



Sequence 1: spatial structure of chemical species and physical properties



Fiches de synthèse mobilisées (collection en français) :

- Fiche n°1a : structure spatiale des molécules et des ions
- Fiche n°1b : cohésion de la matière
- Fiche n°1c : formules chimiques et isomérisation de constitution
- Fiche n°1d : isomérisation spatiale



Sommaire des activités ETLV :

- ACTIVITY 1: Cohesion of matter
- ACTIVITY 2: Hydrogen bonds in DNA
- ACTIVITY 3: Chirality and smell

ACTIVITY 1: Cohesion of matter

Objective: understanding how DNA strands stick together

DOCUMENT 1: DNA Deoxyribonucleic acid

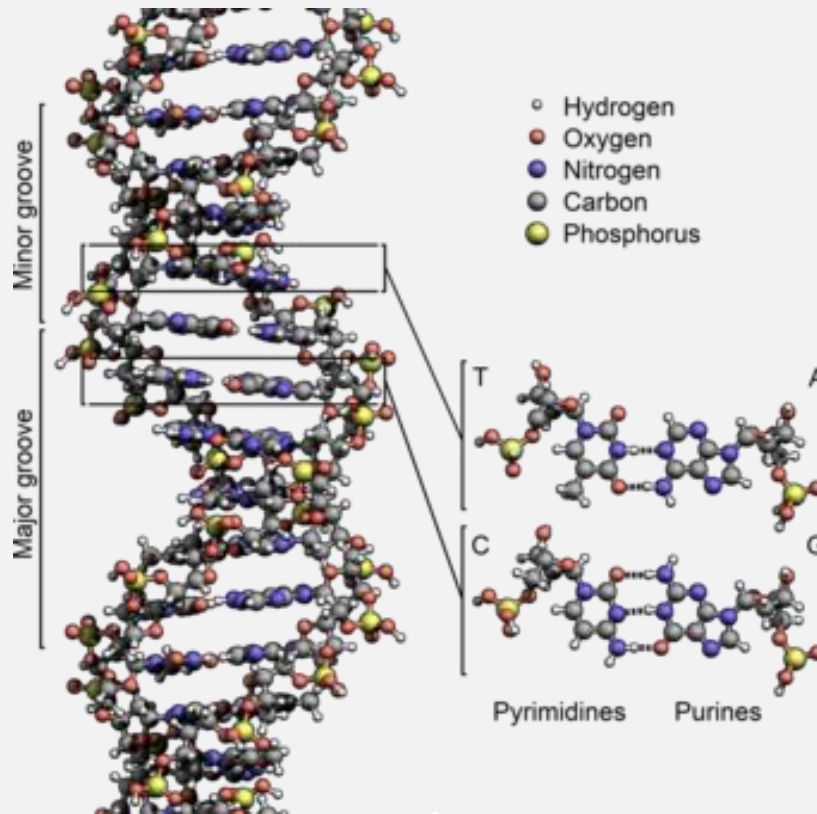
Deoxyribonucleic acid is a molecule composed of two polynucleotide chains that **coil around each other** to form a **double helix** carrying genetic instructions for the development, functioning, growth and reproduction of all known organisms and many viruses.

The two DNA strands are known as polynucleotides as they are composed of simpler monomeric units called nucleotides. Each nucleotide is composed of one of four nitrogen-containing nucleobases (cytosine [C], guanine [G], adenine [A] or thymine [T]), a sugar called deoxyribose, and a phosphate group. The nucleotides are joined to one another in a chain by **covalent bonds** (known as the phospho-diester linkage) between the sugar of one nucleotide and the phosphate of the next, resulting in an alternating sugar-phosphate backbone. The nitrogenous bases of the two separate polynucleotide strands are bound together, according to **base pairing rules** (A with T and C with G), with **hydrogen bonds** to make double-stranded DNA.

Source: Wikipedia



DOCUMENT 2: DNA structure



The structure of the DNA double helix. The atoms in the structure are colour-coded by element and the detailed structures of two base pairs are shown in the bottom right.

Source: Wikipedia

■ Acquiring vocabulary:

Using the previous documents, find a translation for the following expressions:

English	French
coil around each other	
double helix	
covalent bonds	
base pairing rules	
hydrogen bonds	

■ Understanding:

Why is DNA so important?



What type of bonds are responsible for the cohesion of DNA?

ACTIVITY 2: Hydrogen bonds in DNA

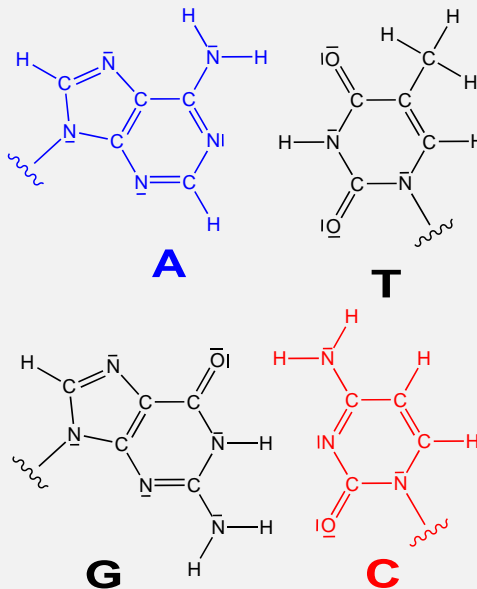
Objective: understanding how hydrogen bonds play a key role in DNA structure

DOCUMENT 1: DNA Deoxyribonucleic acid

... The nitrogenous bases of the two separate polynucleotide strands are bound together, according to **base pairing rules** (A with T and C with G), with **hydrogen bonds** to make double-stranded DNA.

Source: Wikipedia

DOCUMENT 2: Lewis structures of nucleobases



Source: Collection PCM première

■ Understanding and applying:

The base pairing rules are: Adenine pairs up with Thymine and Guanine pairs up with Cytosine. Using document 2, show how hydrogen bonds play a key role in these base pairing rules.

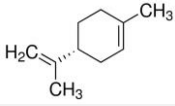
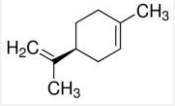


ACTIVITY 3: Chirality and smell

DOCUMENT 1: About limonene

Limonene is a hydrocarbon found in lemon and orange peels. The main component of orange peels is the (R)-limonene isomer and has a weak smell. The (S)-limonene has a lemon like smell and aroma. These two enantiomers are produced in nature whereas usually most chiral compounds are found as a single optical isomer only. At room temperature, limonene is a liquid. It can be used as a green solvent because it is obtained from a renewable source. It is also biodegradable and nontoxic. Limonene has been used as an industrial cleaner and as a food additive for many years as well.

DOCUMENT 2: Structures and specific optical rotations of limonene

	limonene (A)	limonene (B)
structures		
specific optical rotations	+10,6 °·dm ⁻¹ ·l·g ⁻¹	-10,6 °·dm ⁻¹ ·l·g ⁻¹

DOCUMENT 3: Experimental procedure of limonene's extraction by steam distillation

- Introduce 50 g of orange peels in a 250 mL round bottomed flask
- Add 100 mL of water
- Carry out the distillation for 60 minutes
- Collect the distillate obtained in an erlenmeyer flask
- Observe two phases in the distillate and introduce the distillate in a separating funnel
- Collect the essential oil, i.e. limonene, by extraction with cyclohexane.

The residue of the oranges can be recycled in soils.

DOCUMENT 4: Cyclohexane - GHS Classification

Pictograms



Hazard statements

- H225: Highly Flammable liquid and vapor
- H304: May be fatal if swallowed and enters airways
- H315: Causes skin irritation
- H336: May cause drowsiness
- H400: Very toxic to aquatic life
- H410: Very toxic to aquatic life with long lasting



DOCUMENT 5: Vocabulary help

English	French	English	French
Peel	écorce	Renewable	Renouvelable
Round bottomed flask	Ballon	Separating funnel	Entonnoir

■ Understanding and applying:

1. Explain how limonene can be obtained.
2. Explain the term « chiral compounds ». Mark the chiral centers with a (*) in limonene (A) and limonene (B).
3. Determine the configuration for every chiral center in limonene (A) and limonene (B).
4. Give the definition of « enantiomers ».
5. Compare their characteristics and properties.
6. Draw the apparatus of steam distillation that you should use in a lab.
7. Where should the essential oil, i.e. limonene, be in the distillate?
8. According to GHS classification, should you take any safety precautions to carry out the extraction using cyclohexane?
9. Draw the separating funnel before and after the separation.
10. Which operation should be then proceeded to obtain only the essential oil containing limonene?

■ Going further:

11. Give two main industrial applications of limonene.
12. In your opinion, does limonene have a future in terms of sustainable development?



Activity summary

What you must remember:

- **hydrogen bonds**
- **nucleobases**
- **cohesion of matter**
- **chirality**
- **enantiomers**
- **physical and chemical properties of enantiomers**
- **Cram's representation**
- **extraction**
- **steam distillation**

Skills linked to the curriculum:

Compétences	Capacités à maîtriser	Où dans cette séquence ?
APP	Utiliser du vocabulaire spécifique	Activités 1, 3
	Lire et comprendre des documents scientifiques	Activités 1, 2 et 3
ANA	Mettre en lien des documents pour émettre des hypothèses en réponse à une question scientifique	Activités 1, 2, et 3
COM	S'exprimer à l'écrit en utilisant le vocabulaire adapté	Activité 1
REA	<ul style="list-style-type: none">• Utiliser un modèle	Activité 2
	<ul style="list-style-type: none">• Déterminer la configuration absolue d'un atome de carbone asymétrique• Repérer une molécule chirale• Identifier les relations d'énantiomérie• Extraire et exploiter des informations sur les propriétés biologiques de stéréoisomères	Activité 3