In our lab we are integrating tools in molecular and evolutionary biology, genomics and biochemistry to study the evolution of chromatin and genome architecture.

Our current research focuses on centromeres - specialized chromosomal regions, which enable the assembly of the kinetochore protein complex and the attachment of spindle microtubules to ensure the faithful segregation of sister chromatids during cell division. Paradoxically to this essential function it is surprising that different strategies of centromere organization have evolved. While most eukaryotes have monocentric chromosomes where spindle attachment is restricted to a single chromosomal region resembling such classic X-shape like structures under the microscope, many lineages have evolved holocentric chromosomes where spindle microtubules attach along the entire length of the chromosome. Though holocentromeres have been known since more than 70 years the evolutionary transition from monocentromeres to holocentromeres has remained enigmatic ever since.

MOLECULAR ARCHITECTURE OF CENH3-DEFICIENT HOLOCENTROMERES

We found that the histone H3 variant, CENH3/CENP-A presumed to be the defining component of centromeres in most eukaryotes has been lost in independently derived holocentric insects. These findings raise the questions how those CenH3-deficient organisms define their centromeres? Using genomics we map and characterize the molecular architecture of CenH3-deficient holocentromeres in Lepidoptera (butterflies and moths), thereby also providing insights into the evolutionary transition to their holocentric architectures (Senaratne et al. 2020, Current Biology).
ASSEMBLY OF CENH3-DEFICIENT KINETOCHORES IN LEPIDOPTERA

CENH3/CENP-A functions as the cornerstone enabling kinetochore assembly in most eukaryotes. To address how CenH3-deficient kinetochores form we use proteomic and cell biological approaches in lepidopteran cell lines and in vivo models. We have recently identified several conserved kinetochore components including CENP-T that emerged as a key component for CenH3-deficient kinetochore formation in Lepidoptera. See also Cortes-Silva et al., Current Biology, 2020.
SPATIAL ORGANIZATION OF HOLOCENTRIC CHROMOSOMES

Centromeres have a strong impact on spatial genome organization. Using Hi-C we determine how holocentric chromosomes are organized within the nucleus. To learn more see Muller et al. Trends in Genetics, 2019
EVOLUTION TO CENH3-DEFICIENT HOLOCENTROMERES ACROSS INSECTS

Using comparative genomics we study the evolution of kinetochore components in CenH3-deficient and encoding insects. In addition we aim to evaluate the impact of holocentric architecture on chromosome segregation.
Evolution of centromeres and chromosome segregation

UMR3664 - Nuclear Dynamics