Introduction to RNA structure and function
RNA classification

**Messenger RNA:**
- Carry genetic information,
- Structure less important.

**Non-coding RNA:**
- Functional,
- Structure is important.
Cellular functions of RNA

Genetic Functions:
- Messenger RNA
- Viroids
- Transfer RNA

Enzymatic functions:
- Splicing (snRNA)
- RNA Maturation (ribonuclease P)
- Ribosomic RNA
- Guide RNA (snoRNA)
RNA structure and function

- RNAs have a 3D structure,
- This 3D structure allows complex functions,
- The variety of RNA structures allow the specific recognition of a wide range of ligands,
- Some molecules target these RNA structures (antibiotics, antiviruses):

- Linezolid
- Doxycyclin
- Sparsomycin
- Chloramphenicol
Ribonucleotides

- Nitrogenous bases
- Ribose
- Phosphate
RNA vs DNA

- RNA is a short linear molecule
  DNA long ≠ RNA short

- RNA are usually single stranded
  ADN double stranded ≠ ARN single stranded

- « turnover » relatively fast
  ADN stable ≠ ARN versatile
RNA vs DNA: Chemical nature

- 2’-OH group attached to sugar (instead of 2’-H): more polar
- Substitution of thymine by uracil = suppression of group 5-CH3

Small modifications => big effects
RNA vs DNA: Modification of the local and global geometry

Local conformation:
- C2’ endo
- C3’ endo

Global conformation:
- RNA favorite: [diagram]
- DNA favorite: [diagram]
RNA vs DNA: Consequence of the modification of the geometry

Small furrow is flat
Big furrow is deep
RNA vs DNA: RNA-Protein and DNA-Protein interactions are different

**DNA-Protein:** Secondary structure elements insert in big furrow

**RNA-Protein** interaction are more specific. Usually using less structured regions.
Central assumption: RNA secondary structure forms before the tertiary structure.

Secondary structure prediction is an important step toward 3D structure prediction.
Base pairing in RNAs

- As in DNA, bases can interact through hydrogen bonds.
- Beside the 2 canonical base-pairs, RNA allows “Wooble” (G-U) base-pairs.
- A-U and G-C are “isosterus” while G-U induce a distortion of the backbone.
RNA secondary structure

The secondary structure is the ensemble of base-pairs of the structure.
RNA secondary structure representations

Brackets

..((((((((....((....)))..((((....))))..)))))))))

Circular

Classical

Dot plot
Modeling RNA secondary structure

- Read from left to right
- The last open parenthesis is paired with the next closed parenthesis
- Dots are unpaired nucleotides
RNA Nomenclature

Hairpin

Bulge

Multi-Loop

Internal Loop

Stem

Exterior Loop

CUAGCAGUCAGUGUCAGACUGCAACAGCACACUAGCAGUGUCAGACUGCAACAGCACGACACUAGCAAGUGUCA

(((((((((((((((((((((........)))))))))))))))))))))))))))))))))))))))))))))))

5'  

3'
Loop decomposition

- Hairpin loop
- Bulge loop
- Interior loop
- Multibranched loop
- Unconstrained single-stranded region

Base pairs?
Stacking pairs!!
RNA secondary structure description

A secondary structure can be decomposed in a sequence of loops:

- **Hairpin**
- **Stack**
- **Bulge**
- **Internal loop**
- **Multi-loop**

- : Sequence neighbors
- : Spatial neighbors