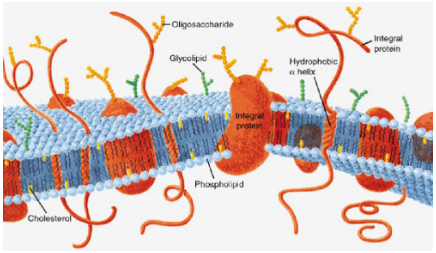
Biomaterials

바이오소재(재료) 중 일반적인 바이오 분자에 대한 개괄적인 내용

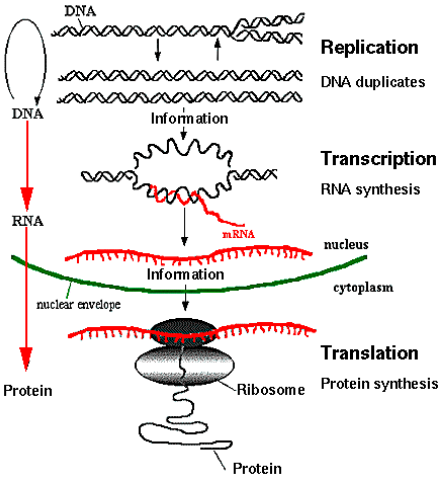
Biomaterials in NanoBio

- Proteins
- DNA/RNAs (Nucleic Acids)
- Lipids, Sugars, ...



Cell surface

The central dogma



Biomaterials in NanoBio?

Bio-contents? Bio-linkers for interfacing?

- **Antibodies**
- **(Strept)Avidin**-biotins — Proteins
- Fluorescent **proteins**
- **Nucleic acids** as backbone or signaling
- **Aptamers** (nucleic acids) — Nucleic Acids
- Stem cells
- … (and also just whatever you want to include)

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NanoBio- or BioNanotechnology?

- "Nanoscale" study of biology (or life)
- "Nanoscale" materials/devices to study biology
- "Nanoscale" bio-materials
- … (or just whatever you want it to be)

Who's in? physicists, engineers, chemists, biologists, clinicians, …

Tool-Developers		Tool-Users
Physicists	⇄	Biologists
Engineers		Clinicians
Chemists		Chemists
…		Engineers
		…

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Our NanoBio- or BioNanotechnology?

- BioMEMS?
- NanoMedicine:
- Biosensors
- Biochips
- Single molecule studies
- … (or just whatever you want to include)

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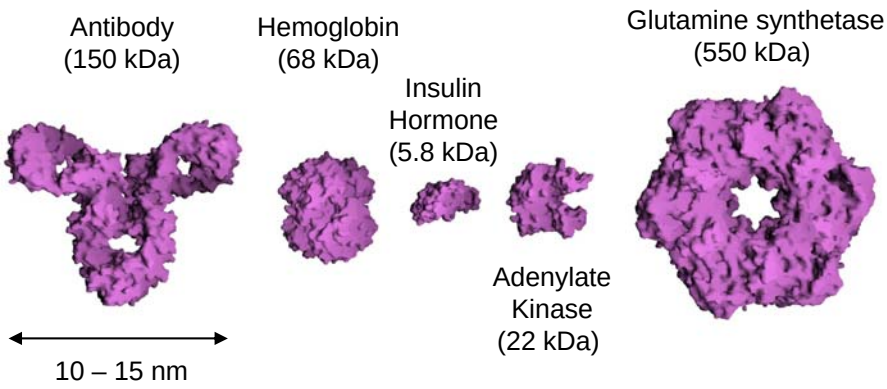
Components & structure of protein

Size (2 – 50 nm)



MW ~= number of amino acids × 120

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Components & structure of protein

Structures

- Primary structure:

Amino acid sequence

- Secondary structure:

Local structures

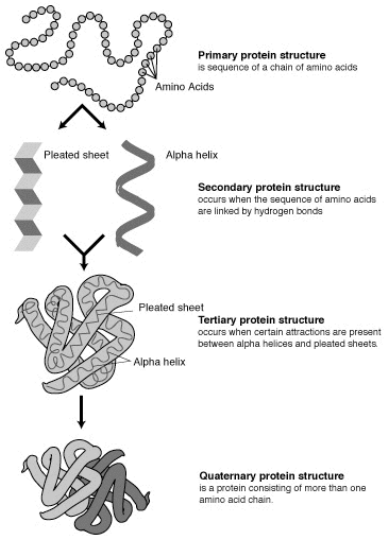
(alpha helix & beta sheet)

- Tertiary structure:

Overall shape (fold)

- Quaternary structure:

Protein complexes



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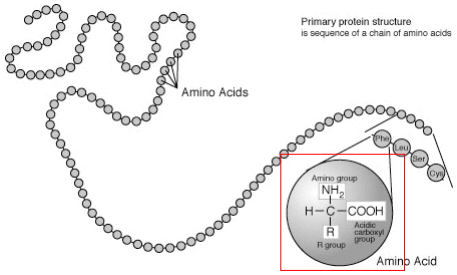
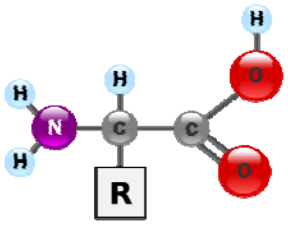
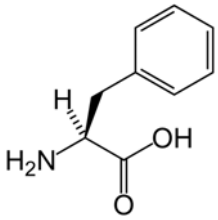
Amino Acid





Isomerism: L (S), D (R)



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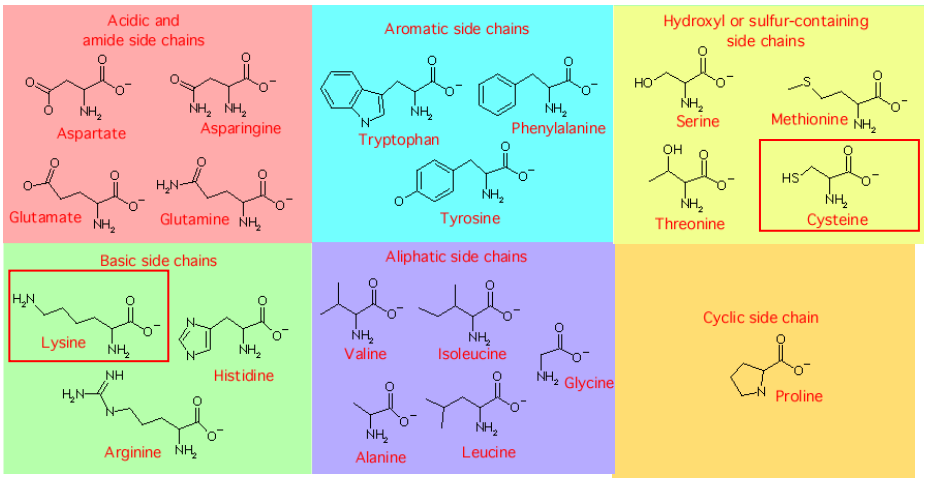
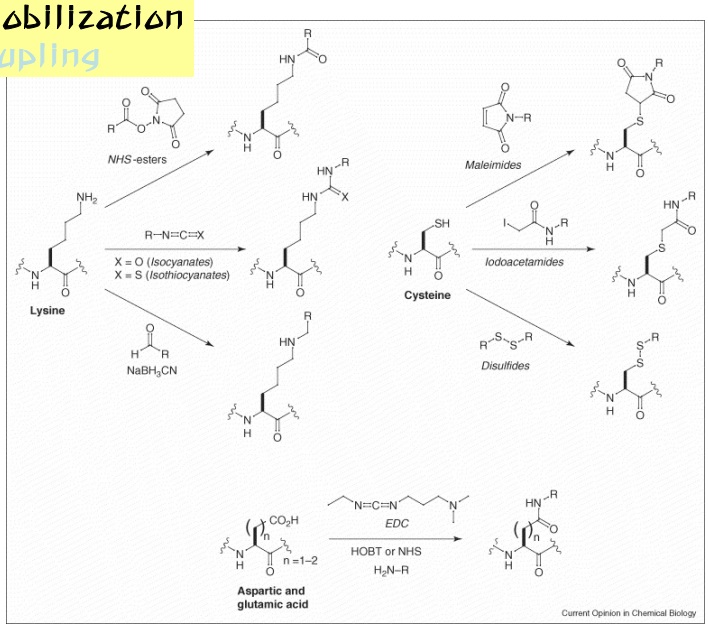
Protein chemical modification

Target moieties: Lysine & Cysteine

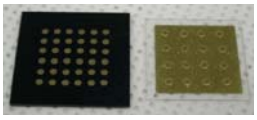


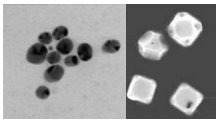
Protein Immobilization

Covalent coupling



Biointerface Technologies





Chip/Sensor devices

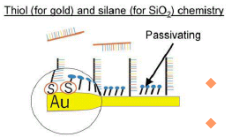
Nanomaterials

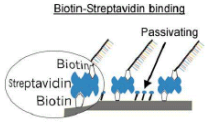
Biointerface technology

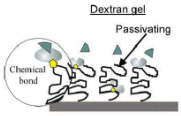
- Bio-contents preparation: protein, DNA, ...
- Surface chemistry
- Biomolecule engineering/immobilization

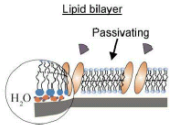
Sensing & profiling

Medicinal/biological applications









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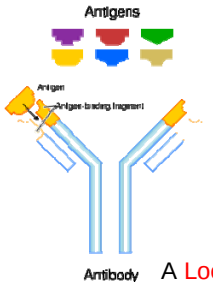
Antibody (Immunoglobulins, Ig)

Antibodies are host proteins that are produced by the immune system in response to foreign molecules that enter the body. These foreign molecules are called antigens, and their molecular recognition by the immune system results in selective production of antibodies that are able to bind the specific antigen. Antibodies are made by B lymphocytes and circulate throughout the blood and lymph where they bind to their specific antigen, enabling it to be cleared from circulation.



- Each antibody binds to a specific antigen
- Highly specific and strong interaction

Most widely used in biosensors & proteomic tools

A Lock and Key interaction

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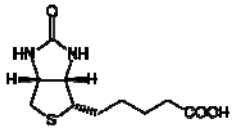
Avidin-biotins

- In the whites of eggs (birds, reptiles, …)
- Biotin (vitamin H or B7)
- Kd : 10^{-15} M, how tight?



- Streptavidin: avidin-like protein in bacterium *Streptomyces avidinii*
- Highly specific binding to biotin and biotin derivatives

Comparison of available biotin-binding proteins.

	Avidin	Streptavidin	NeutrAvidin Protein
Molecular Weight	67K	53K	60K
Biotin-binding Sites	4	4	4
Isoelectric Point (pI)	10	6.8-7.5	6.3
Specificity	Low	High	Highest
Affinity for Biotin (K_d)	10^{-15} M	10^{-15} M	10^{-15} M
Nonspecific Binding	High	Low	Lowest

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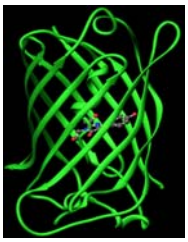
Fluorescent proteins

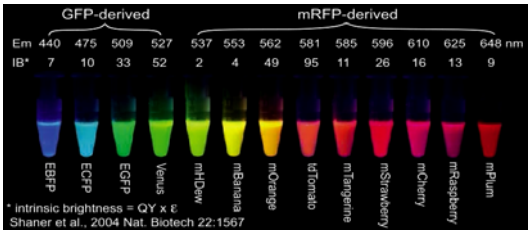
GFP cloned in 1992 from Aequoria victoria

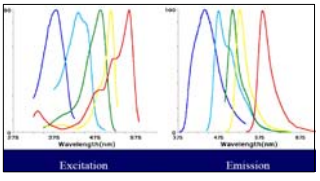


Crystal structure solved in 1996

- **2008 Nobel Prize in Chemistry**
- **GFP mutants: green - yellow - blue**
- **DsRed mutants: red - far red**
- **Many more with a GPF fold**

Many mutants have been developed





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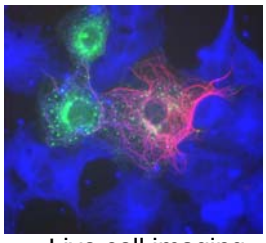
Why fluorescent protein?

Can be expressed in cell from gene...

In vivo imaging



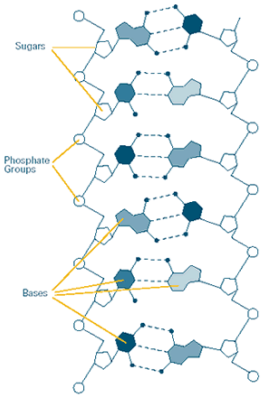
Live cell imaging

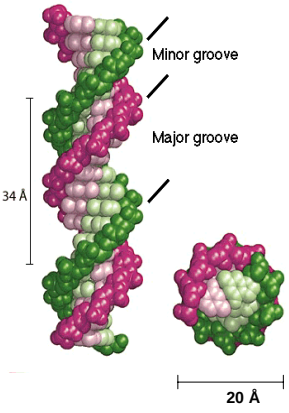
- Genetically fusing with other endogenous proteins
- Genetic sensors

Essay 2. Fluorescence Protein에 대한 장단점과 응용가능성을 이해했다면, 형광 특성을 갖는 나노 물질인 Quantum Dot 을 사용할 수 있을 것이라는 생각을 할 수 있다. **살아 있는 쥐의 간의 암세포의 존재 유무를 쥐를 해부하지 않고 확신할 수 있는 최적화된 방법과 그 과정을 체계적으로 작성하세요.** (주의사항1. 형광을 이용한 imaging 방법을 사용할 것 (즉 MRI 나 PET과 같은 방법은 논외임. 주의사항2. 가시광선은 피부를 통과하지 못한다는 것을 주지할 것. 주의사항3. 현 기술로 가능하다고 생각하고 참고한 문헌을 첨부할 것.) (Due Date 4.30)

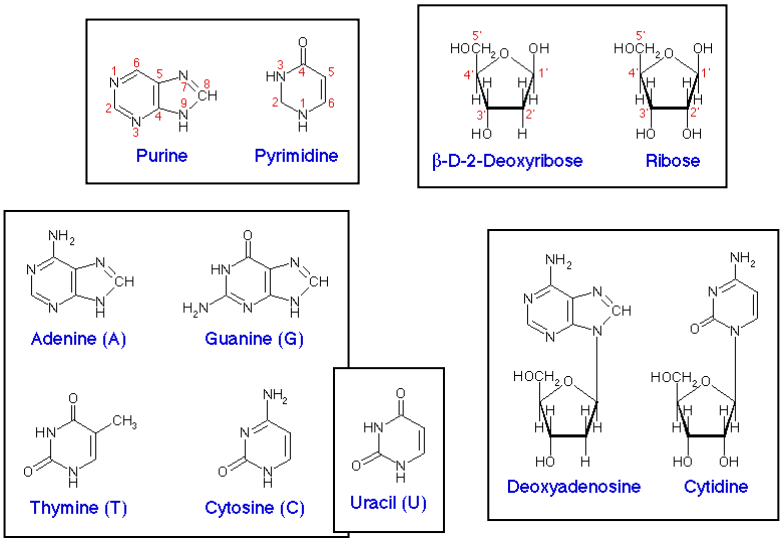
Nucleic acids in NanoBio

- Backbone, building block
- Signal amplification
- Aptamers (nucleic acids)
- Therapeutic agents
- Targets to analyze





Components & Structure of DNA and RNA: Bases



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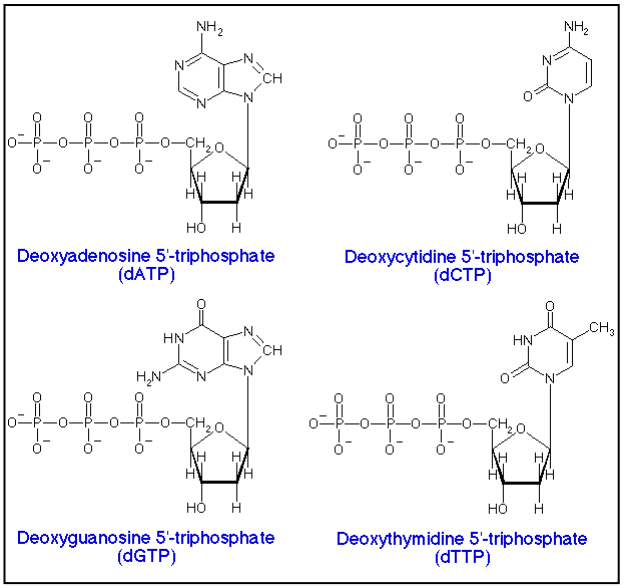
Components & Structure of DNA and RNA: NTPs



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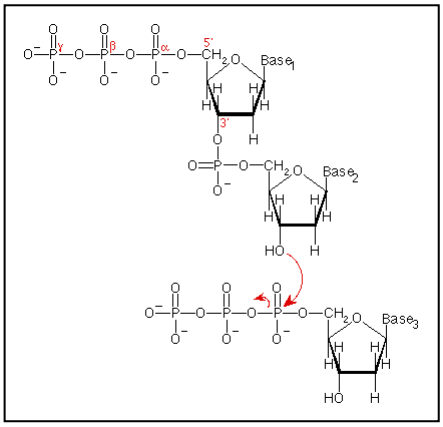
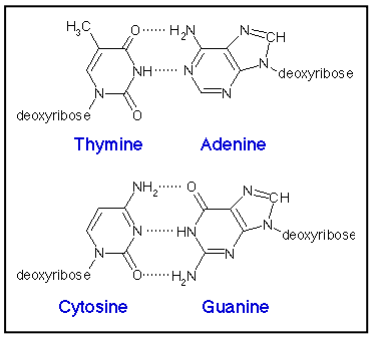
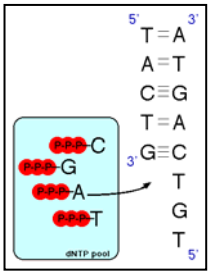
Components & Structure of DNA and RNA: Synthesis







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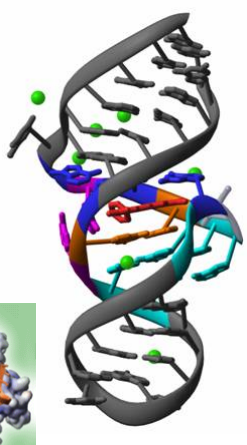
Cancer Targeting: Aptamer

Aptamers are oligonucleotides that bind to molecular targets in a manner conceptually similar to antibodies



They offer specific competitive advantages such as:

- Little or no immunogenicity or toxicity
- Chemically synthesized, allowing for lower cost and easily scaled production
- Very stable

Aptamer properties:

- pM – nM affinity range
- Time to discovery: 4-6 months
- Any protein is a potential target

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