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Presentation

On

Burgeoning nanotechnology for diabetic wound healing: a novel approach towards future[sciforum-069447]

by

Debojyoti Mandal

[Electronic mail: debojyoti2108@gmail.com]

Address correspondence to: Dr. Jeena Gupta

Discipline - Bioengineering and Biosciences

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Background

- 537 million adults (20-79 years) are living with diabetes - 1 in 10. This number is predicted to rise to 643 million by 2030 and 783 million by 2045 [1]
- Unfortunately, India is in 2nd position with 72.2 millions diabetic people as of now ; number will increase to 124.9 millions by 2045 [1]
- The annual incidence of diabetic wound including foot ulcer worldwide is between 9.1 to 26.1 million.[2]
- Around 15 to 25% of patients with diabetes mellitus develop a diabetic foot ulcer during their lifetime.[3]
- As the number of newly diagnosed diabetics are increasing yearly, the incidence of diabetic foot ulcer and other wounds is also bound to increase[4]
- Nanomaterials have been proven to be the most promising agent for faster wound healing among all the other wound healing materials.
- Owing to their high surface area to volume ratio,nanomaterials have not only been used for drug delivery vectors but also can affect wound healing by influencing collagen deposition and realignment and provide approaches for skin tissue regeneration.

Relevence for wound healing

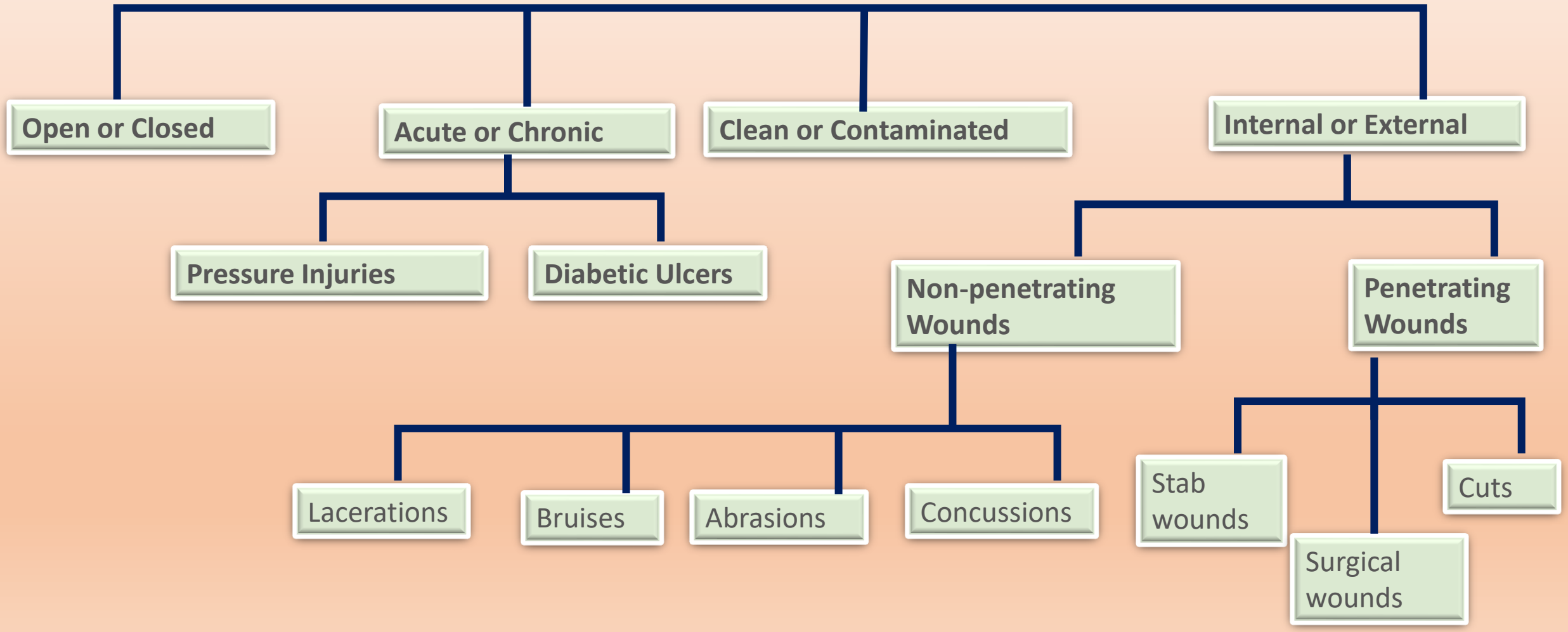
TRANSLATIONAL RELEVANCE

- Nanotechnology driven therapeutics can influence a specific biochemical event within the impaired healing process, being able to change one or more wound-healing phases.
- This offers unique opportunities compared to dressing-based the conventional wound care products.
- A major advantage of these nanoplatforms is their adaptability and tunability. For instance, nanotherapeutics can be used in controlled and sustained released of the active ingredient over a period of days or weeks, while conventional delivery systems such as dressings films or gels can sustain the release of the therapeutic agent over 1 to 2 days [4].

CLINICAL RELEVANCE

- Chronic wounds have an important economic impact in developed countries, and it is expected to increase as the population ages.
- Current therapies cannot fully address the impaired healing, provoking wound complications like infections and poorly wound closure.
- Thus, new biomolecules and therapies that promote wound healing, prevent wound infections or inflammation, among others, are needed.
- Several nanotechnological approaches with multiple functions and different mechanisms have proved their potential in wound animal models, and could be the next generation of wound nanotherapies [5],[6]

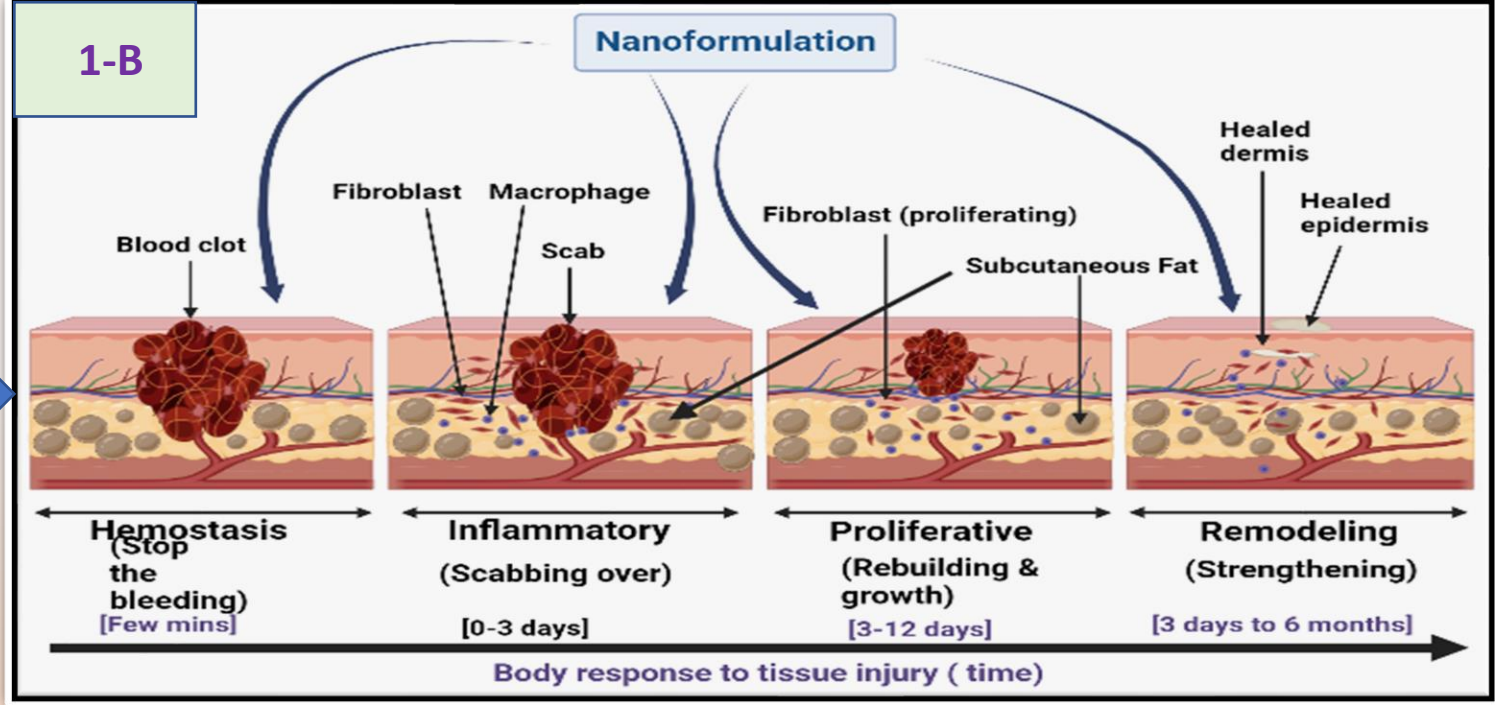
Types Of Wounds



Wound healing vs diabetes

1-A

1-B



1-C

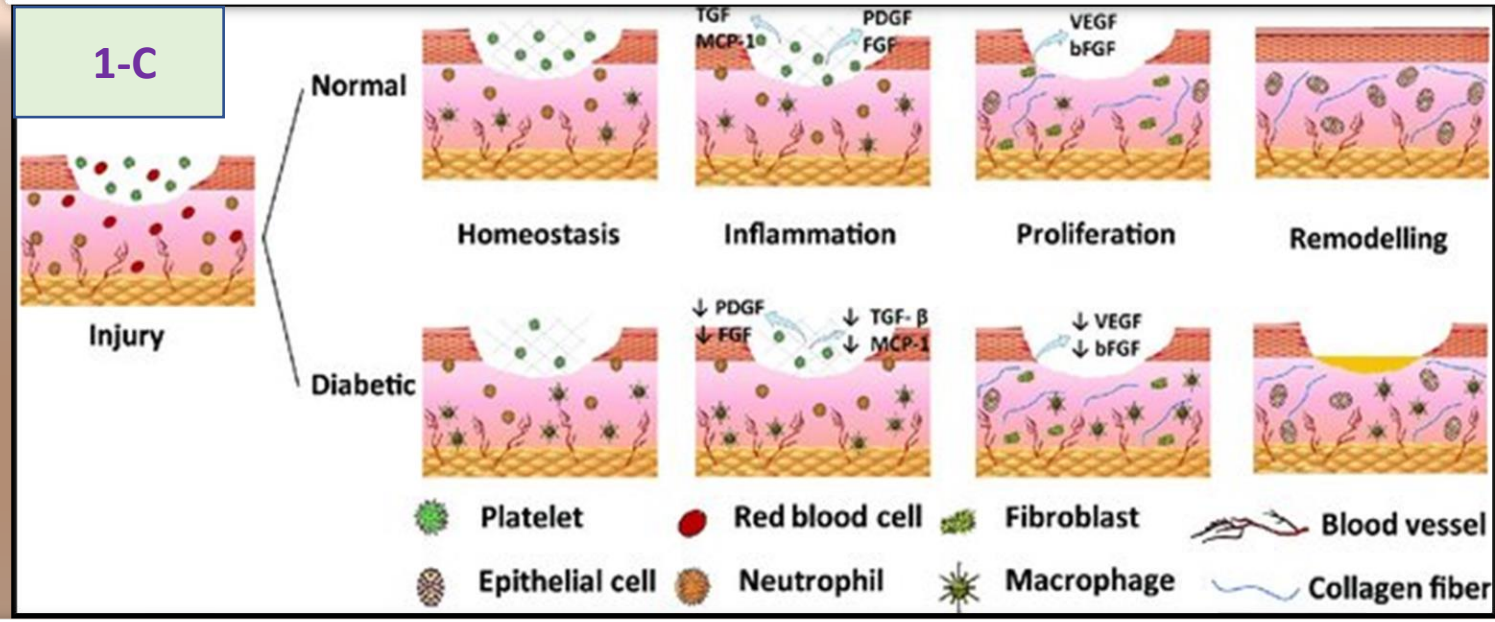


Figure: 1-A) Normal wound: 1-B)Stages of wound healing:1-C)Normal vs Diabetic wound healing

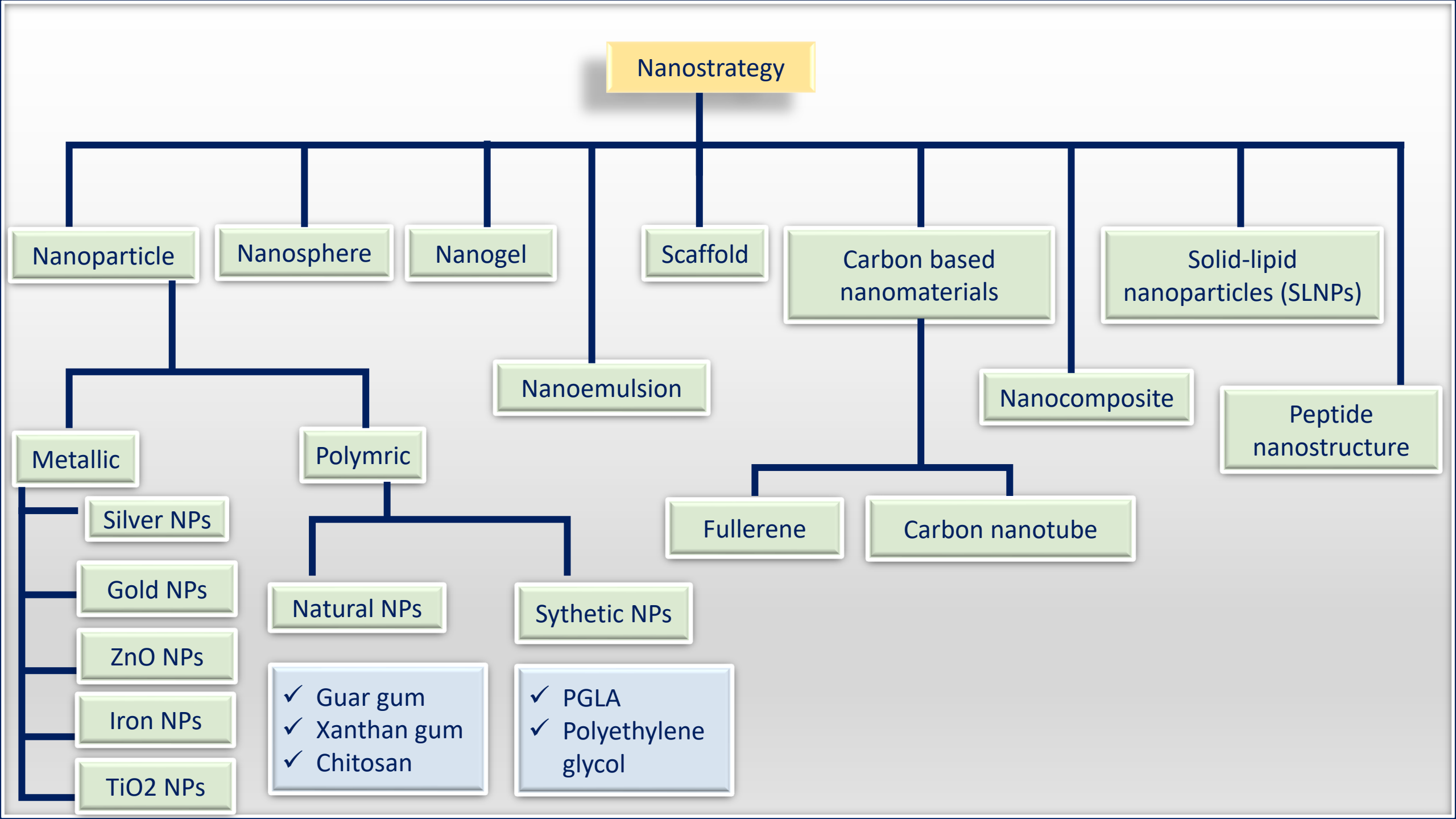
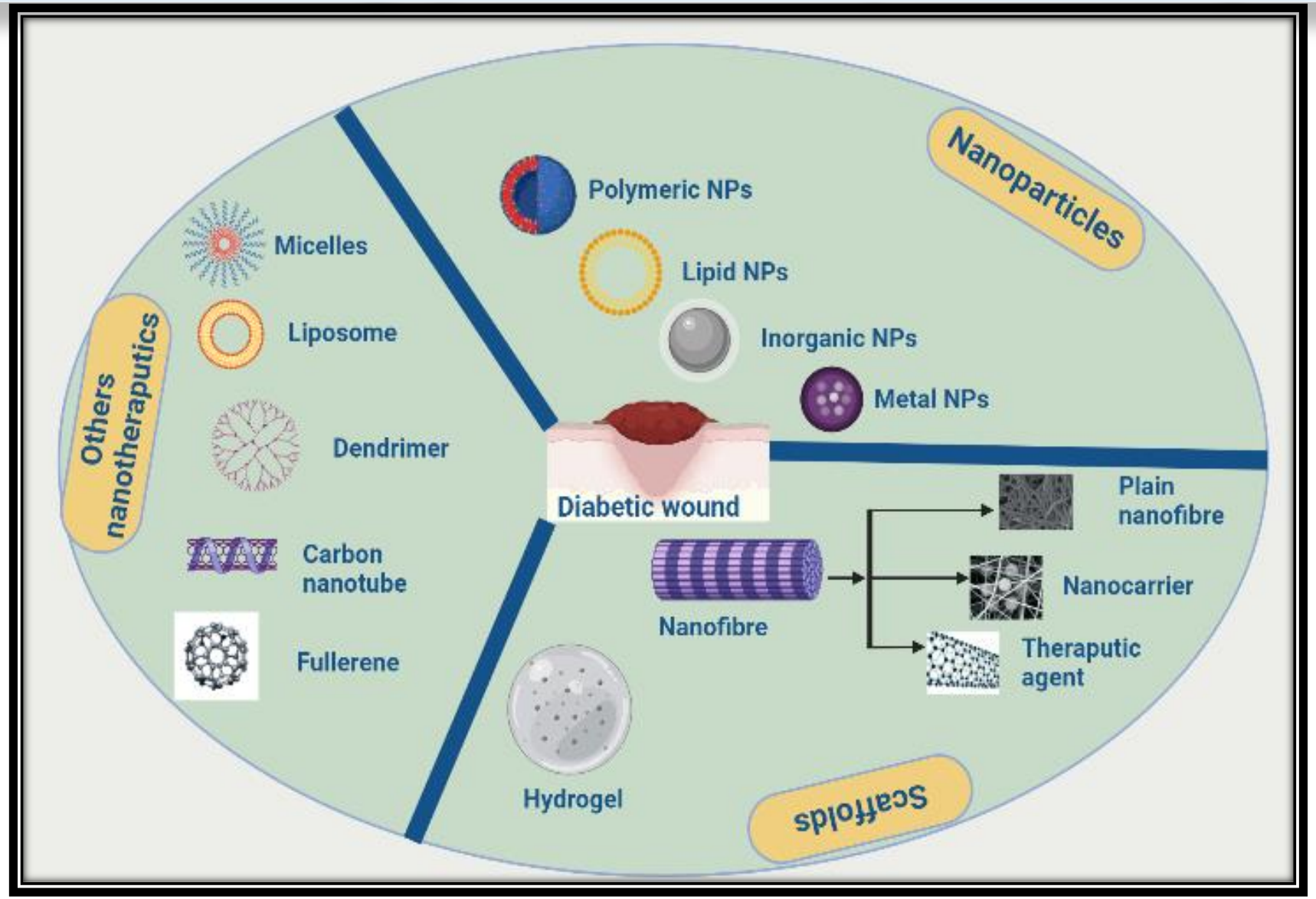

Nanostrategy
Nanoparticle
Nanosphere
Nanogel
Nanoemulsion
Scaffold
Carbon based nanomaterials
Nanocomposite
Solid-lipid nanoparticles (SLNPs)
Peptide nanostructure
Metallic
Polymric
Silver NPs
Gold NPs
ZnO NPs
Iron NPs
TiO2 NPs
Natural NPs
Sythetic NPs
Fullerene
Carbon nanotube
✓ Guar gum
✓ Xanthan gum
✓ Chitosan
✓ PGLA
✓ Polyethylene glycol

Figure 2: Nanomaterials used in wound healing [NPs=nanoparticles]



Advantages of nanostrategies in diabetic wound healing

- Tunable physical and chemical properties
- Targeted drug delivery
- Increase solubility of highly lipophilic drug
- Increase bioavailibility

Critical Issues

- Despite the development of potential biomaterials and nanotechnology-based applications for wound healing, this scientific knowledge is not translated into an increase of commercially available wound healing products containing nanomaterials.

Future Directions

- Further studies are critical to provide insights into how scientific evidences from nanotechnology-based therapies can be applied in the clinical setting
- NMs, due to their unique properties open a new array of wound-healing products.
- NMs can modify each phase of wound healing as they possess antibacterial and anti-inflammatory activities, proangiogenic and proliferative properties.
- NMs are able to correct expression level of some important proteins and signal molecules to enhance wound healing.
- Thus, NMs or the combination of materials at both micro and nanoscales, may become beneficial enough to overcome most of the challenges that exist in wound care management.

Conclusion

- Development of novel biocompatible and biodegradable NMs, which are able to correct all phases of wound healing, can be a future goal for researchers working in this area.
- It is important to note that any outcome of NM therapeutics depends on the NM formulation, doses and methods of application.
- As NMs are highly active compared with its bulk, toxicity of NMs must be taken into consideration in every case before its usage in wound care products.

Glimpse of my research work with Nanotechnology on diabetic wound healing

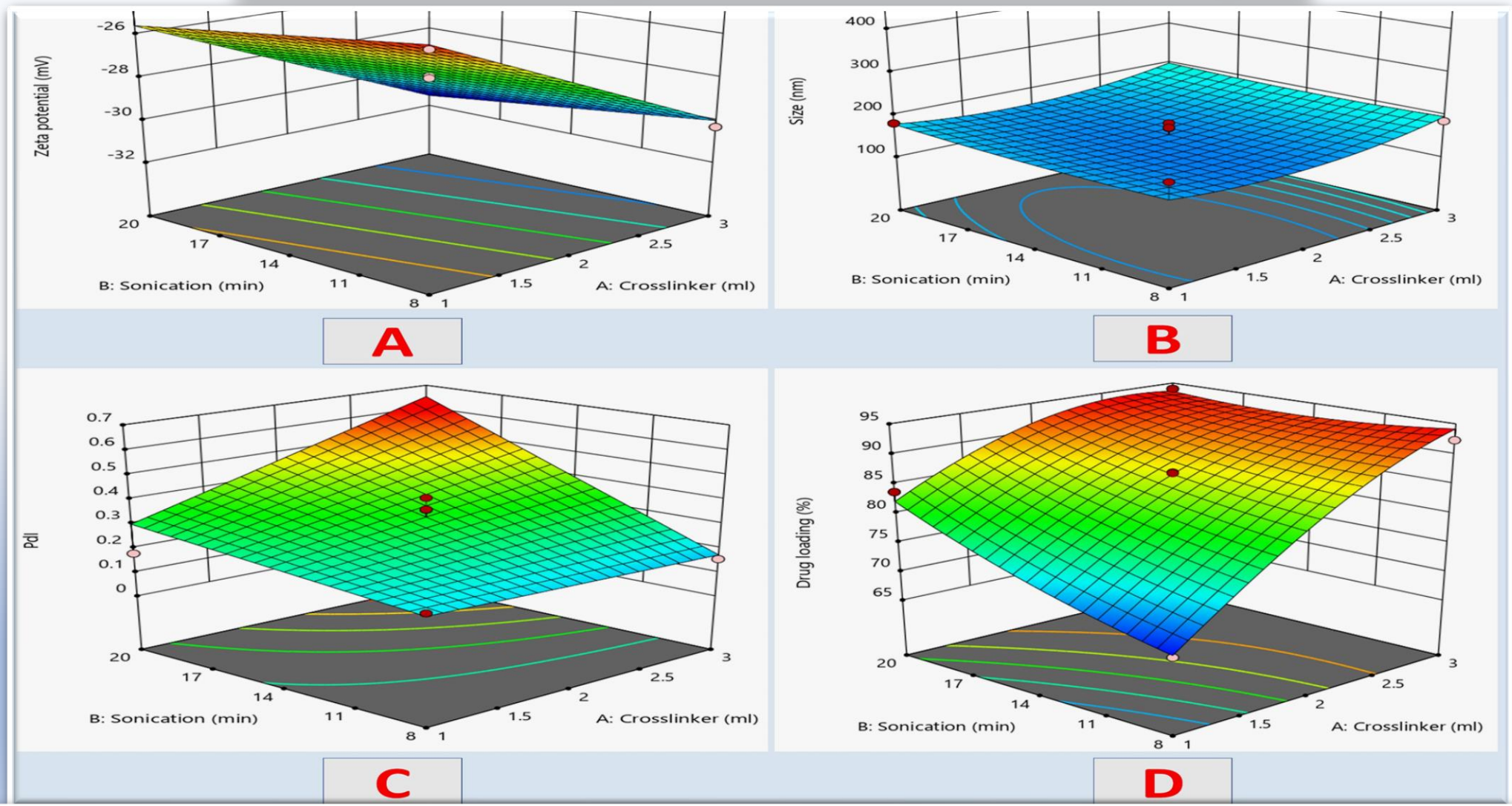


Figure - Optimized Nanoformulation with BBD[Box Behnken Design]

[A) Optimized zeta potential value; B) Optimized particle size; C) Optimized PDI value; D) Optimized drug loading(%) value]

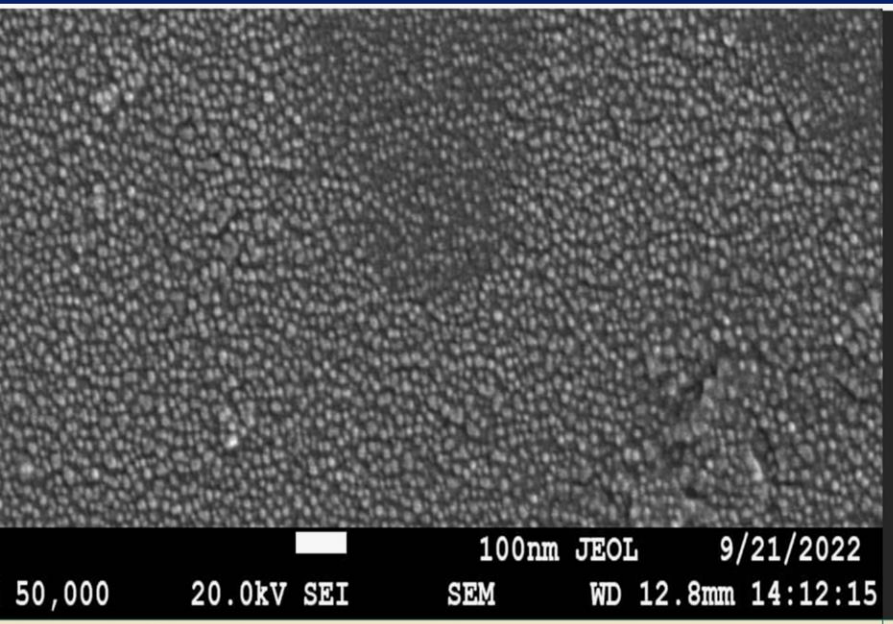


Fig. 3: Scanning electron microscope image

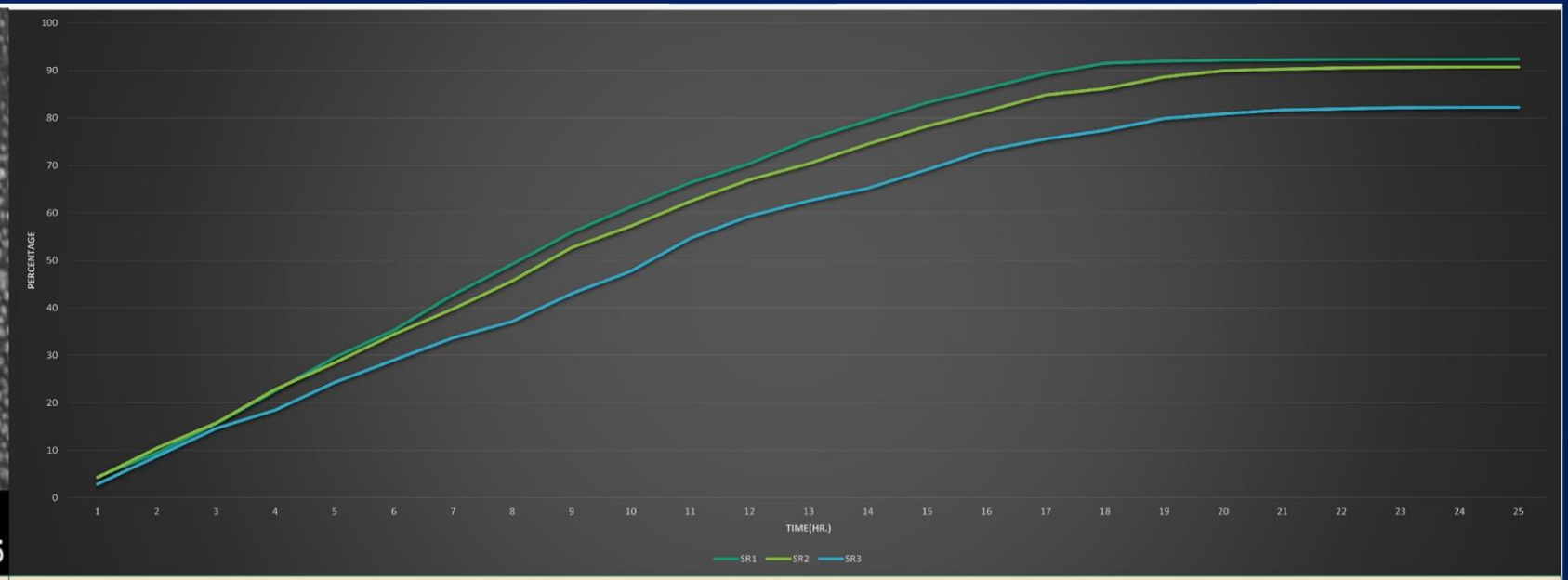


Fig. 4: Drug Release Study Of Some Sample Formulation

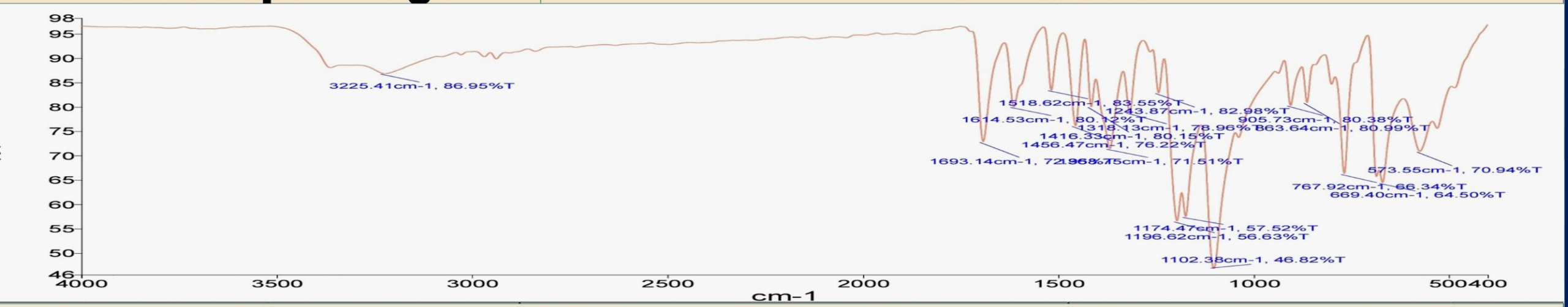


Fig. 5: FTIR Analysis of Drug loaded Nanoparticles

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THANK YOU