

RNA Secondary Structures and Their Analysis

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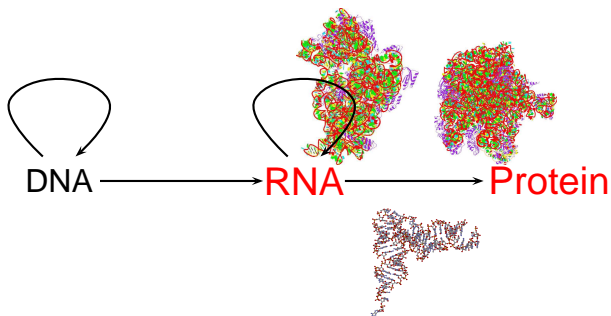
Dept. of Statistics, Oxford Univeristy

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Outline

- 1 RNA Genes – What, Where and Why
- 2 RNA Structure

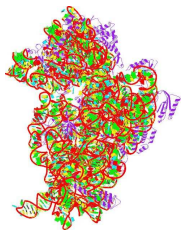
Central Dogma



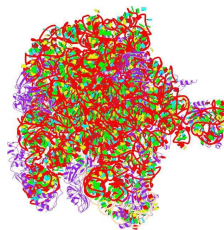
Genetic material stored in DNA, functional in proteins

But RNA crucial in translation and some viruses use RNA for storage

Ribosome



30S subunit

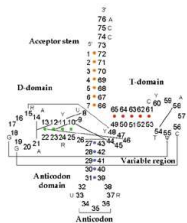
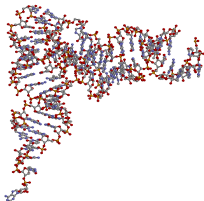


50S subunit

Large protein/RNA complex responsible for translating messenger RNA to proteins

RNA molecule predominantly responsible for reading mRNA

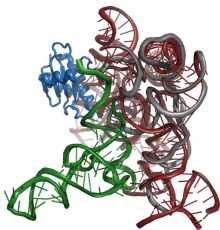
Transfer RNA



Small RNA molecules matching amino acids to codons

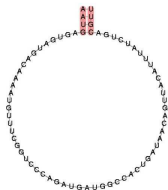
Amino acid attaches to acceptor stem and anticodon attaches to codon

RNase P



Maturation of tRNA by splicing

Small nucleolar RNA



C/D snoRNA



H/ACA snoRNA

Chemical modification of rRNA, tRNA *etc.*

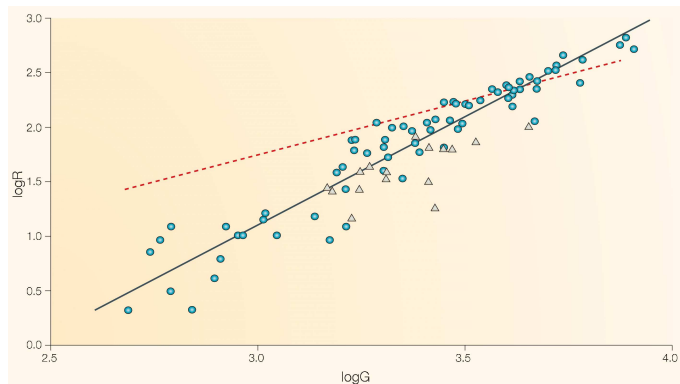
New and old!

Class	Function	Occurrence
rRNA	Translation	Ubiquitous
tRNA	Translation	Ubiquitous
RNase P	tRNA maturation	Ubiquitous
snoRNA	Chemical modification	Eukarya, Archaea
snRNA	Splicing	Eukarya
tmRNA	tRNA + mRNA	Bacteria
μ RNA	Regulation	Multicellular
Xist	Chromosome silencing	Vertebrata

RNAs are found ubiquitously in core biological processes

...but also very localised in the tree of life

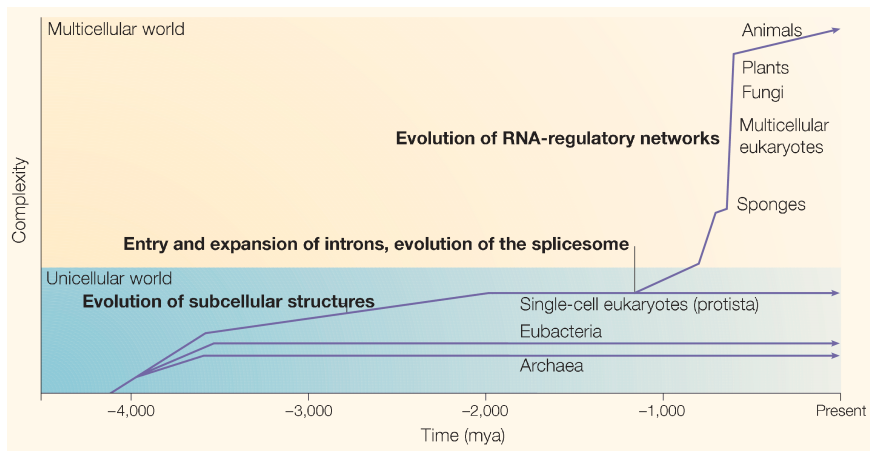
Importance of RNA Regulation



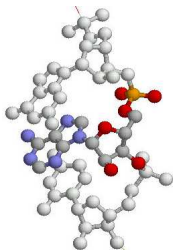
Regulatory genes (R) against total genes (G) – best fit slope is 1.96 ± 0.15

Plotted for bacteria (circles) and archaea (triangles)

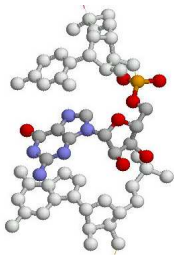
Importance of RNA Regulation, continued



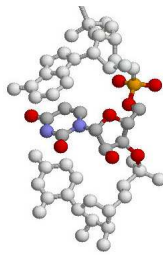
Primary Structure



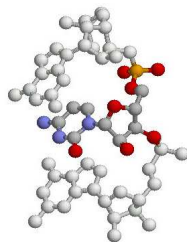
Adenine



Guanine



Uracil



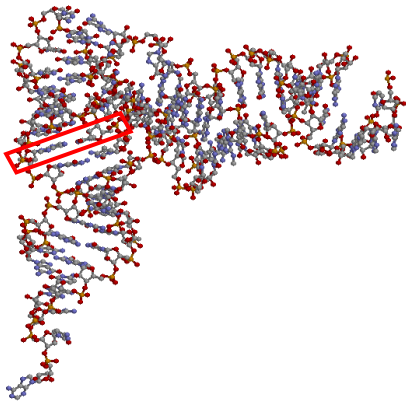
Cytosine

Primary structure of yeast tRNA^{Phe}

```
GCGGAUUUAG CUCAGUUGGG AGAGCGCCAG  
ACUGAAGAUC UGGAGGUCCU GUGUUCGAUC  
CACAGAAUUC GCACCA
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Structure

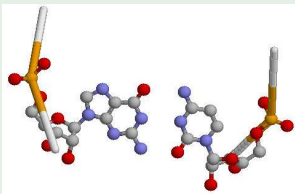
Tertiary structure is full three dimensional configuration



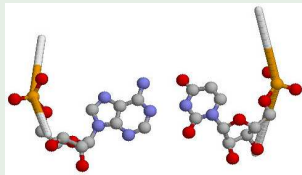
Structure of yeast
tRNA^{Phe}

Secondary Structure

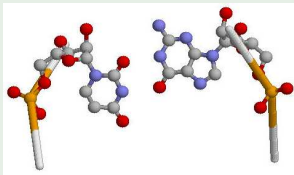
Secondary structure is set of base pairs



Guanine–Cytosine base pair



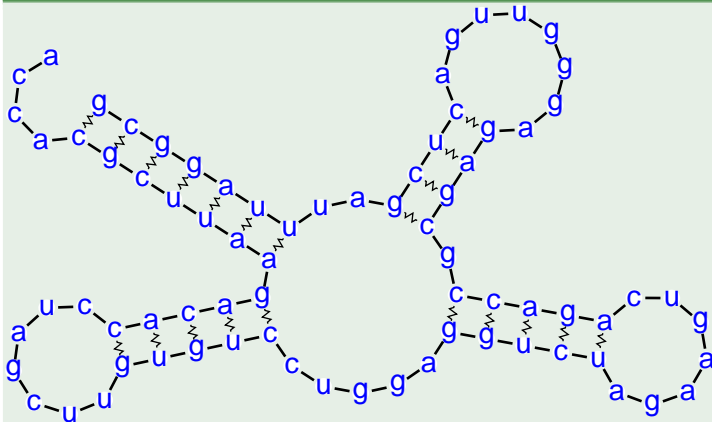
Adenine–Uracil base pair



Uracil–Guanine wobble base pair

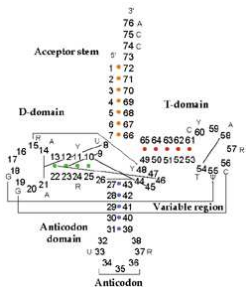
Secondary Structure

Secondary structure is set of base pairs

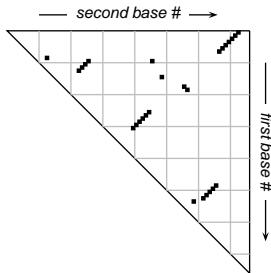


Secondary structure of yeast tRNA^{Phe}

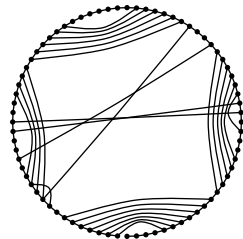
Structure Representations



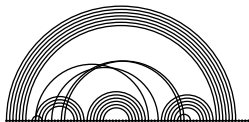
Standard



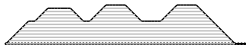
Dot Plot



Nussinov



Dome



Mountain

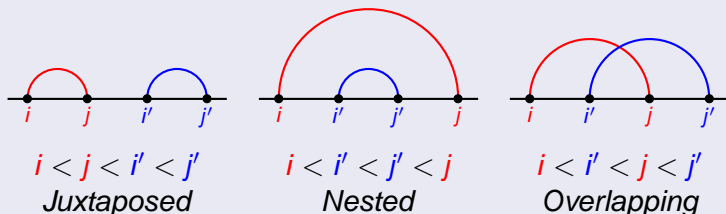
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Bracket

Base Pair Configurations

A base can take part in at most one base pair

Two base pairs $i \cdot j$ and $i' \cdot j'$ can be in one of three configurations:



Two overlapping base pairs are usually called a *pseudoknot*.

Pseudoknots complicate things – you might even see pseudoknots referred to as tertiary interactions – so for the time being we will impose the restriction on secondary structures that they do not contain pseudoknots.

