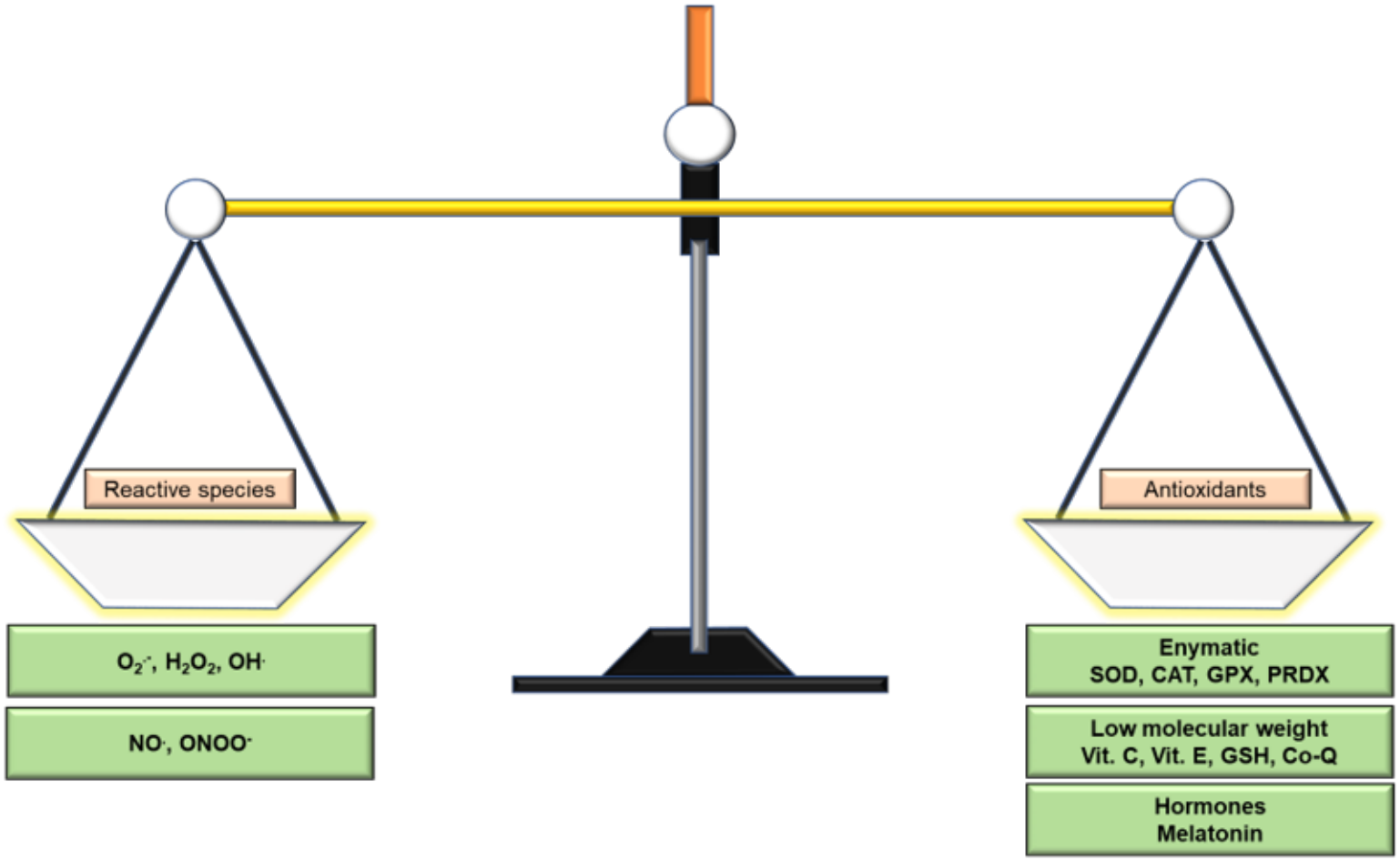


Yentel Mateo-Otero et al. 2024 & Crevis/Shutterstock.com

Oxidative stress

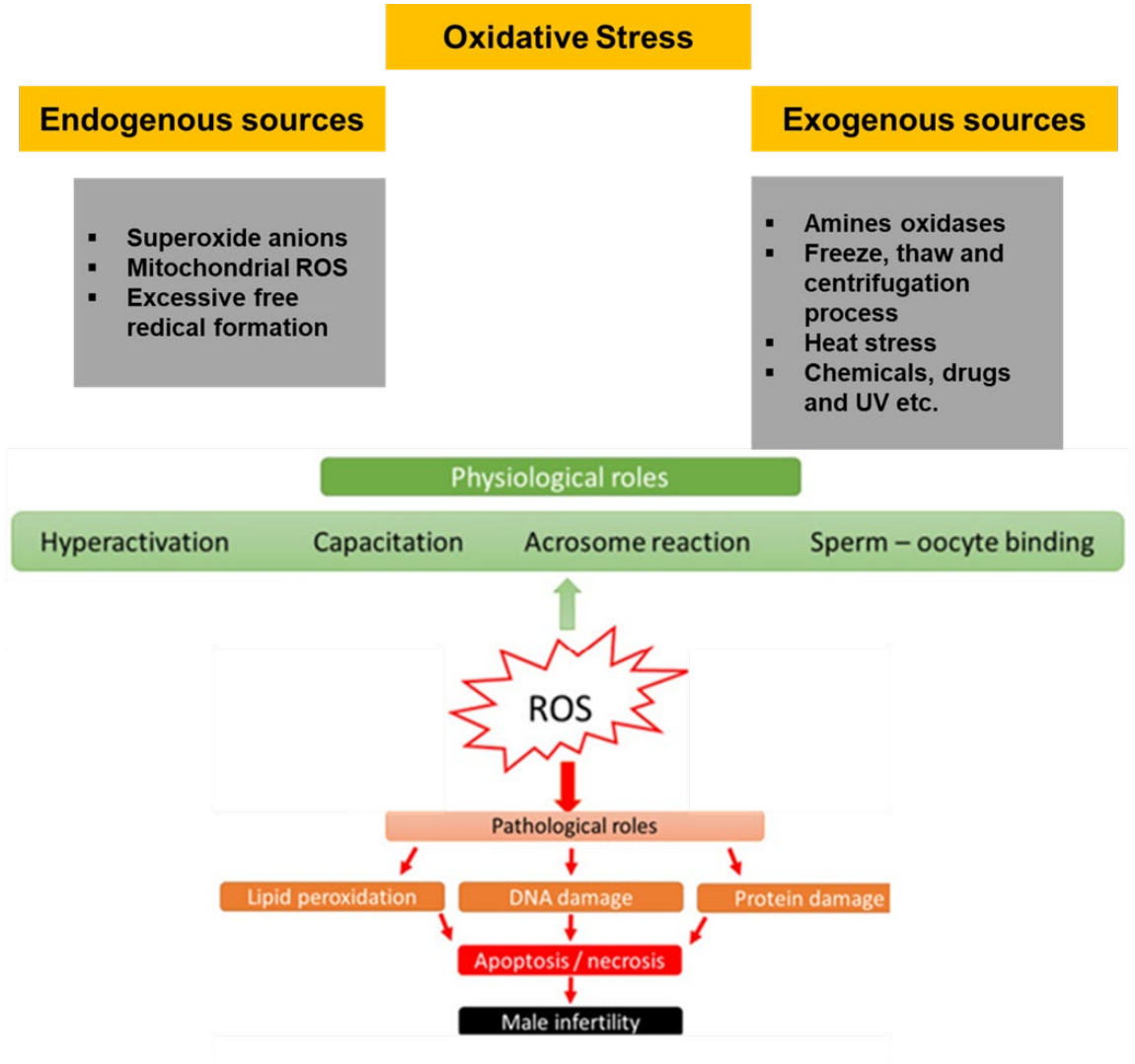
- Oxidative stress is an imbalance between free radicals and antioxidants.



Ramiro-Cortijo et al., 2019

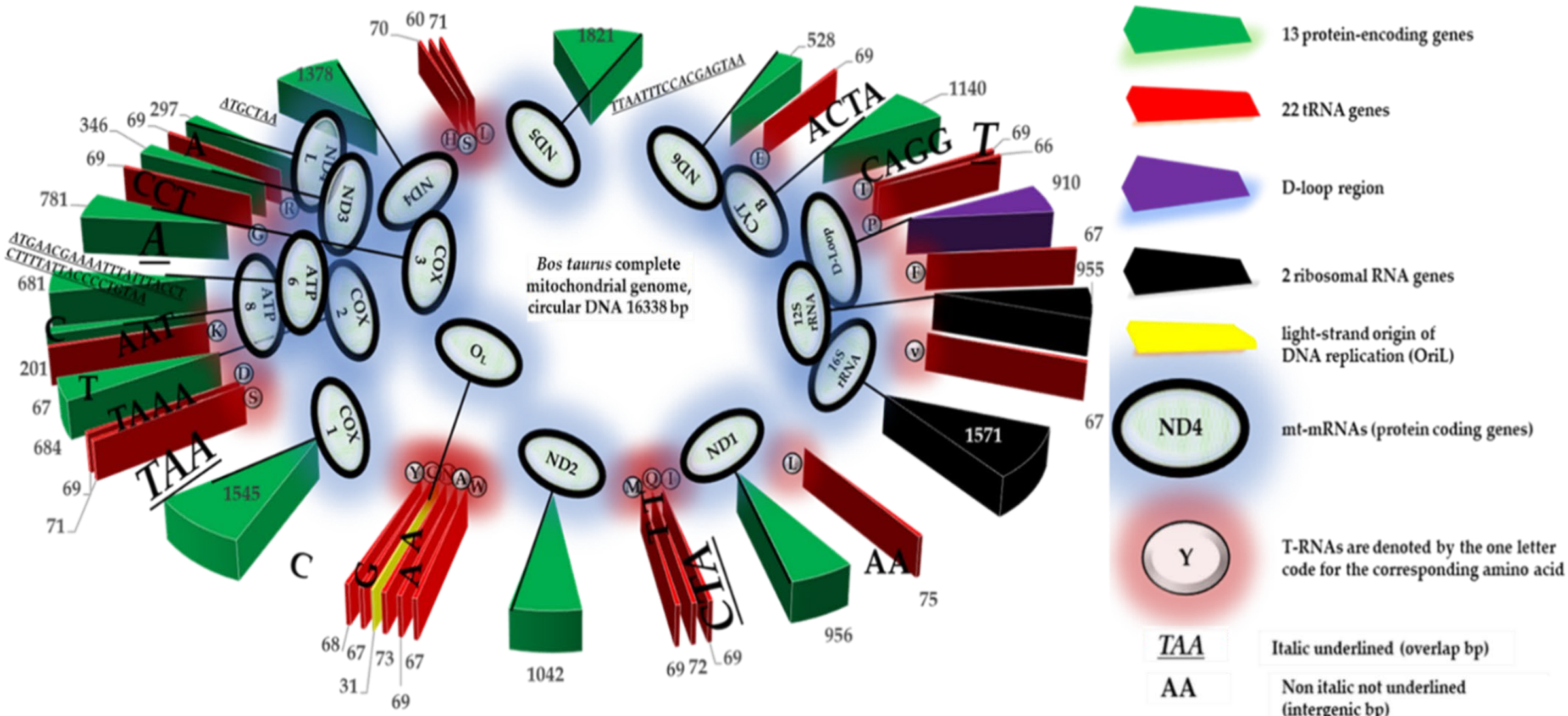
Oxidative stress influences on sperm cells

Spermatozoa utilize both oxidative phosphorylation (OXPHOS); and glycolysis to fulfill their energy requirements.

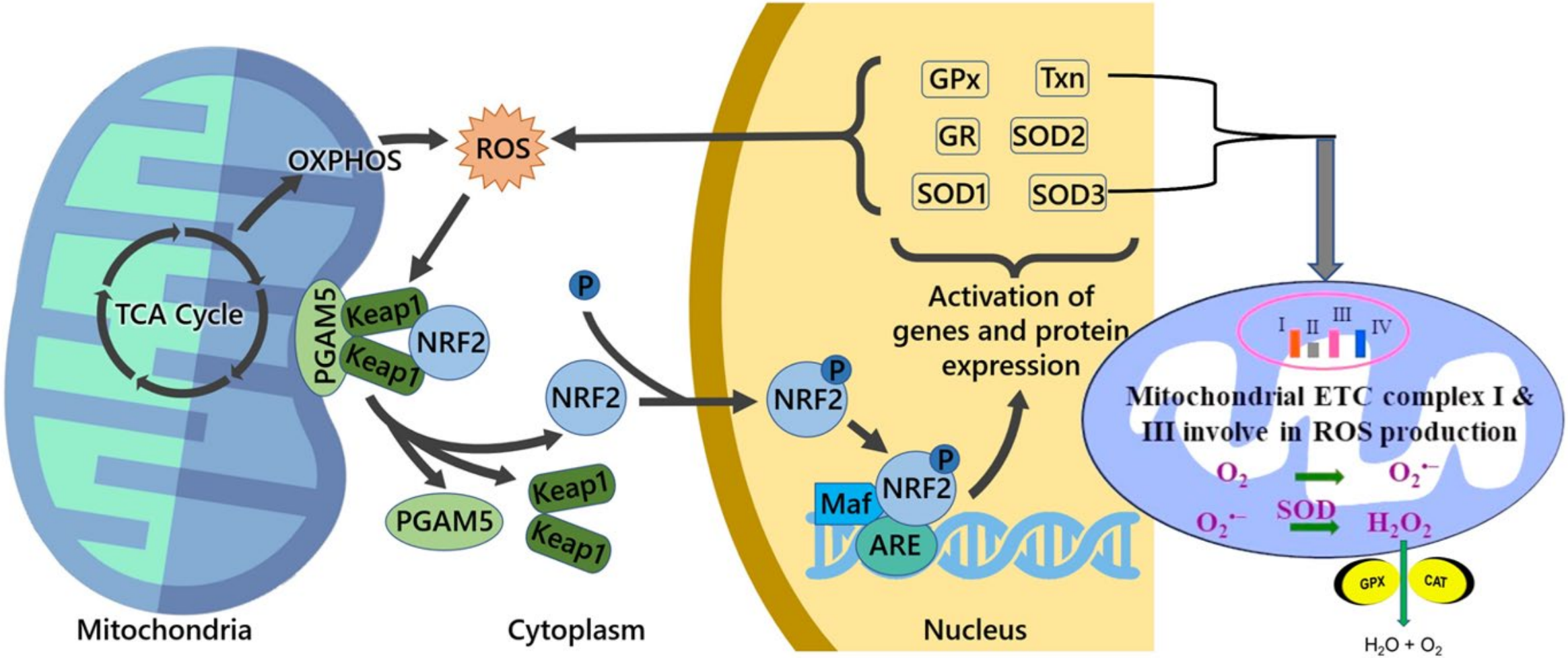


Patricia et al., 2020, Kumaresan et al., 2017, Mauchart et al., 2023

Bos taurus complete mitochondrial genome



Mitochondria as main contributor in stress response



Zheng-Yuan Su et al., 2013

Objectives

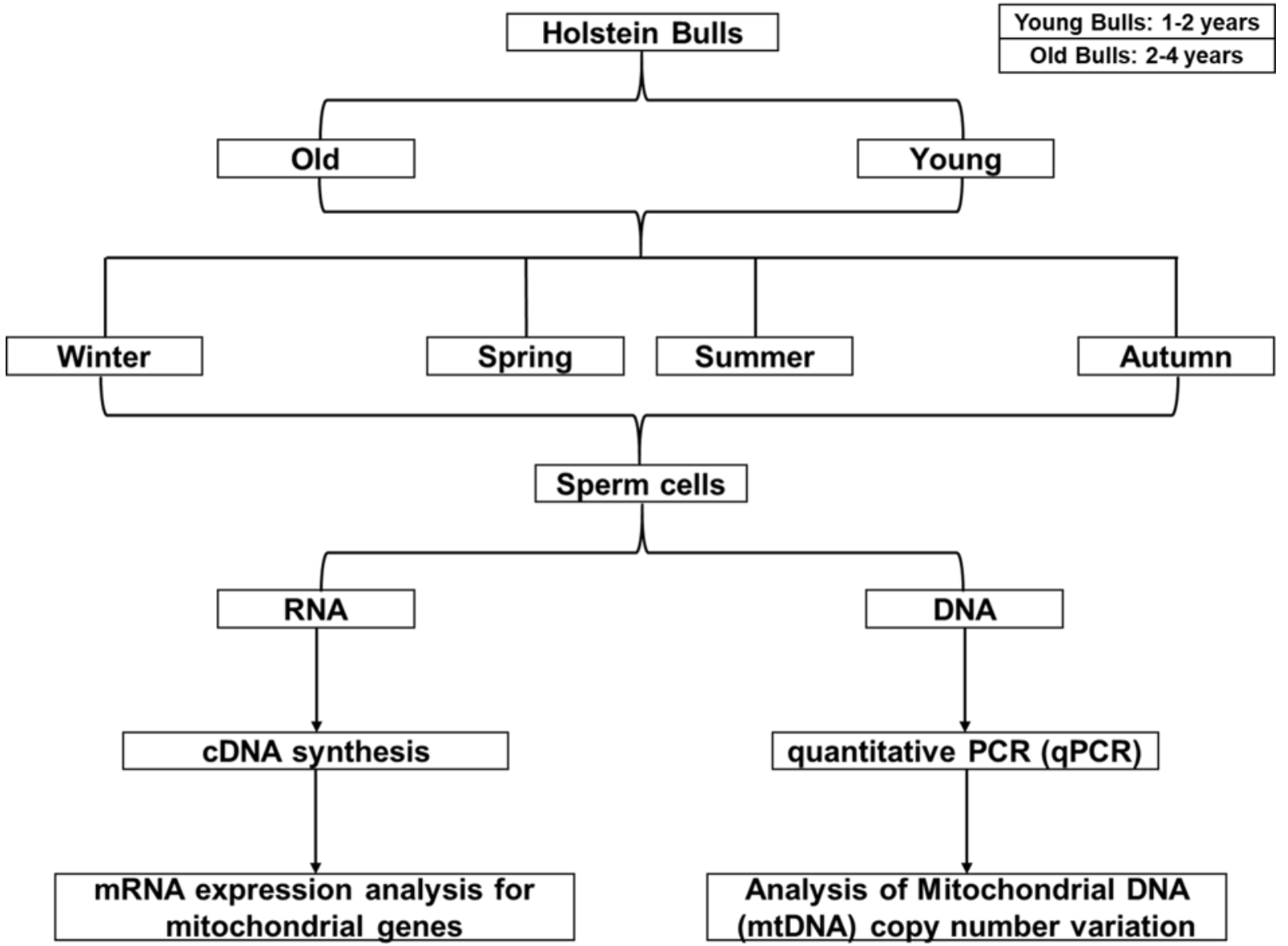
The aims of this study were to:

1. **Investigate the transcription profile of the sperm-borne mitochondrial protein-coding genes (MPCGs) in old and young bulls under different seasons**

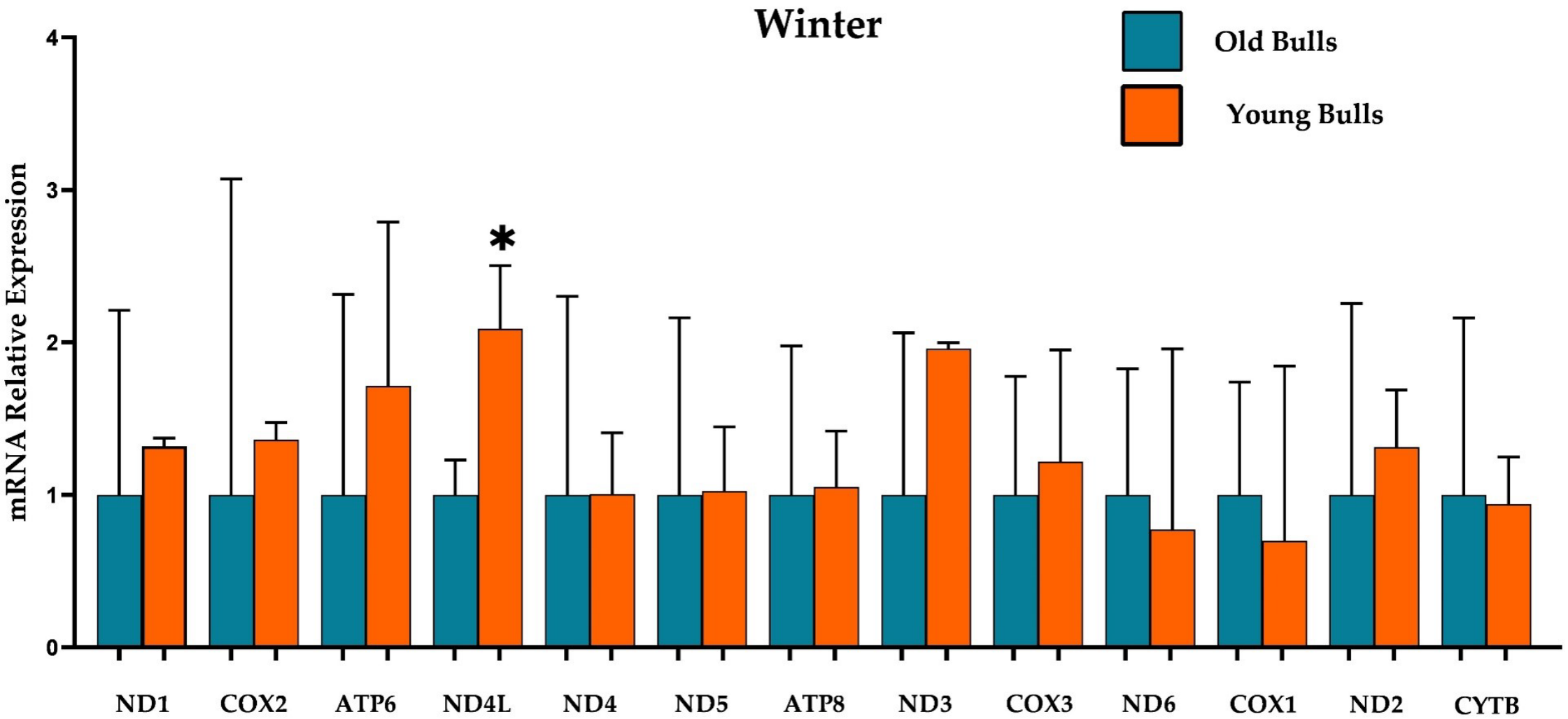
2. **Investigate mitochondrial marker genes for stress tolerance in sperm**

3. **Assessing and linking mtDNA copy number to gene expression and understanding their regulation**

Experimental design

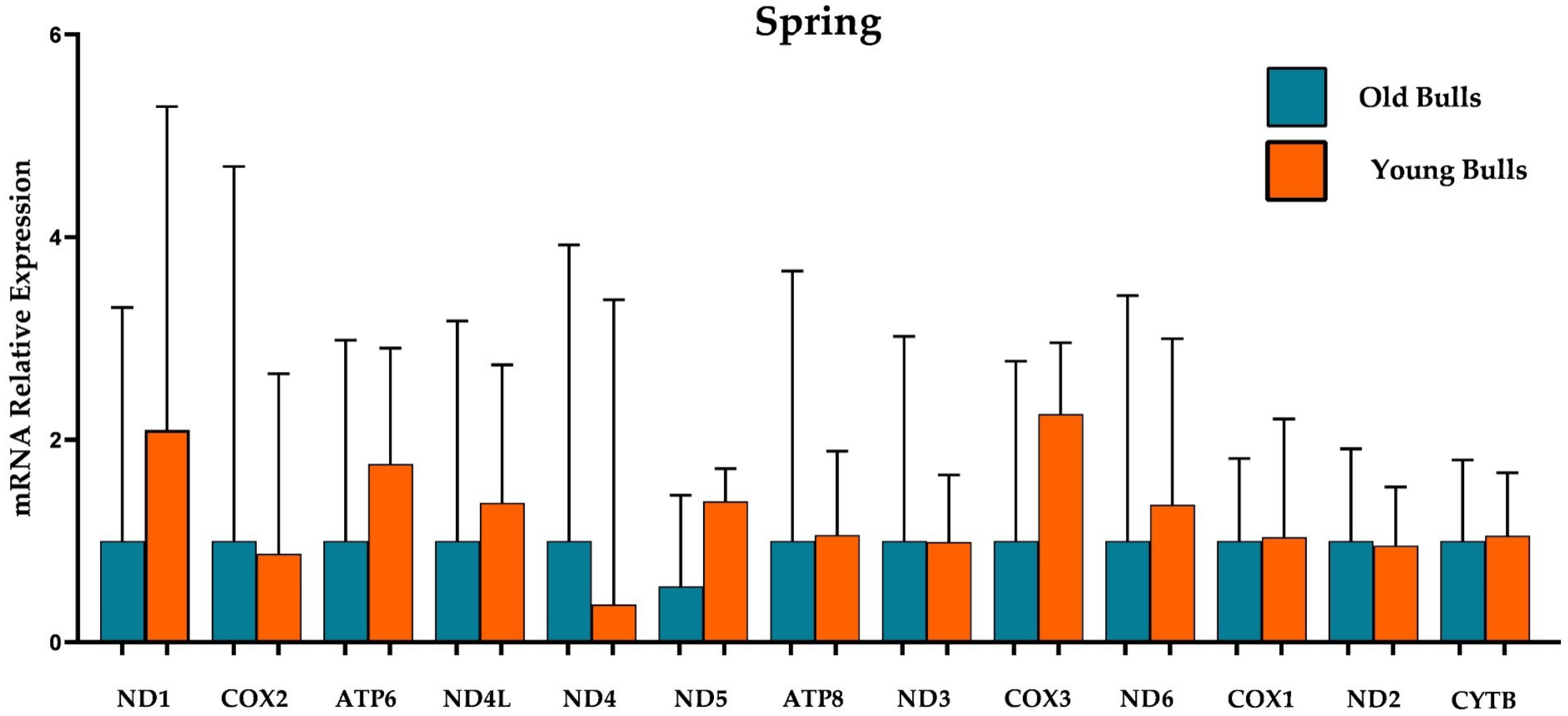


ND4L, ND3 and ATP6 were upregulated in young bulls in winter season



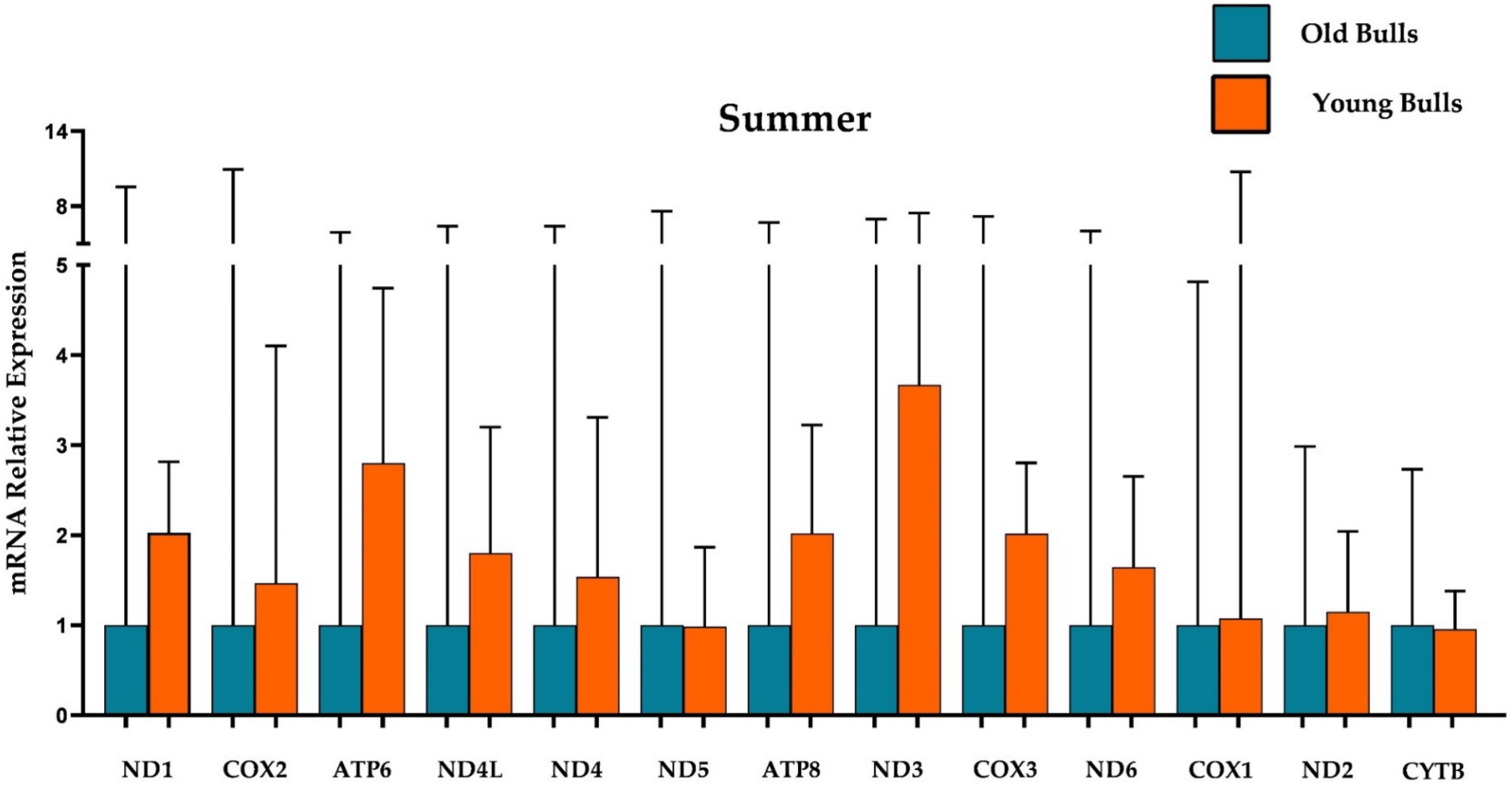
MT-ND1 (NADH Oxidoreductase Core Subunit 1), MT-ND2, MT-ND3, MT-ND4, MT-ND4L, MT-ND5, MT-ND6, MT-CYB (Cytochrome B), MT-CO1, MT-CO2, MT-CO3 (Cytochrome C Oxidase Subunits I, II, III), MT-ATP6, and MT-ATP8 (ATP Synthase Membrane Subunits 6, 8). . Values are presented as geometric mean with geometric ± SD. *p<0.05, significant difference.

ND1, ATP6, ND5, and COX3 showed up-regulation in spring season in young bulls



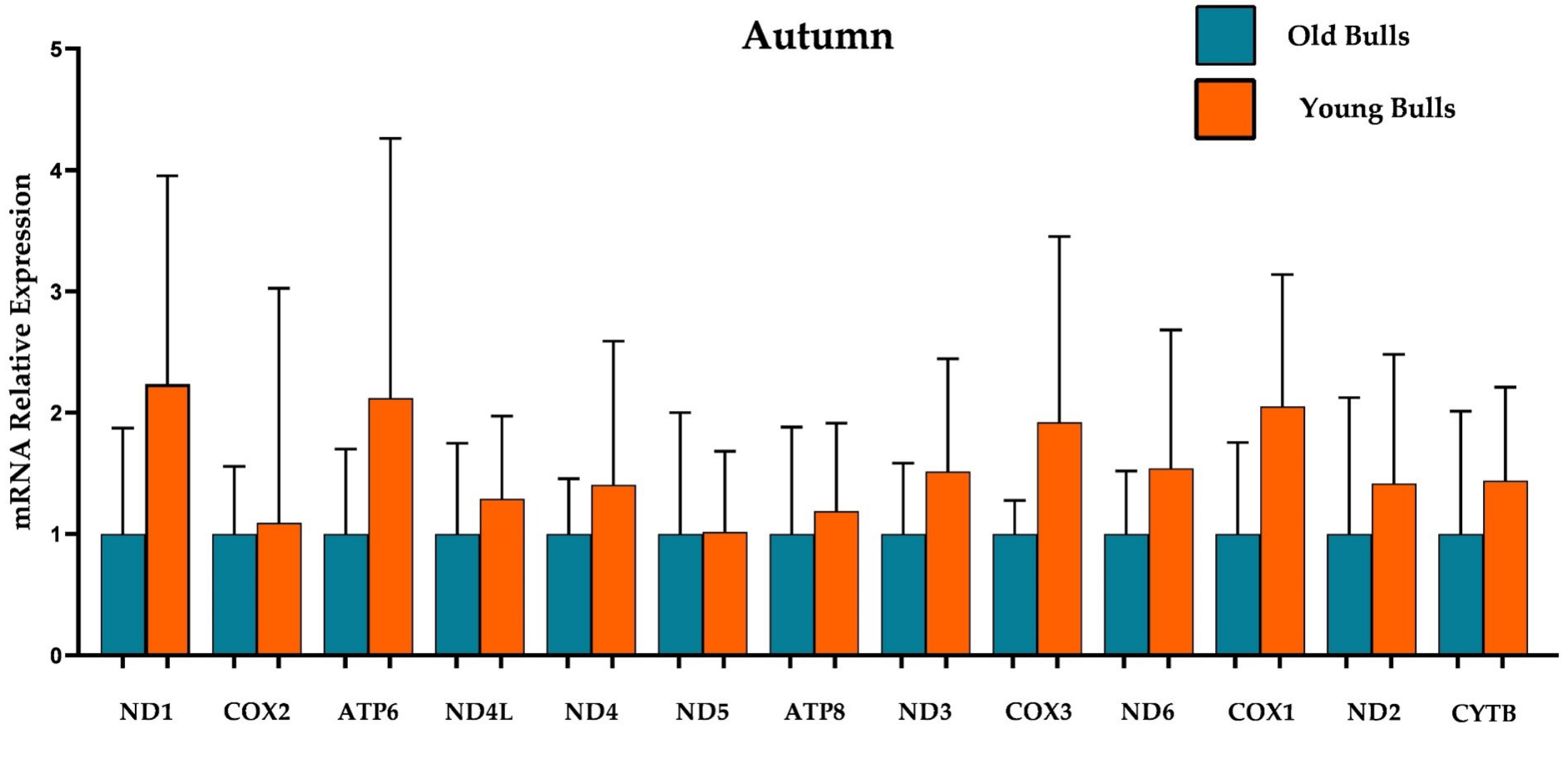
MT-ND1 (NADH Oxidoreductase Core Subunit 1), MT-ND2, MT-ND3, MT-ND4, MT-ND4L, MT-ND5, MT-ND6, MT-CYB (Cytochrome B), MT-CO1, MT-CO2, MT-CO3 (Cytochrome C Oxidase Subunits I, II, III), MT-ATP6, and MT-ATP8 (ATP Synthase Membrane Subunits 6, 8). . Values are presented as geometric mean with geometric ± SD.

Except for ND5, COX1, and CYTB all mt-genes were up-regulated in young bulls during the summer season



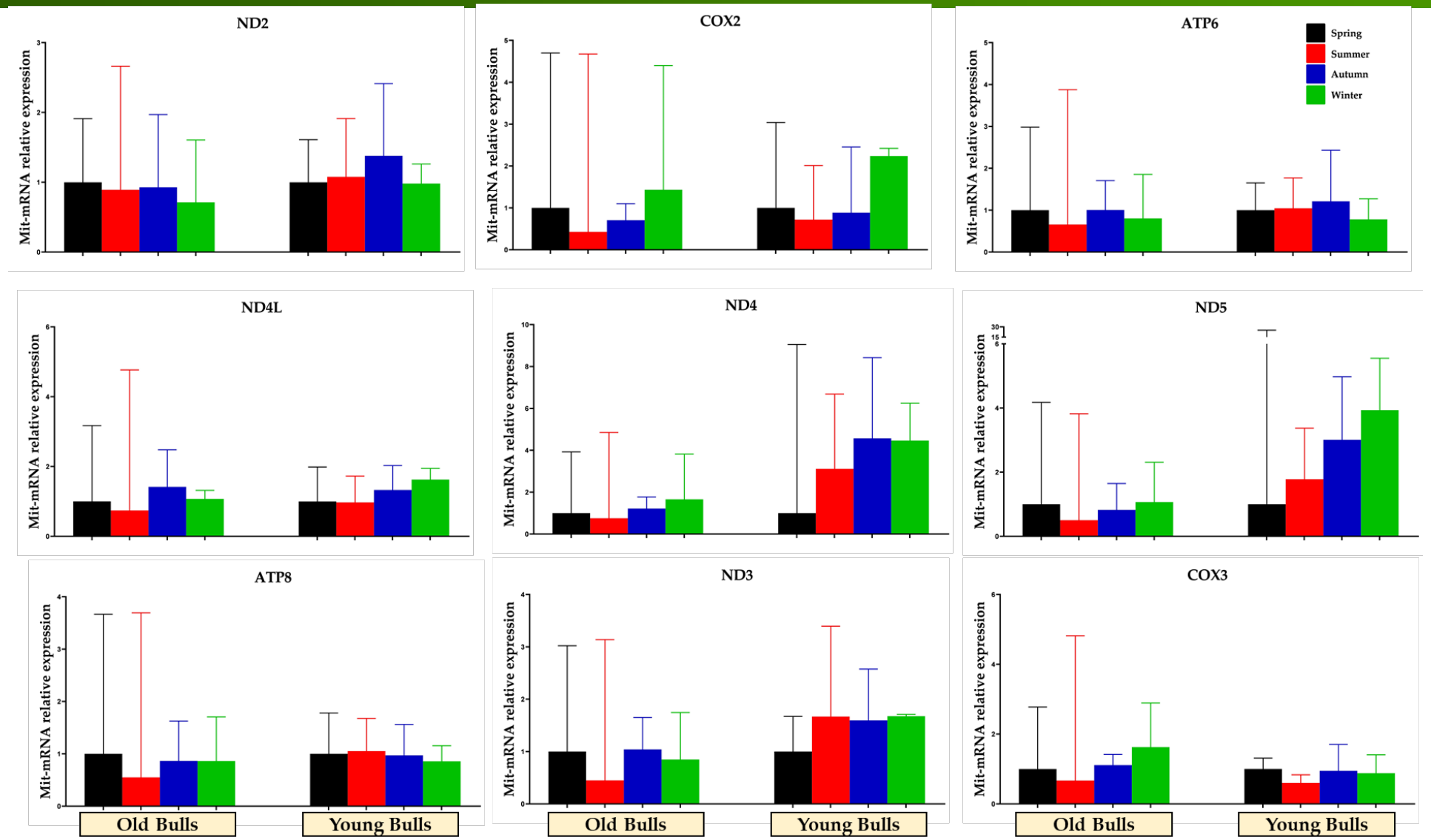
MT-ND1 (NADH Oxidoreductase Core Subunit 1), MT-ND2, MT-ND3, MT-ND4, MT-ND4L, MT-ND5, MT-ND6, MT-CYB (Cytochrome B), MT-CO1, MT-CO2, MT-CO3 (Cytochrome C Oxidase Subunits I, II, III), MT-ATP6, and MT-ATP8 (ATP Synthase Membrane Subunits 6, 8). . Values are presented as geometric mean with geometric ± SD.

ND1, ATP6, COX3 and COX1 were up-regulated in autumn season in young bulls



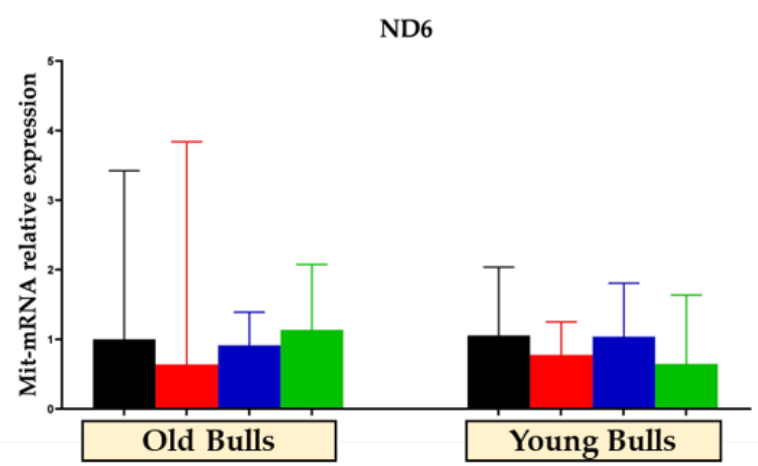
MT-ND1 (NADH Oxidoreductase Core Subunit 1), MT-ND2, MT-ND3, MT-ND4, MT-ND4L, MT-ND5, MT-ND6, MT-CYB (Cytochrome B), MT-CO1, MT-CO2, MT-CO3 (Cytochrome C Oxidase Subunits I, II, III), MT-ATP6, and MT-ATP8 (ATP Synthase Membrane Subunits 6, 8). . Values are presented as geometric mean with geometric ± SD.

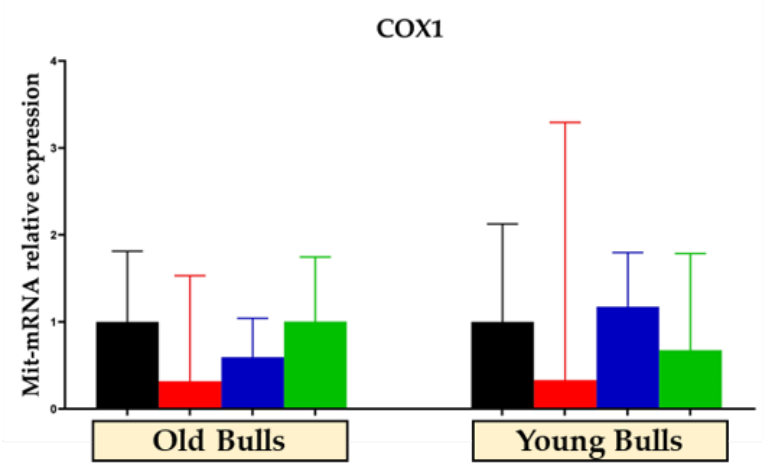
COX2 and ATP6 revealed the same pattern in young and old bulls

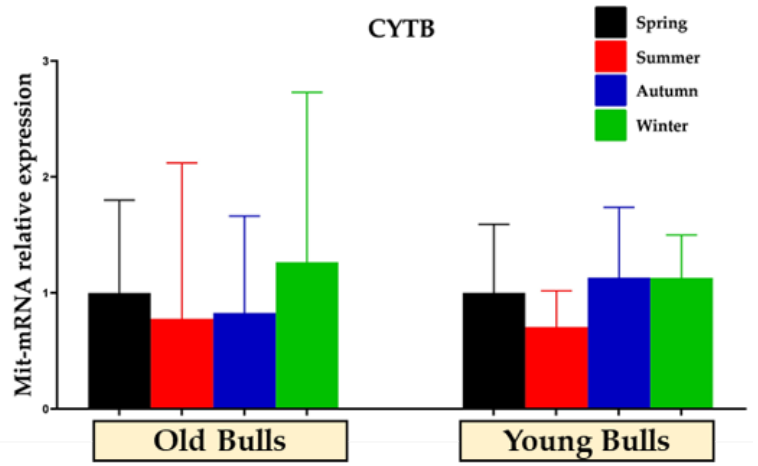


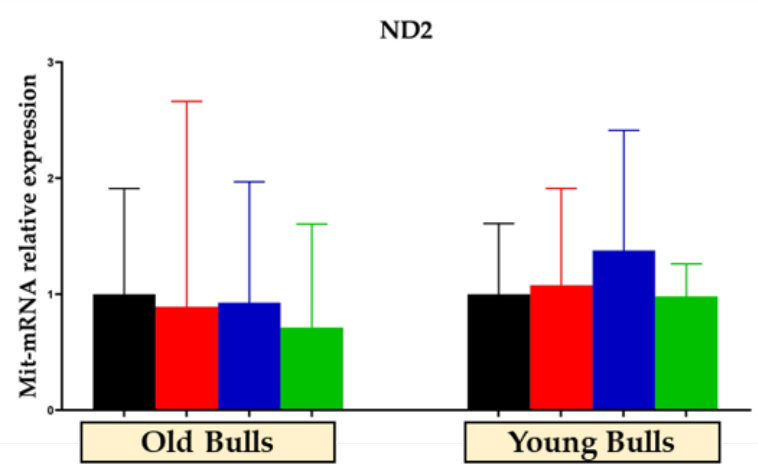
MT-ND2 (NADH Oxidoreductase Core Subunit 2), MT-ND3, MT-ND4, MT-ND4L, MT-ND5, MT-CO2, MT-CO3 (Cytochrome C Oxidase Subunits I, II, III), MT-ATP6, and MT-ATP8 (ATP Synthase Membrane Subunits 6, 8). . Values are presented as geometric mean with geometric ± SD. *p<0.05, significant difference.

CYTB and ND2 showed the same pattern in old and young bulls



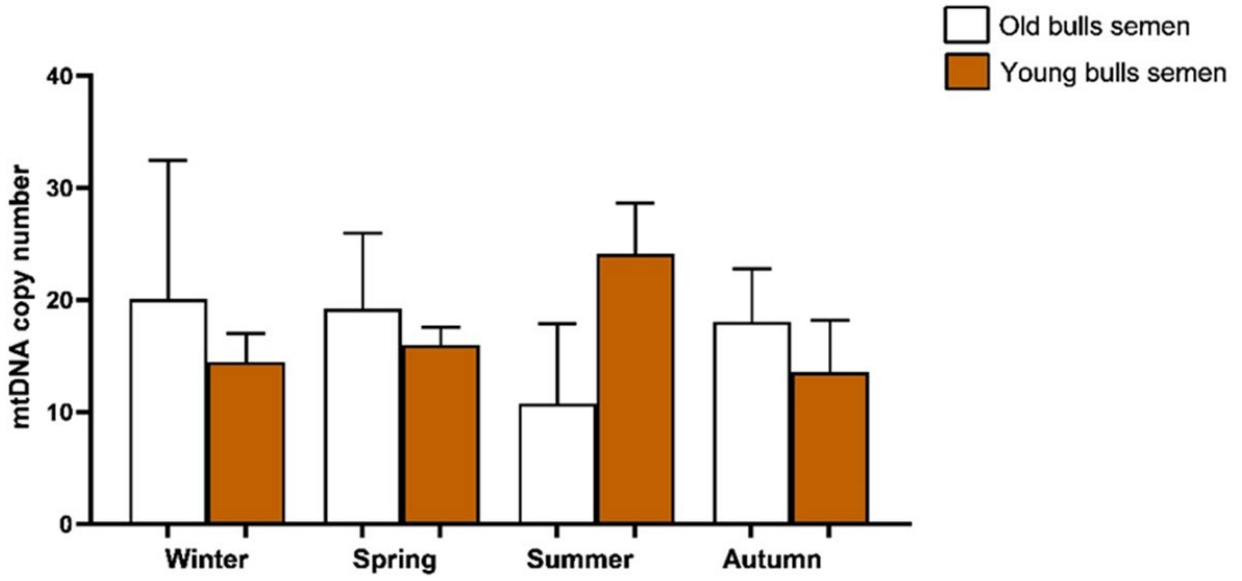


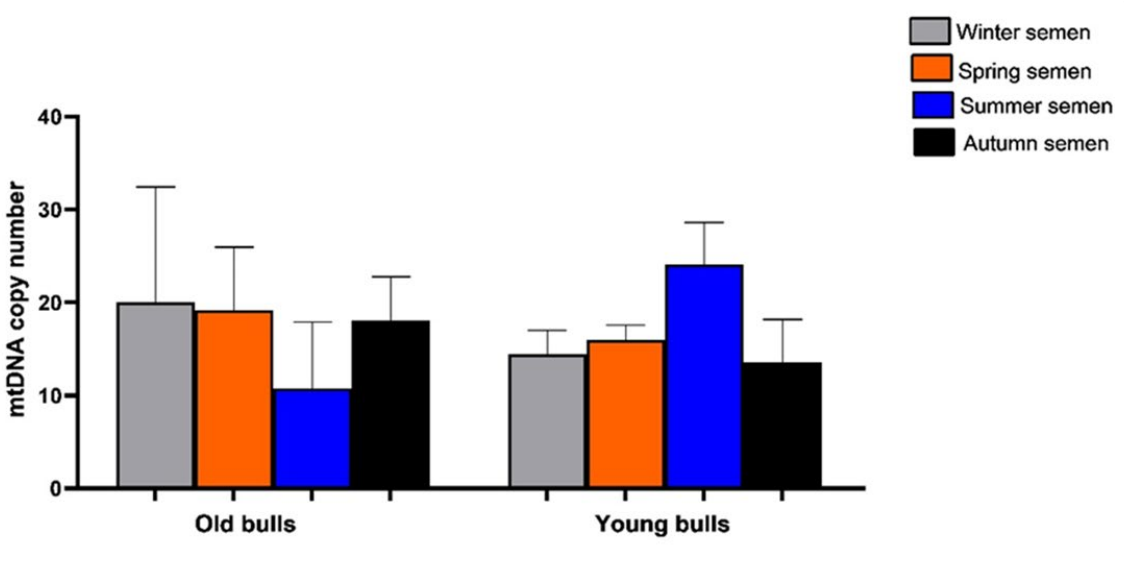




MT-ND2 (NADH Oxidoreductase Core Subunit 2), MT-ND3, MT-ND4, MT-ND4L, MT-ND5, MT-CO2, MT-CO3 (Cytochrome C Oxidase Subunits I, II, III), MT-ATP6, and MT-ATP8 (ATP Synthase Membrane Subunits 6, 8). . Values are presented as geometric mean with geometric ± SD.

Higher Mt-DNA Copy number in young bulls' spermatozoa during summer season





Data are mean ± SE

Summary and Take-home message

- ND1, ND3, ND4L ATP6, COX1, and COX3 were highly expressed in young bulls throughout the year
- Among the above genes ND4L expressed significantly higher in young bulls
- Mt-DNA copy number is linked with the up-regulation of mt-coding genes in young bulls during the summer season

ND4L can be considered as one of the marker mitochondrial genes for further validation in responses to stress tolerance

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Thank you for your attention