



# Nanodiamond for Biomedicine

## ダイヤモンドナノ粒子の医療応用

京都大学 大学院人間・環境学研究科 物質科学講座 博士課程2年 Yu Jie (余 杰)

## Introduction 研究の背景

### ◆ What is nanodiamond? (ナノダイヤモンドとは)

- Diamond is a form of carbon materials (ダイヤモンドは炭素材料の一種です)
- Nanodiamond is diamond with a size below 100 nanometers (ナノダイヤモンドは100ナノメートル以下の大きさのダイヤモンドです)

#### Different form of carbon materials



Coal



Pencil

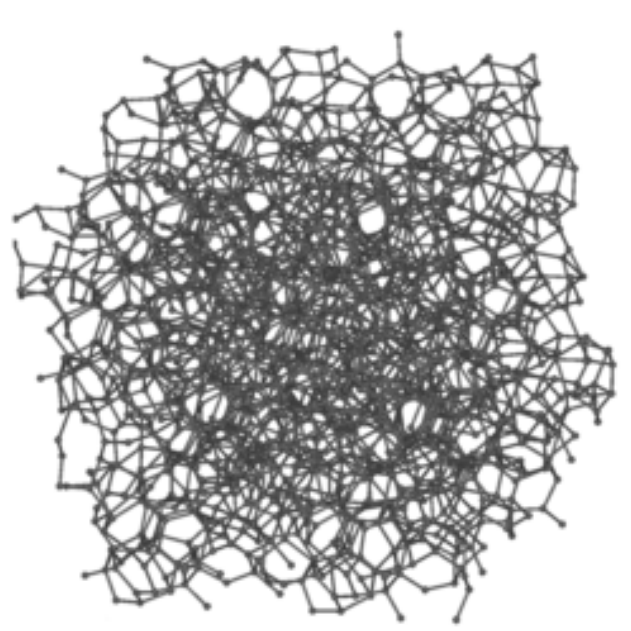


Diamond

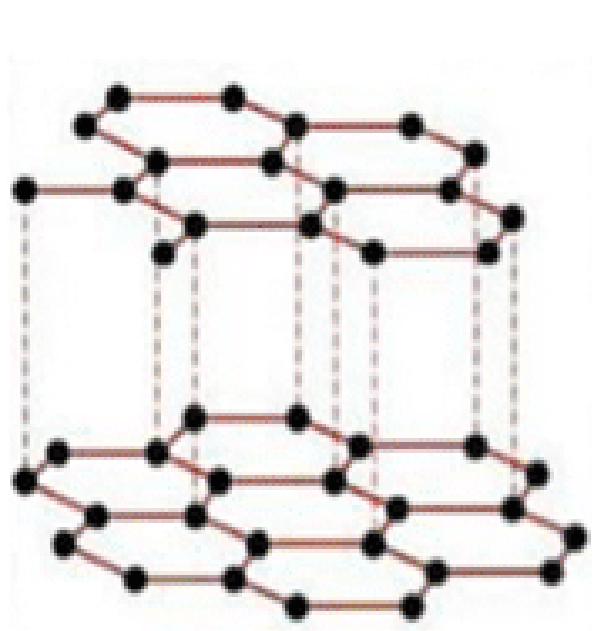
\* Data from Wikipedia

- Difference in chemical structures (化学構造の違い)

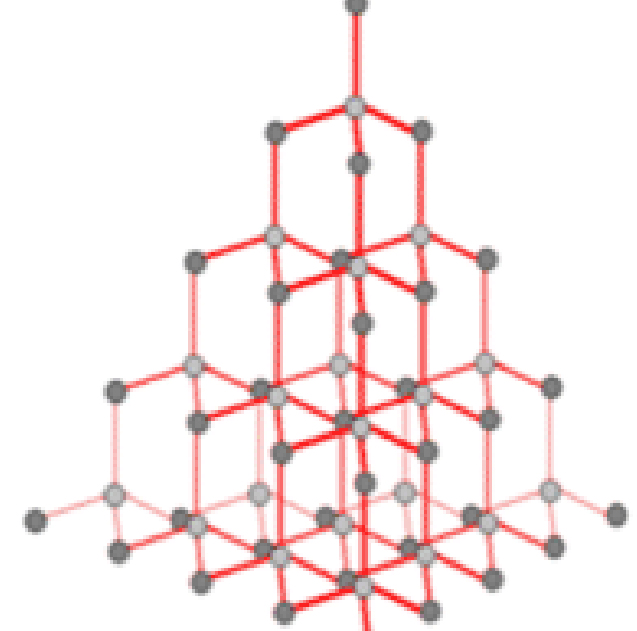
#### Chemical structure



Amorphous carbon



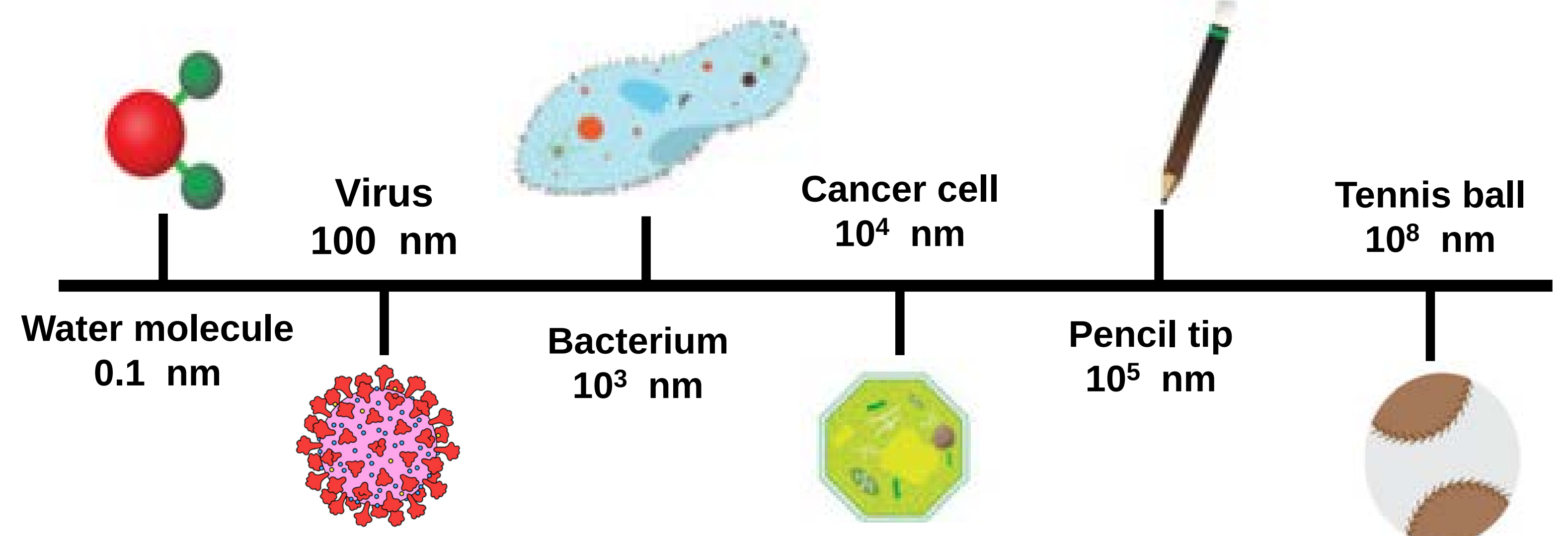
Graphite



Diamond

\* Data from Wikipedia

#### Nanometer scale



\* Data from adobe stock

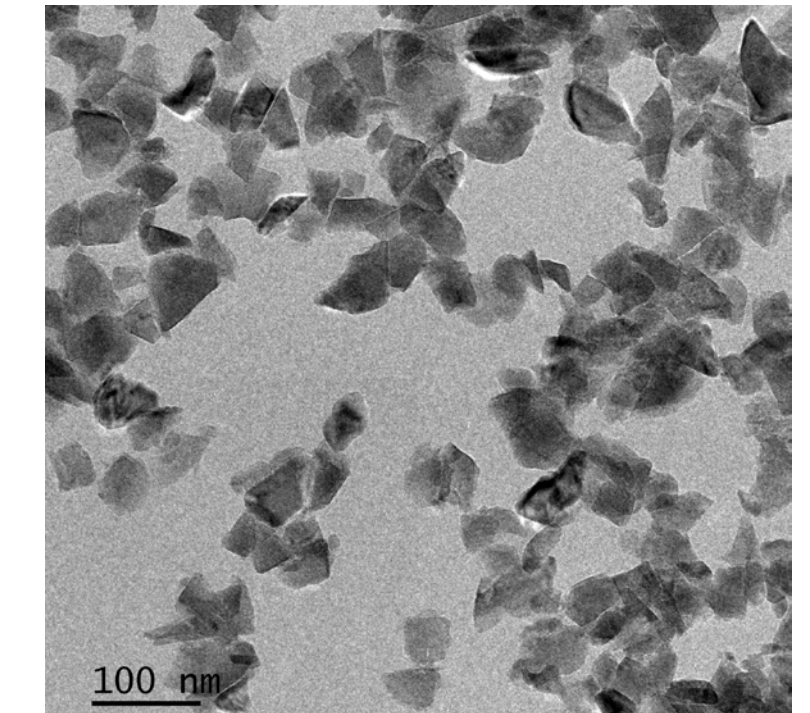
#### Diamond & nanodiamond



Diamond mineral



Nanodiamond image



transmission electron microscope image

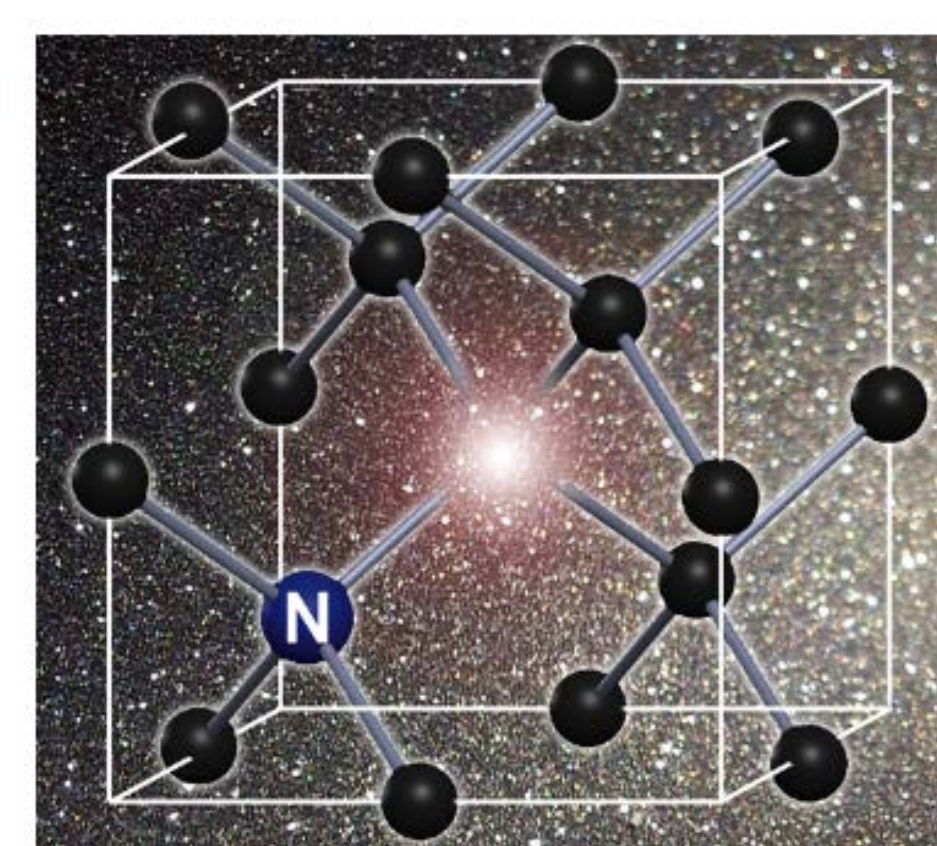
\* Data from sustainable nano

### ◆ What are the advantages of nanodiamond in biomedicine?

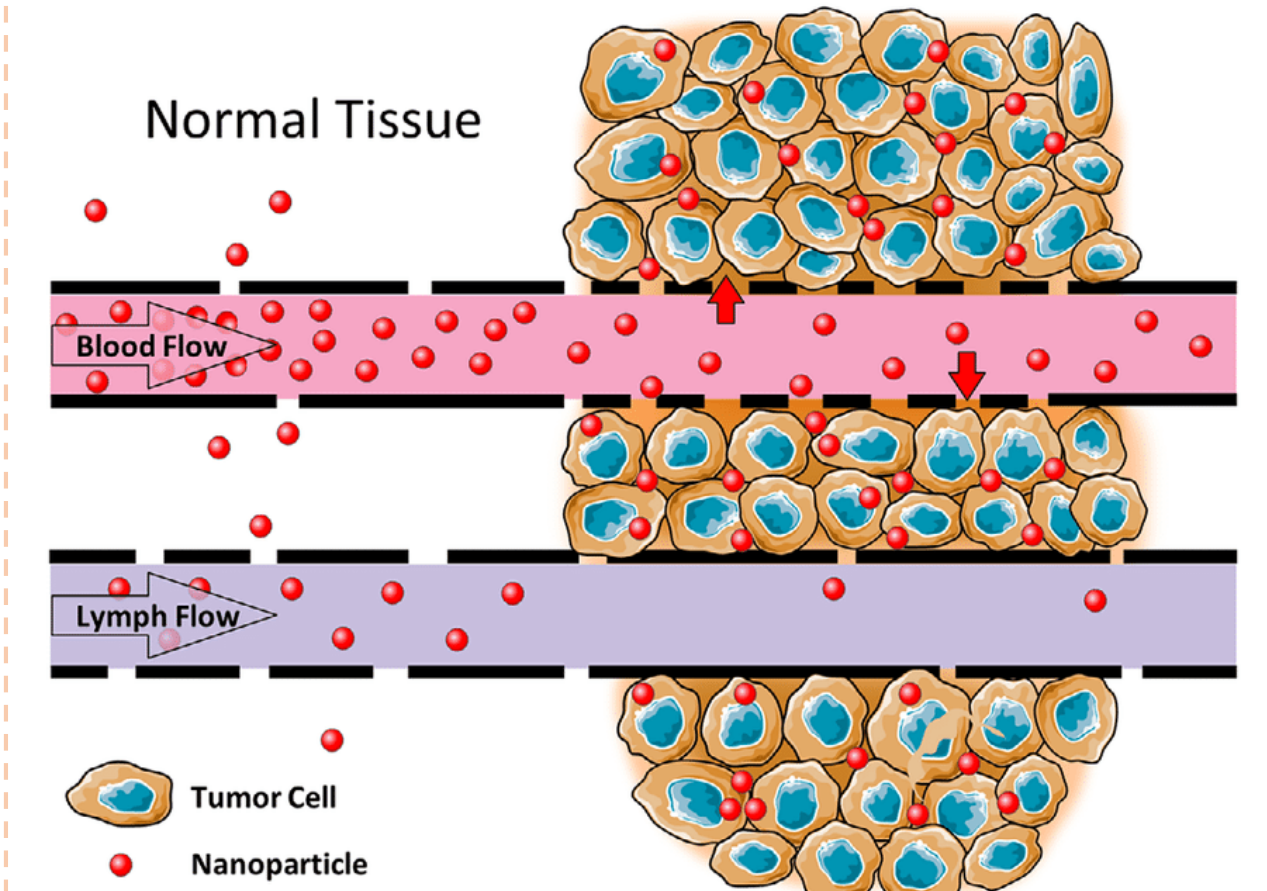
(医療応用におけるナノダイヤモンドの利点は何ですか)

- Superior hardness, fluorescence (優れた硬度、蛍光特性)
- Chemical stability of core, tailorable surface chemistry (コアの化学的安定性、表面修飾可能)
- Nanometer size, non-toxicity (小さい、毒性が無い)

Nitrogen-vacancy center makes nanodiamond fluoresce



Nano size allows particle to accumulate in tumor tissue



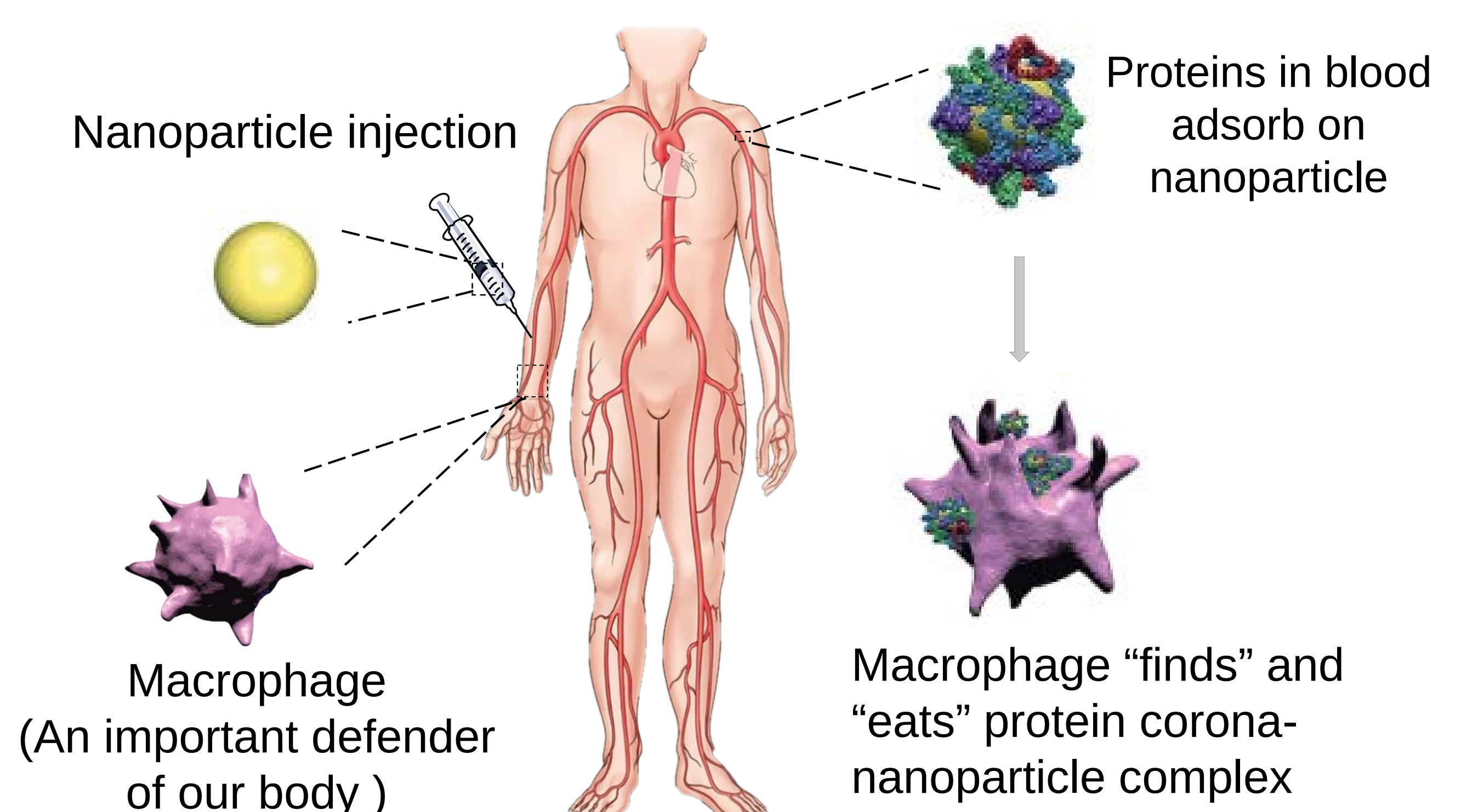
Adv. Therap. 2020, 2000203

### ◆ What are limitations of nanodiamond in biomedicine?

(医療応用におけるナノダイヤモンドの限界は何ですか)

- Easy to aggregate (凝集しやすい)
- Poor dispersibility in water (水への分散性が低い)
- Protein corona formation (タンパク質コロナの生成)
- Non-selectivity to malignant tumor cells (悪性腫瘍細胞への選択性がない)

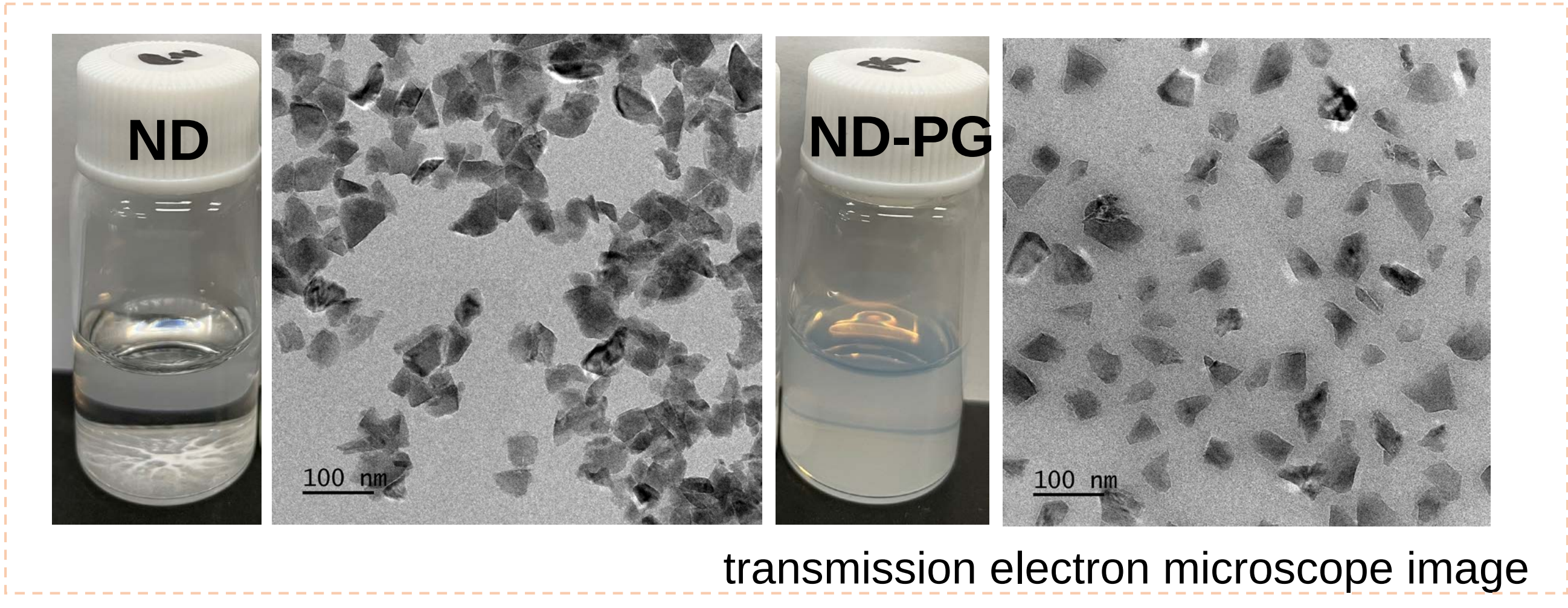
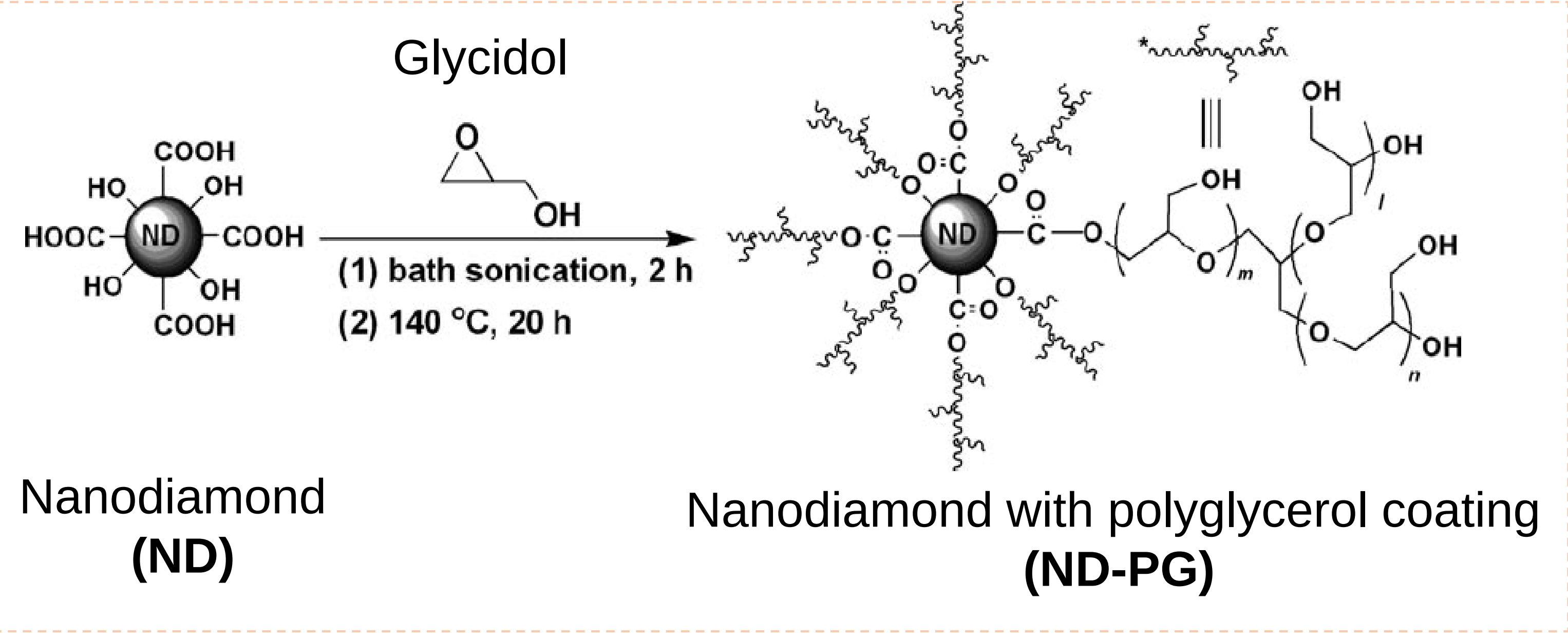
**Protein corona:** proteins that spontaneously adsorb on the surface of nanodiamond once it is in contact with blood



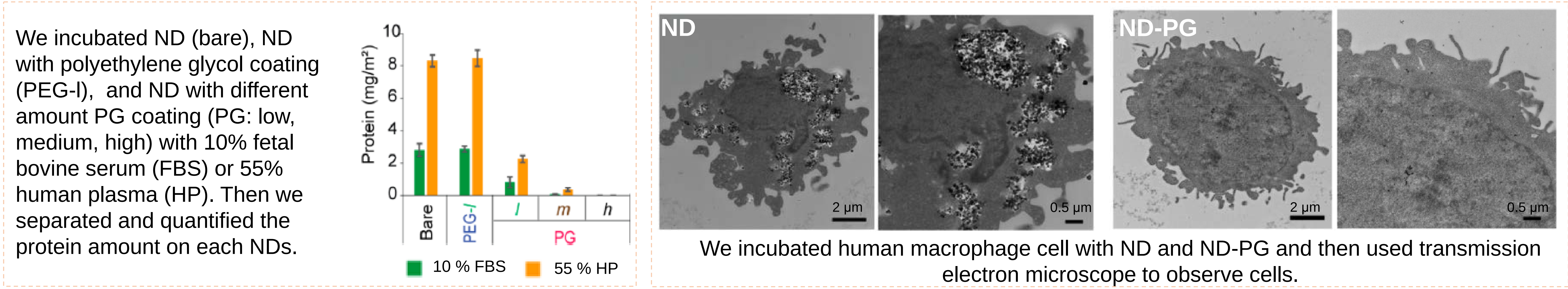
Our research 我々の研究

◆ Polyglycerol coating — invisible cloak for nanodiamond (ポリグリセロールコーティング——ナノダイヤモンドの透明マント)

- Synthesis route (合成法)
- Good dispersibility in saline and no aggregation after PG coating (PGコーティングにより生理食塩水への高い分散性)

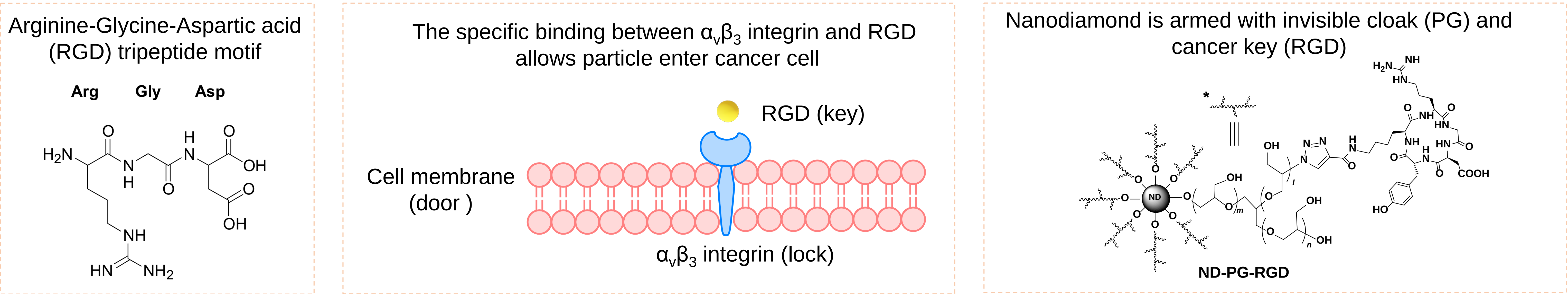


- PG coating prevents protein corona formation and clearance by macrophage (PG コーティングはタンパクコロナの形成とマクロファージによるクリアランスを防止します)

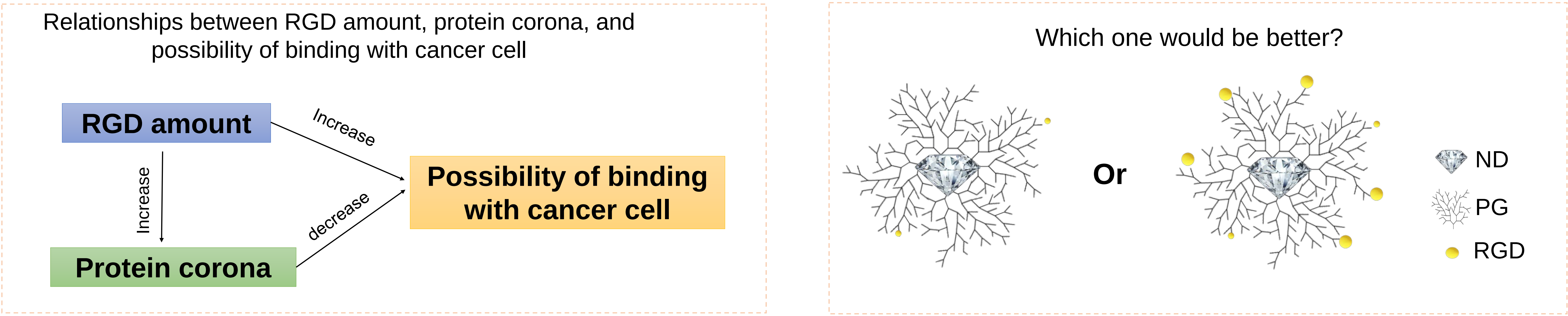


◆ Navigation to specific cancer cells (特定のがん細胞を標的にする)

- The lock and key to cancer cells (がん細胞の錠と鍵)



- Question: Is “less” or “more” more efficient? (質問 —— 多い方が効果的、少ない方が効果的？)



- Preliminary results --- “Less” is more efficient (予備的結果 —— 少ない方が効果的)

We synthesized ND-PG-RGD with different RGD amount (-l: low, -m: medium, -h, high) and incubated with two kinds of tumor cells

