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Current Progress of Electrospun Nanocarriers for Drug Delivery Applications

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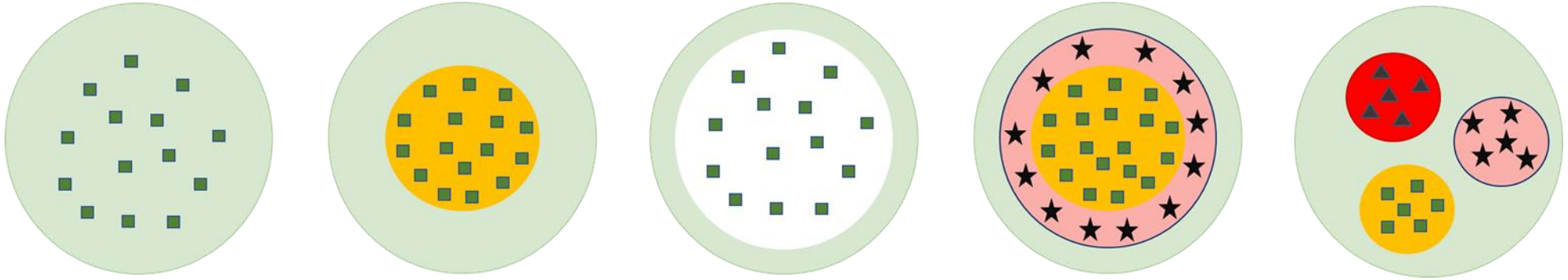
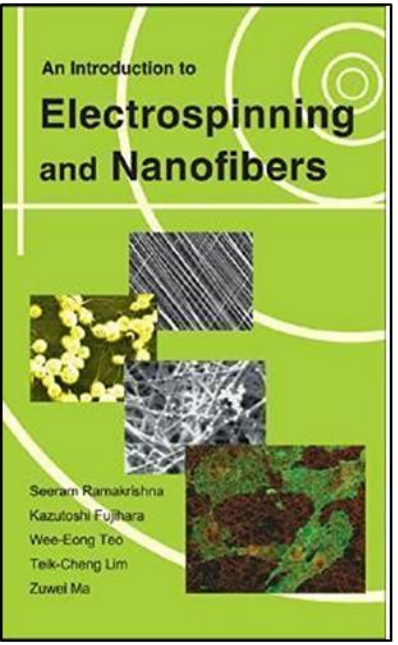
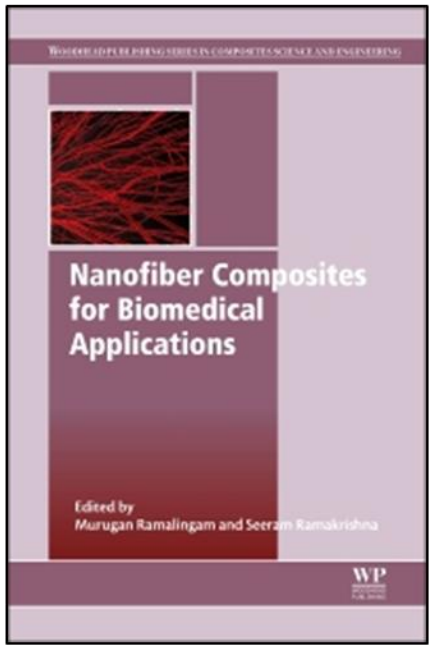
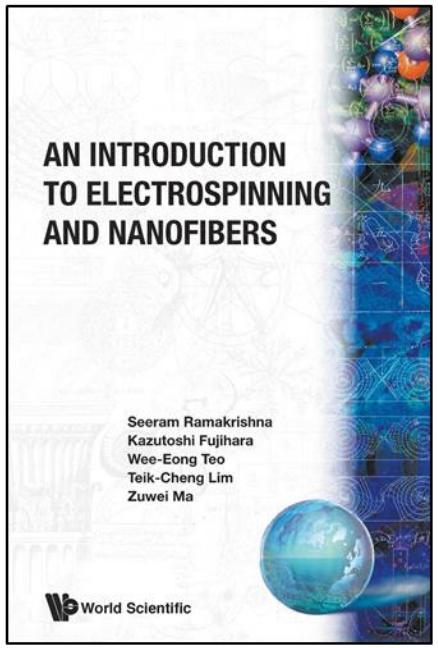
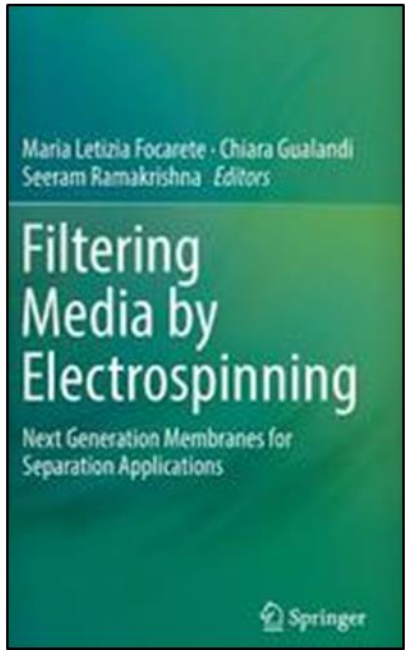


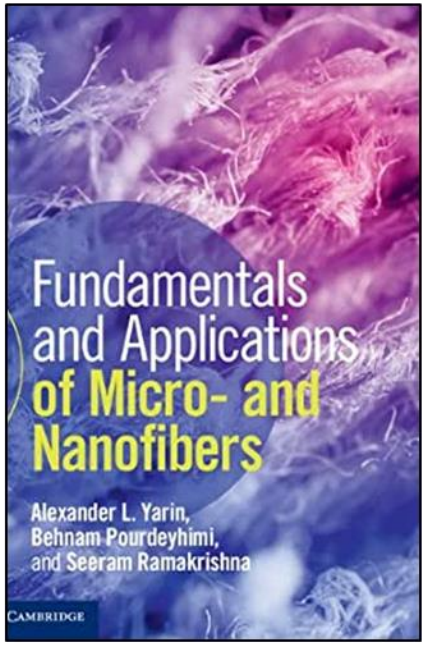
Published book on electrospinning and nanofiber By Seeram Ramakrishna

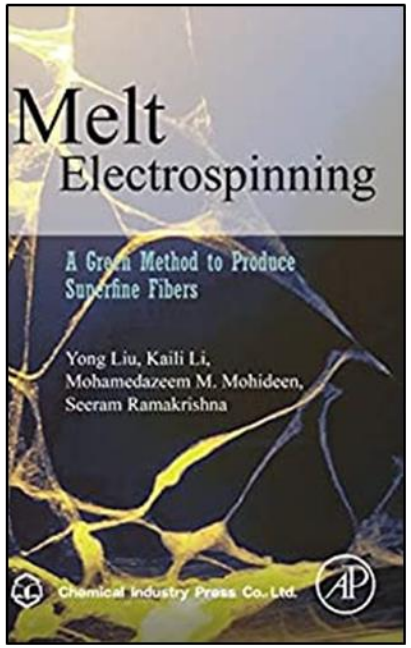








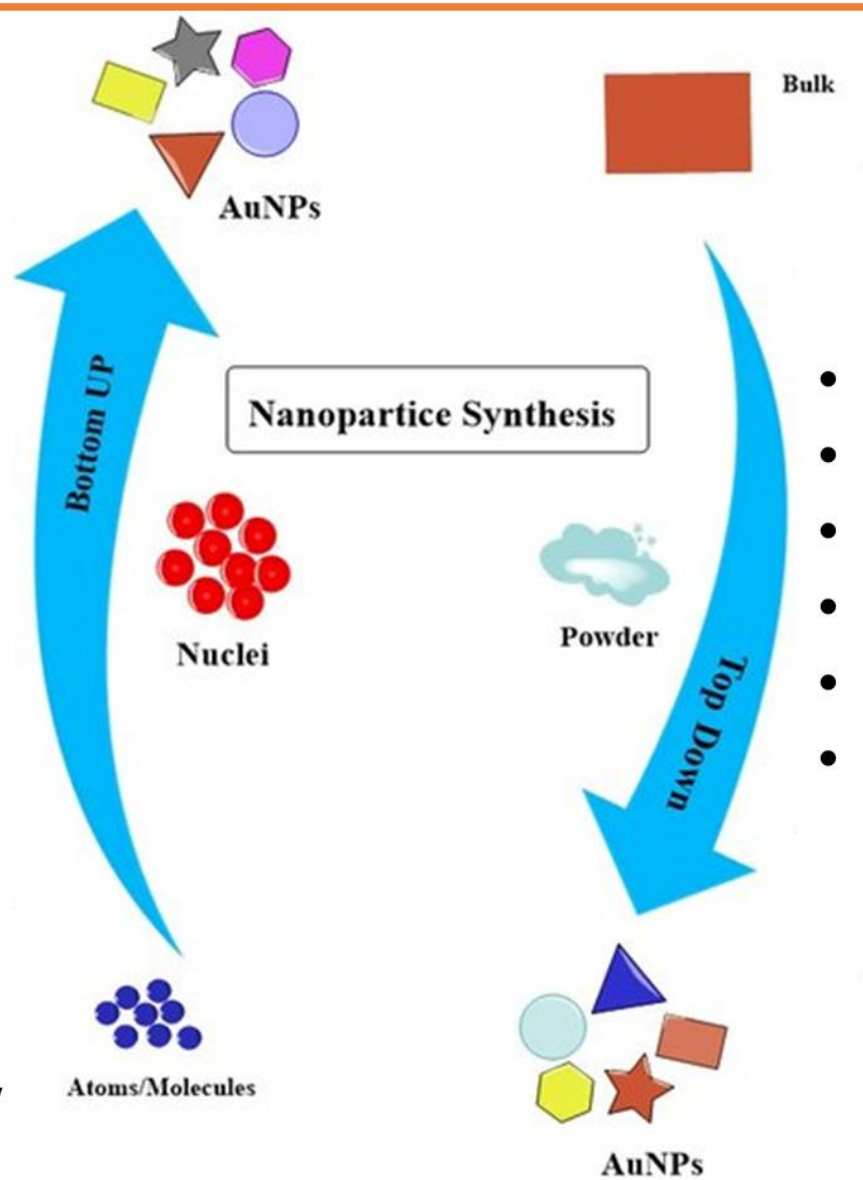




Radhakrishnan Sridhar, *et.al., Chem Soc Rev . 2015, 7; 44 (3), 790-814.*

Nanomaterials synthesis techniques

- Atomic/ Molecular condensation
- Vapour deposition
- Sol-gel process
- Spray pyrolysis
- Chemical/ electrochemical deposition
- Aerosol process
- Bioretardation

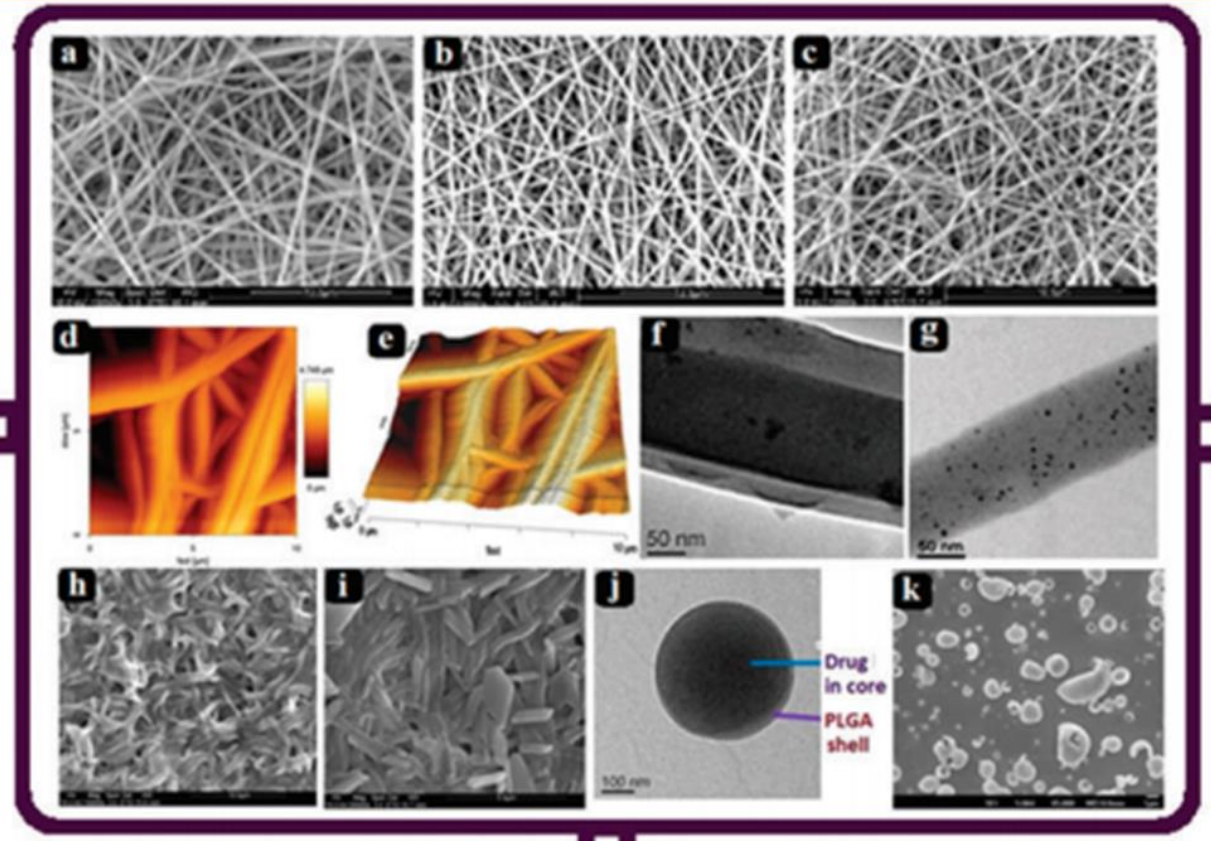


- Spinning
- Sputtering
- Chemical etching
- Thermal /laser ablation
- Mechanical/ball milling
- Explosion process

Muhammad Ovais, et.al., *Applied Microbiology and Biotechnology,* 2017, 101,9, 3551-3565.

Electrospun and electrospray nanomaterials: their applications in various domains

Energy
Including (Solar cell, battery, fuel cells, electronics, oil and gas

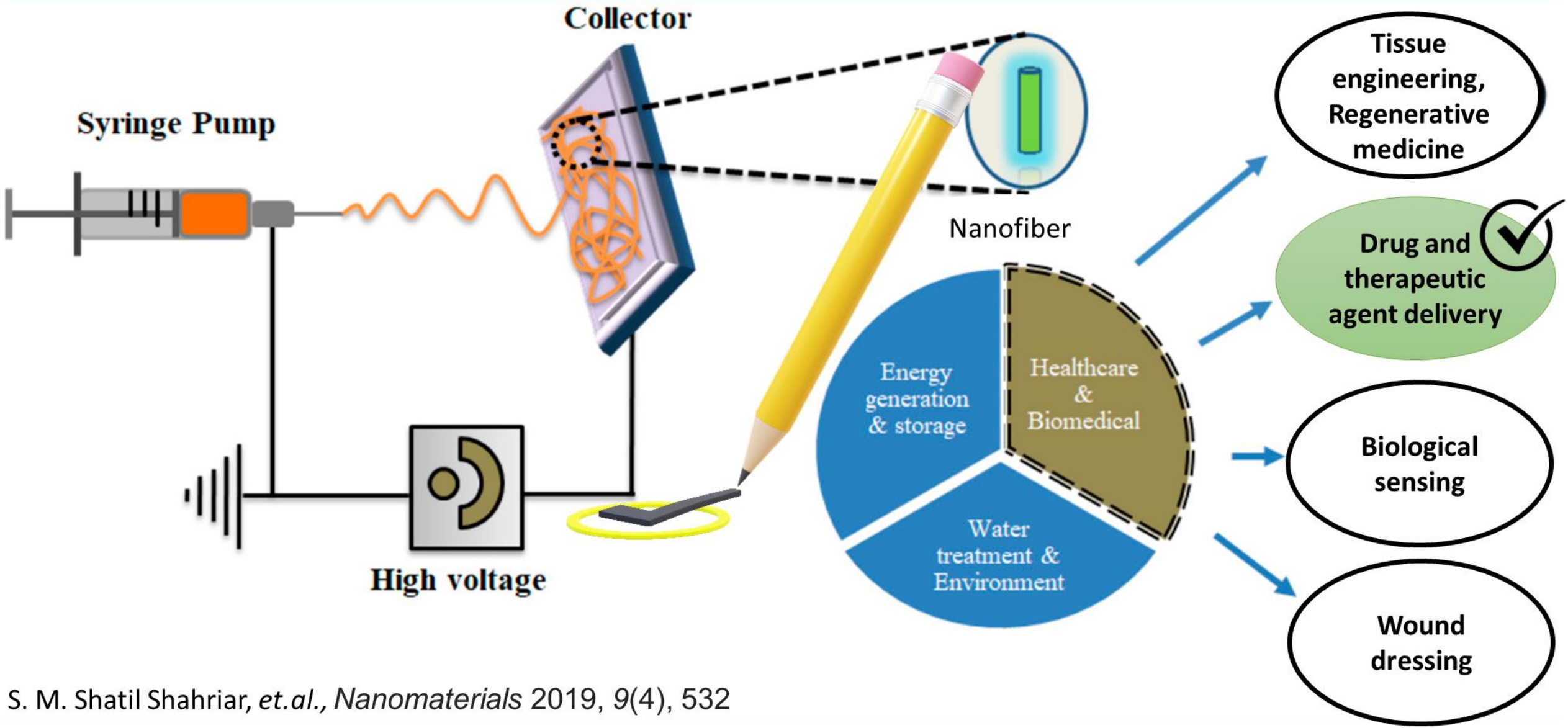


Health Care

Water filtration, Air filtration, Defence

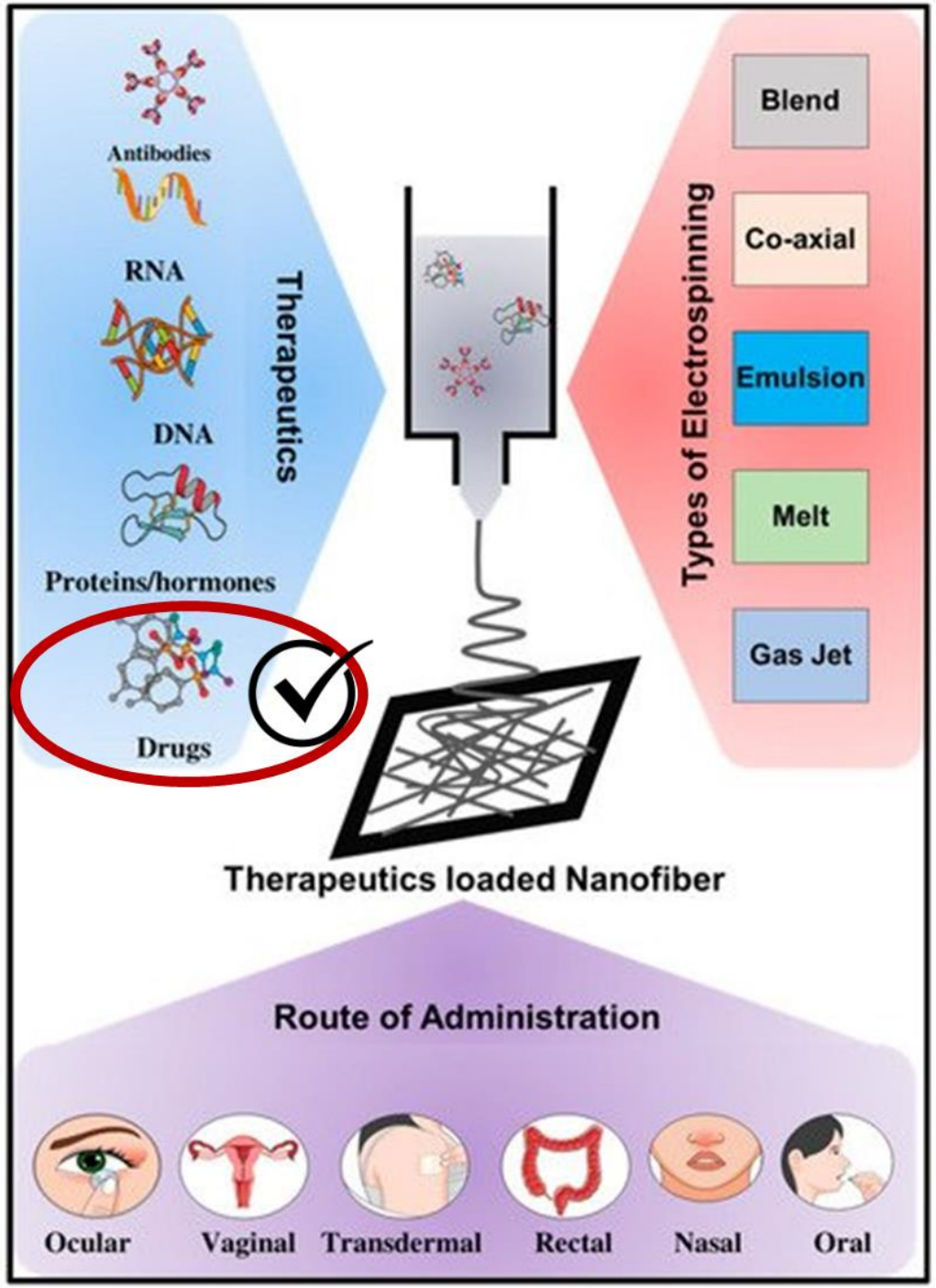
Radhakrishnan Sridhar, *et.al.,* Chem. Soc. Rev., 2015, 44, 790--814

Electrospinning process and various healthcare and biomedical applications of nanofibers



S. M. Shatil Shahriar, *et.al., Nanomaterials* 2019, *9*(4), 532

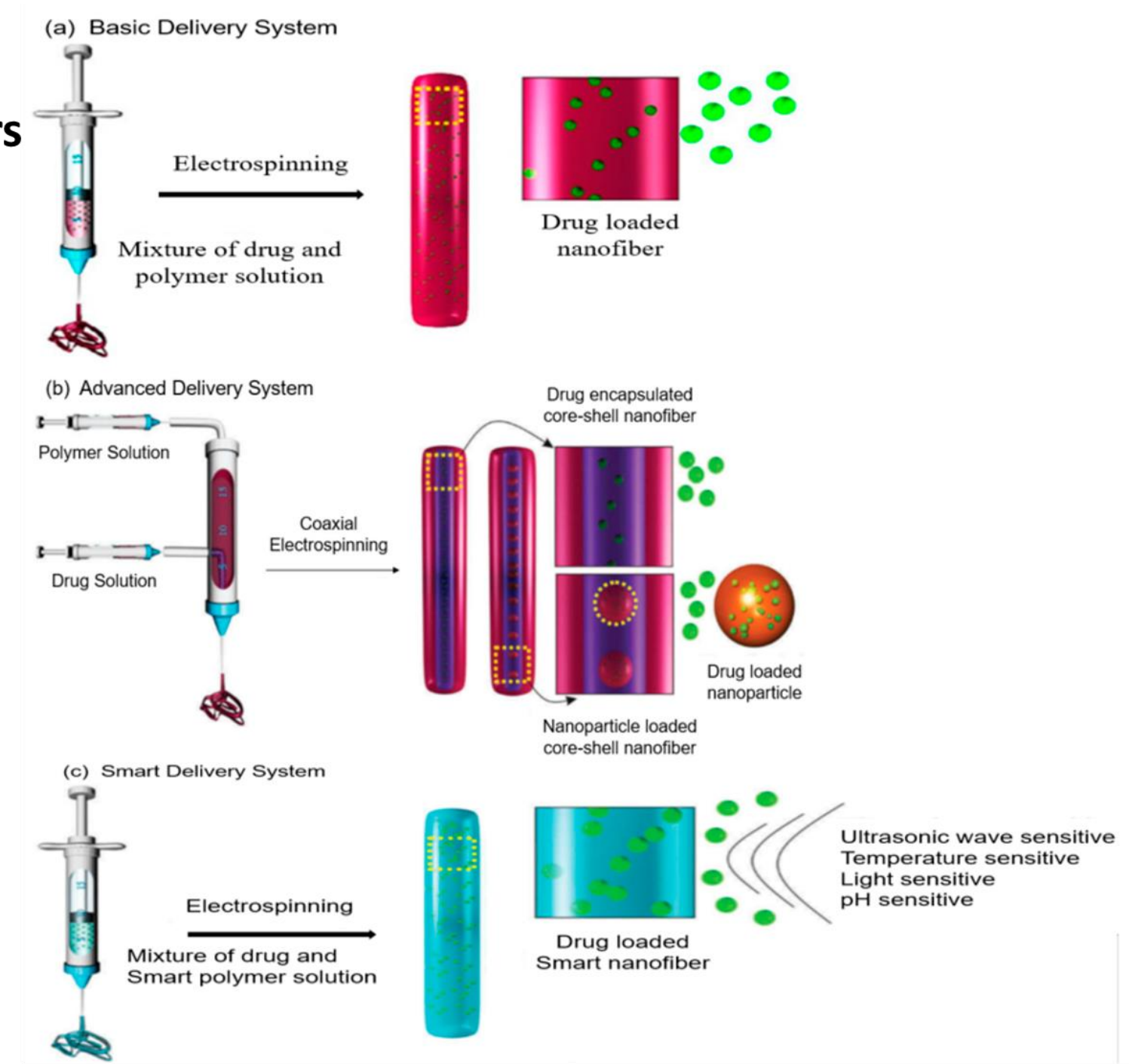
Types of electrospinning, different therapeutics-loaded nanofibers and their route of administrations



S. M. Shatil Shahriar, *et.al., Nanomaterials* 2019, *9*(4), 532

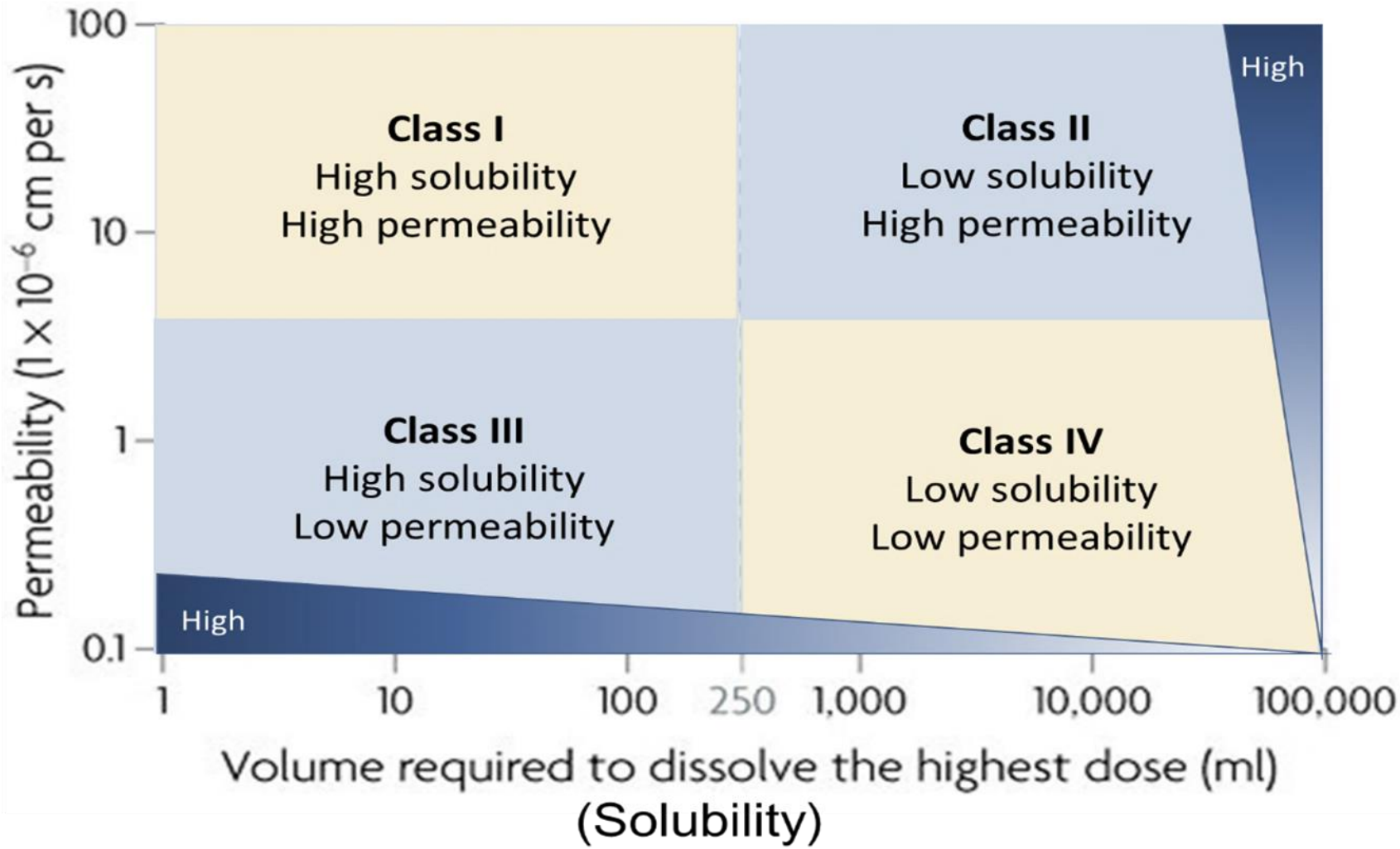
Drug loading strategies to nanofibers

(a) Basic antibacterial delivery systems,
(b) Advanced antibacterial delivery systems (core–shell structure, nanoparticle decorated and multidrug loaded),
(c) Smart delivery systems (stimuli responsive)



S. M. Shatil Shahriar, *et.al., Nanomaterials* 2019, *9*, 4, 532

The biopharmaceutical classification system based on solubility and permeability



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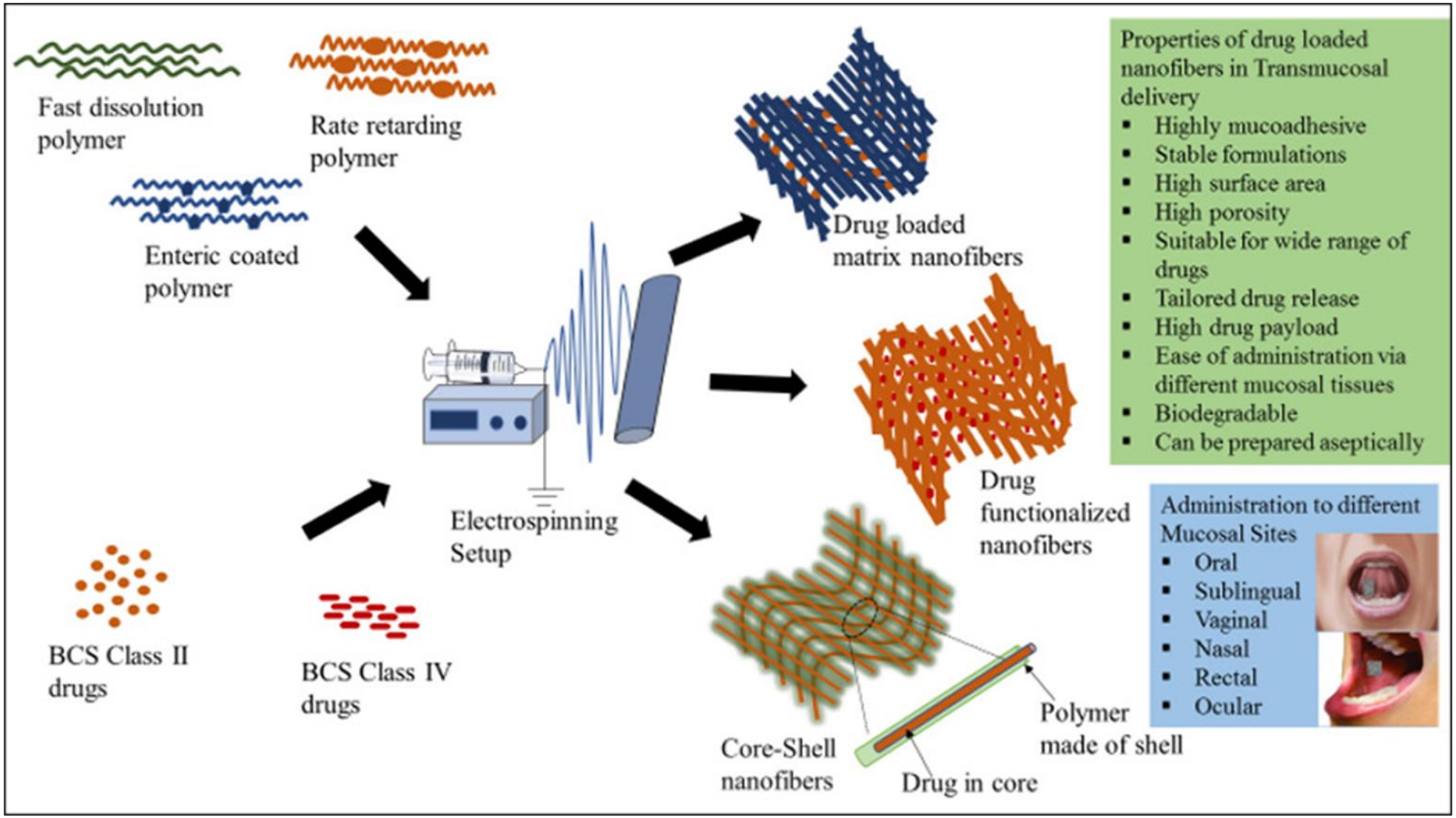
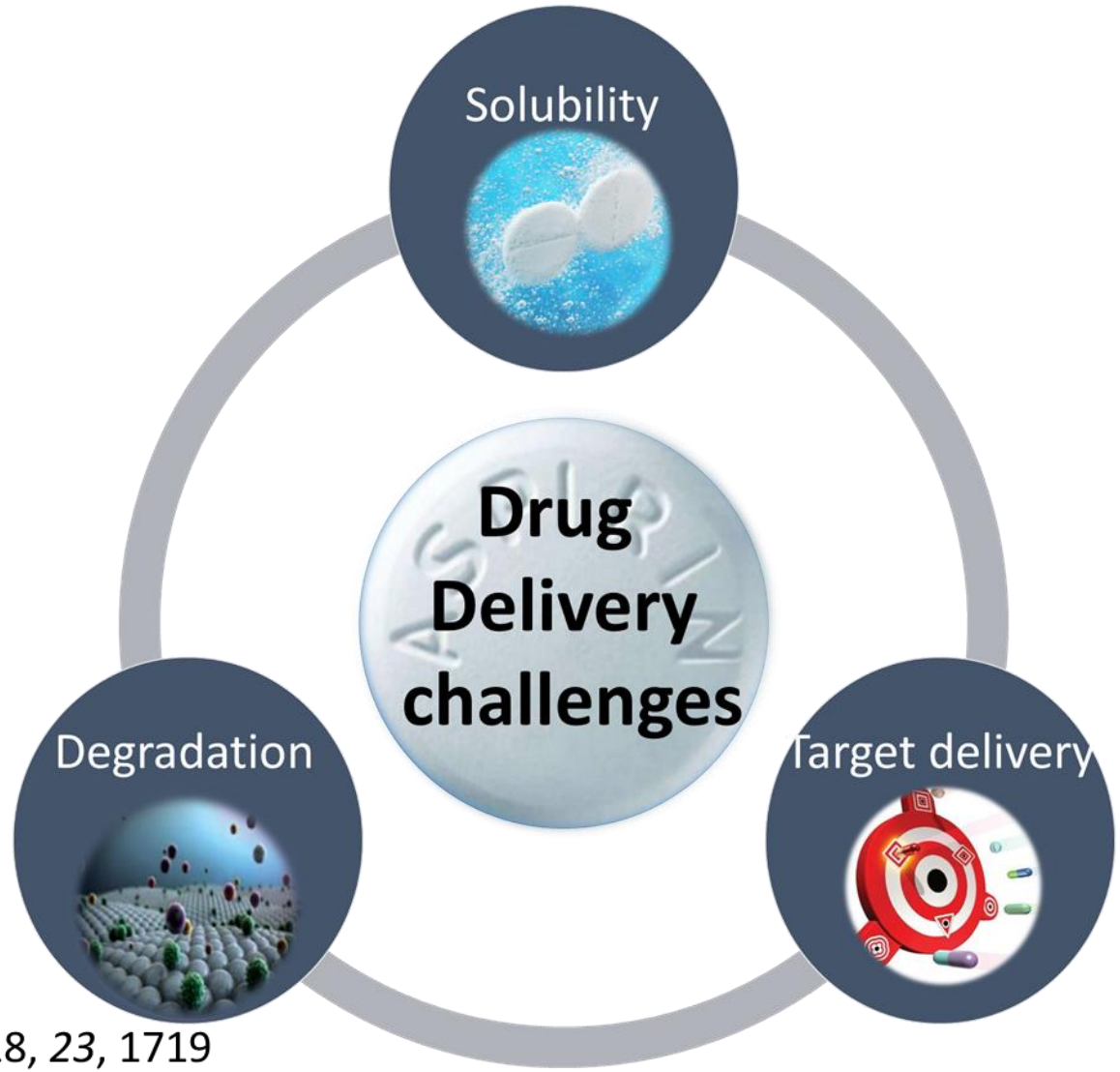
Electrospun nanofibers for the delivery of active drugs through nasal, oral and vaginal mucosa



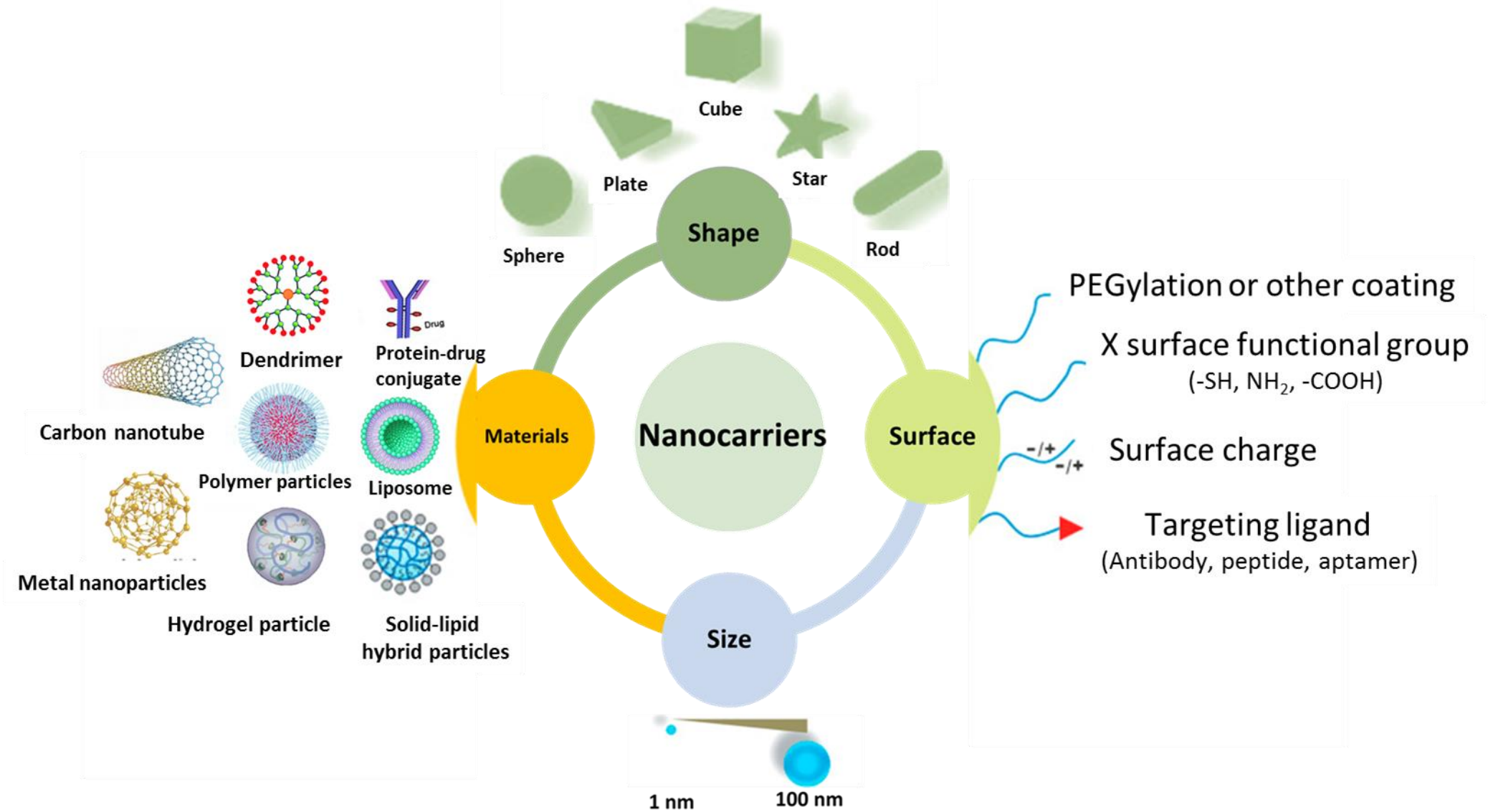
Hasham S. Sofi, *et. al.,* Materials Science and Engineering: C, 2020, 111, 110756

Drug delivery challenges

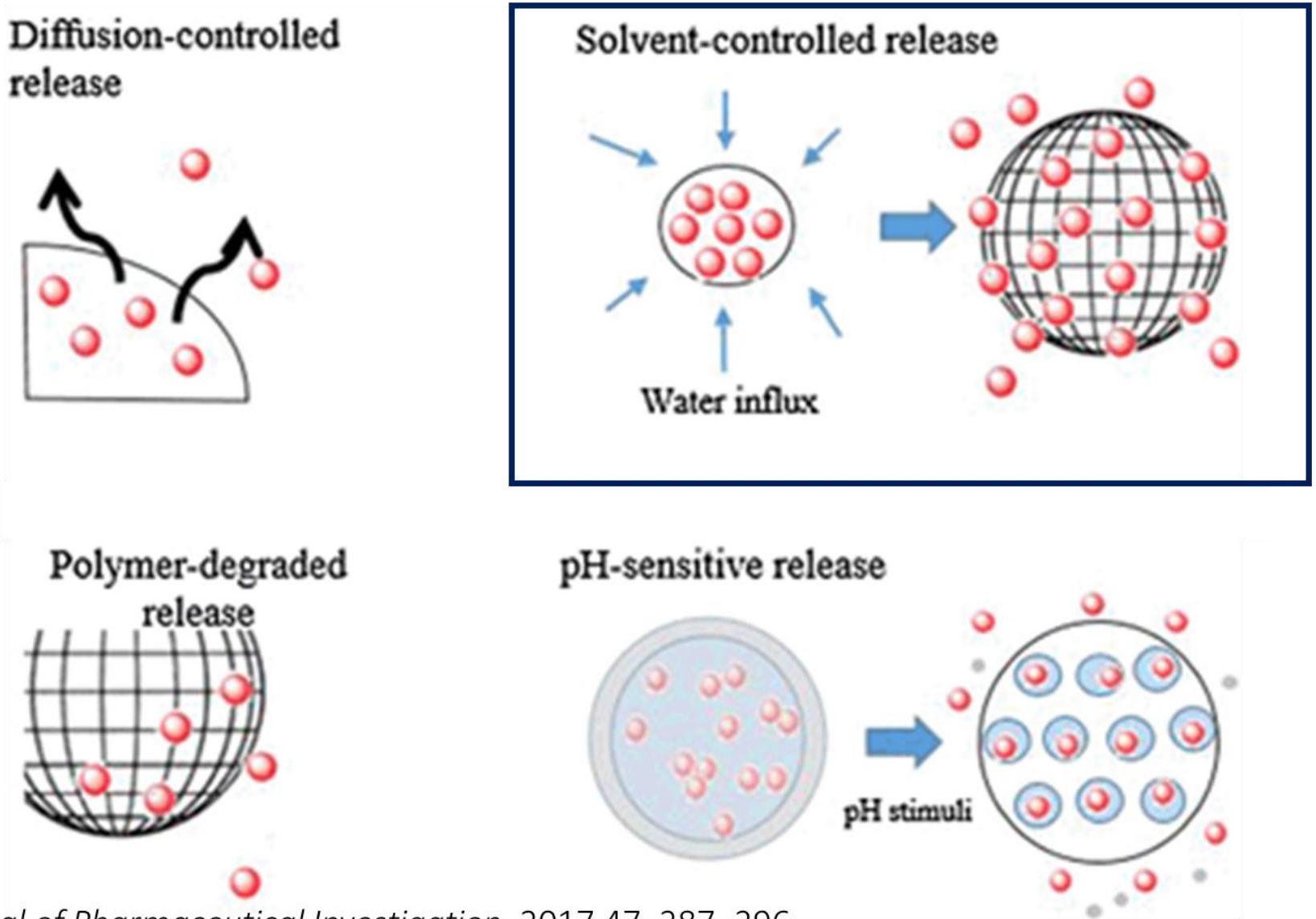


Gupta, D. *et.al*., *Molecules* 2018, *23*, 1719
Bhushan S. Pattni and Vladimir P. Torchilin , Targeted Drug Delivery : Concepts and Design, 2014, PP 3-38

Nanocarriers for drug delivery and biophysicochemical properties

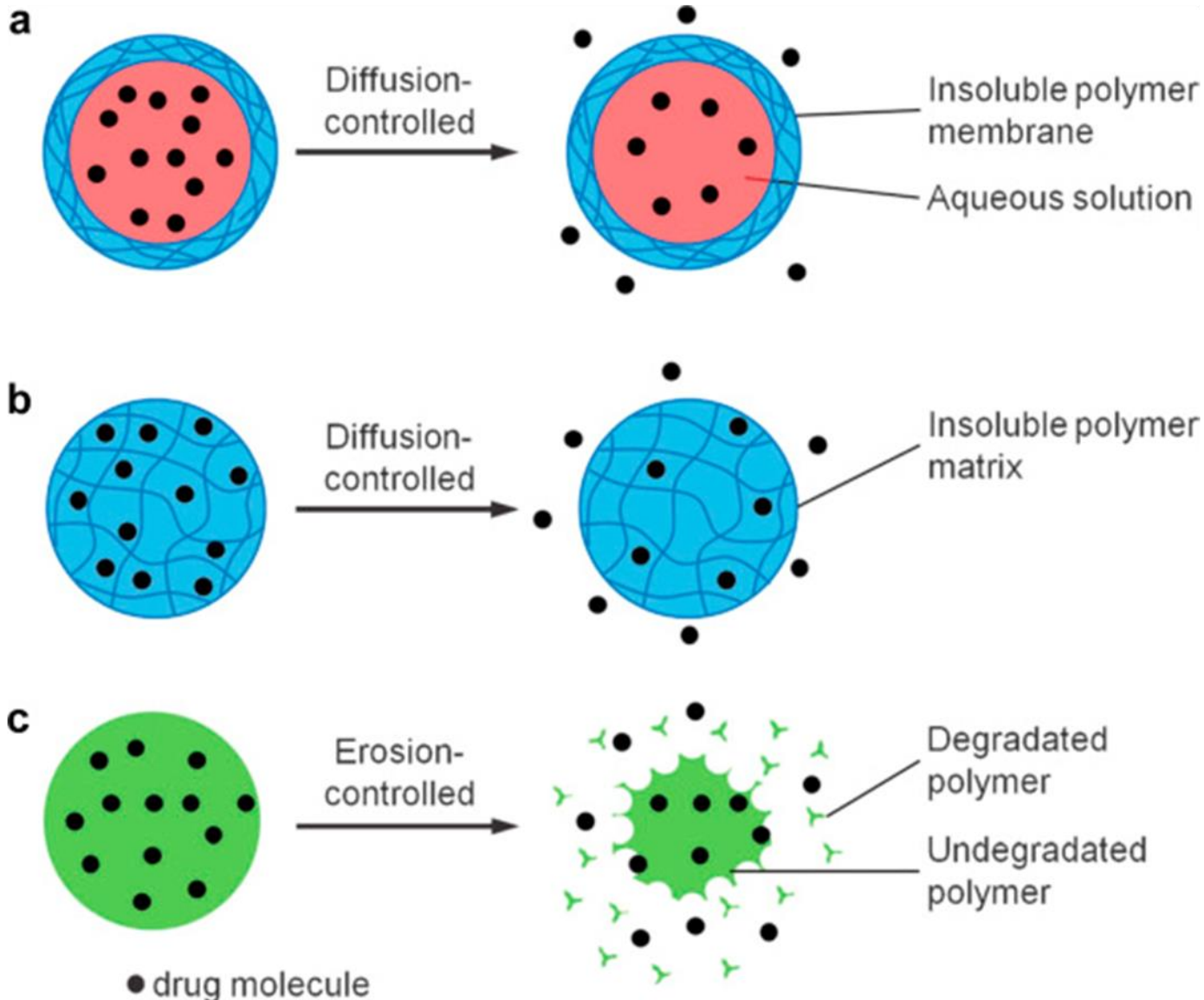


Various mechanisms of drug release from nanocarriers



Gi-Ho Son, *et. Al., ,Journal of Pharmaceutical Investigation*, 2017,47, 287–296

Solvent control release



Hendrik Hein, *et.al., Surface Science Reports,* 2017, 72, 1, 1-58

Current spinning methods

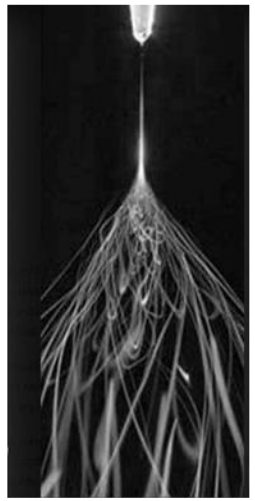
Electrospinning

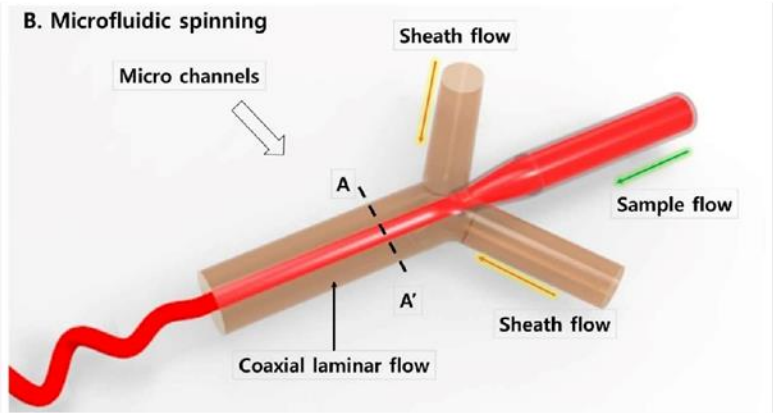
Microfluid spinning

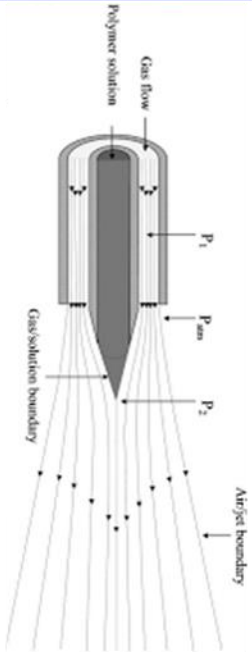
Solution blow spinning

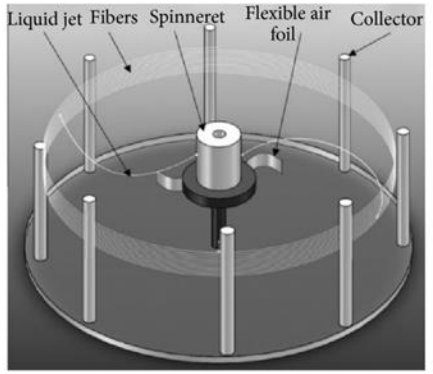
Centrifugal spinning

Electrospray



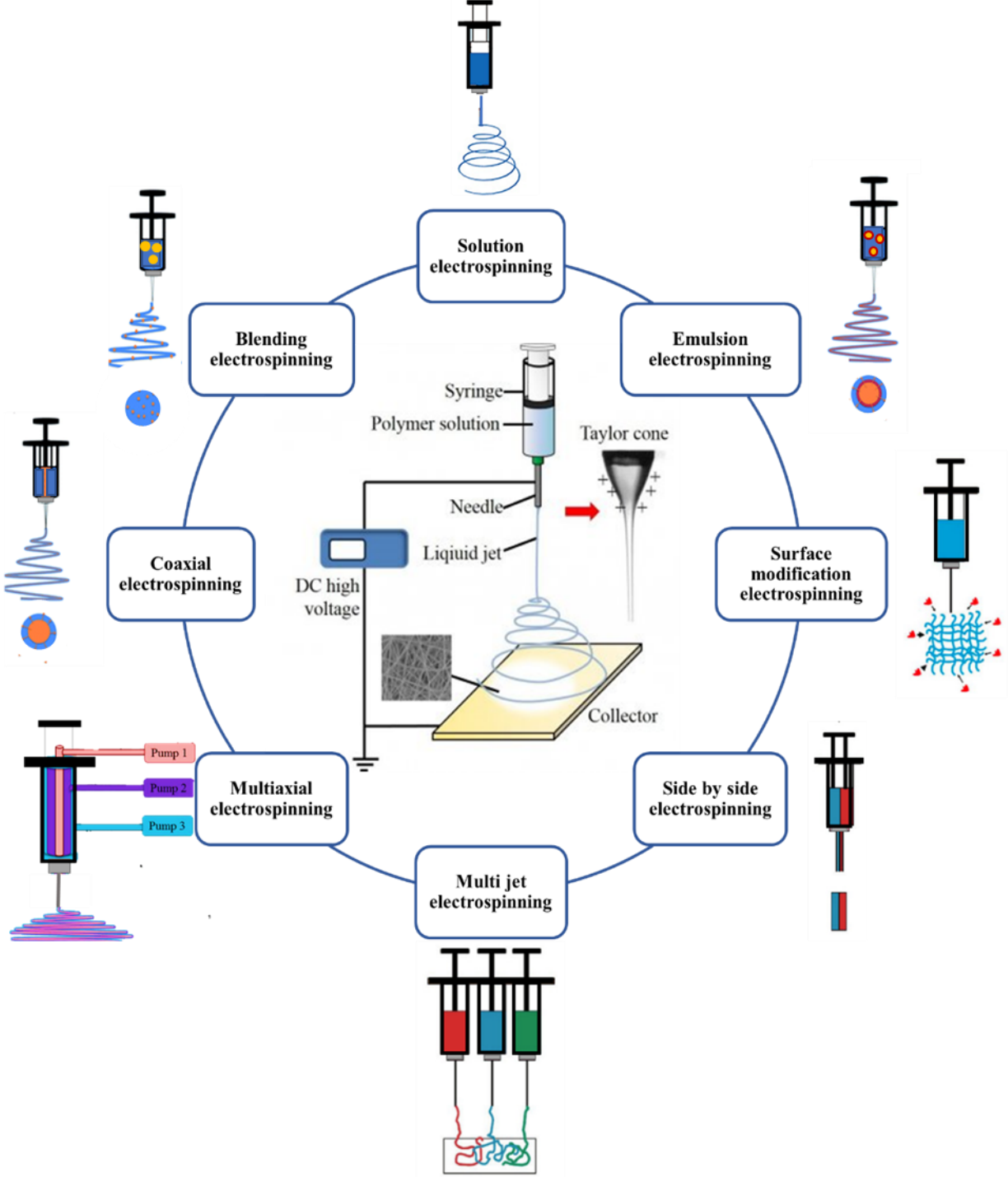




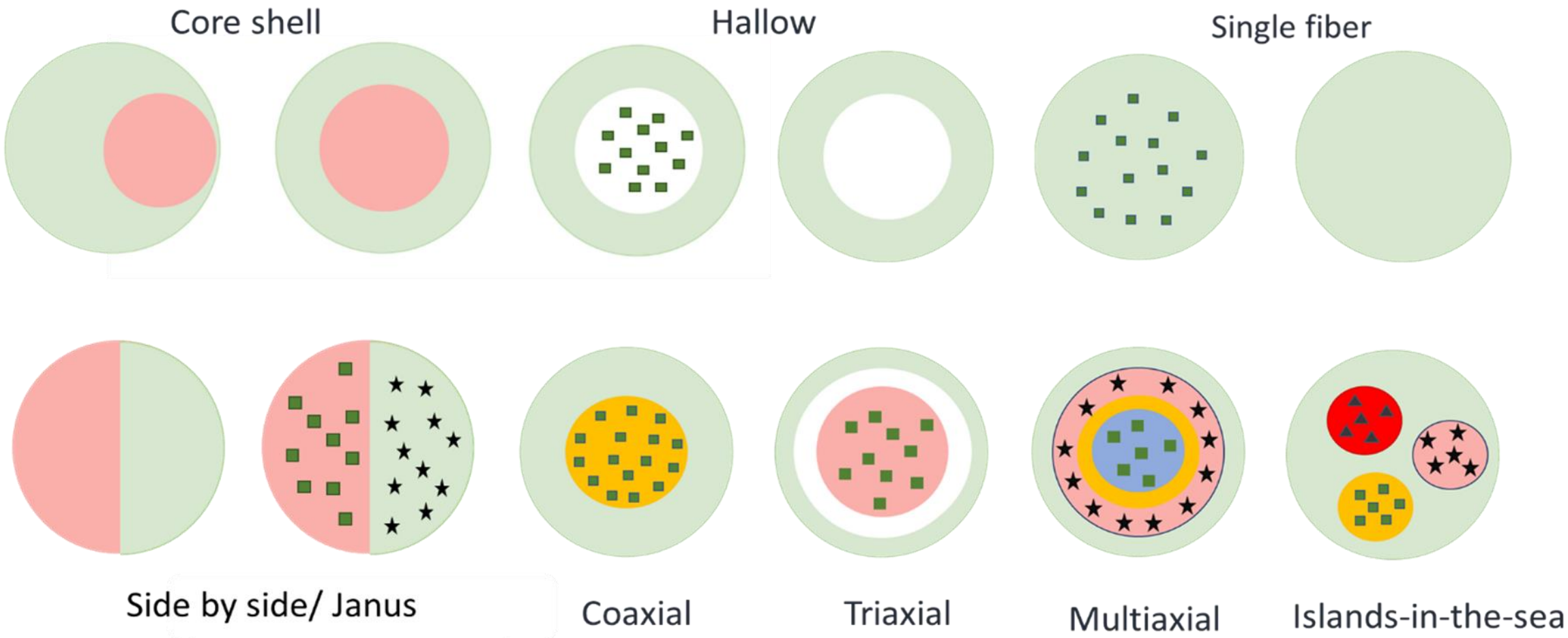


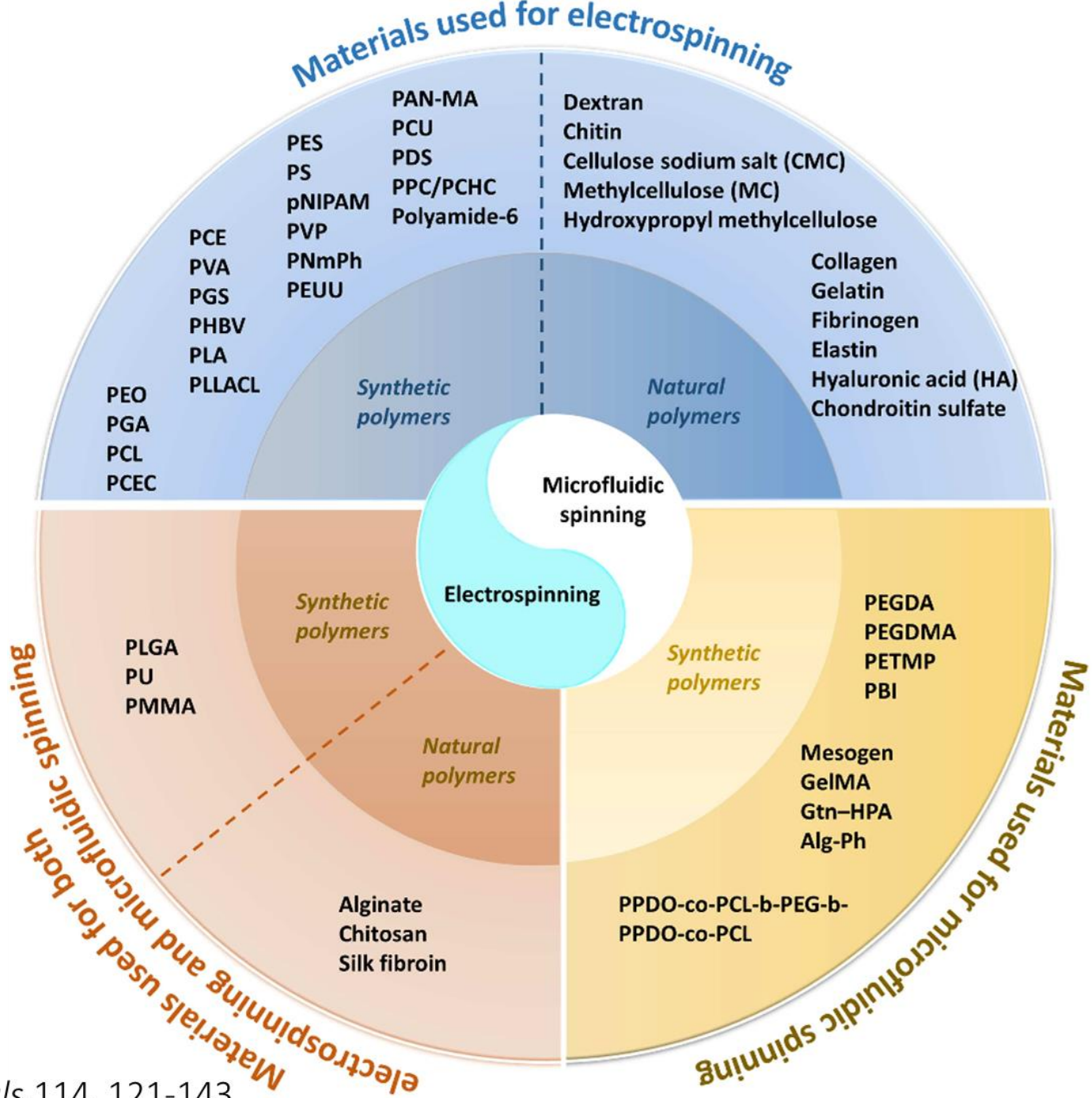
Jie Cheng, *et.al., Biomaterials,* 2017, 114, 121-143

Types of electrospinning for fabrication of nanocarriers for drug delivery applications



Nanofiber Cross section





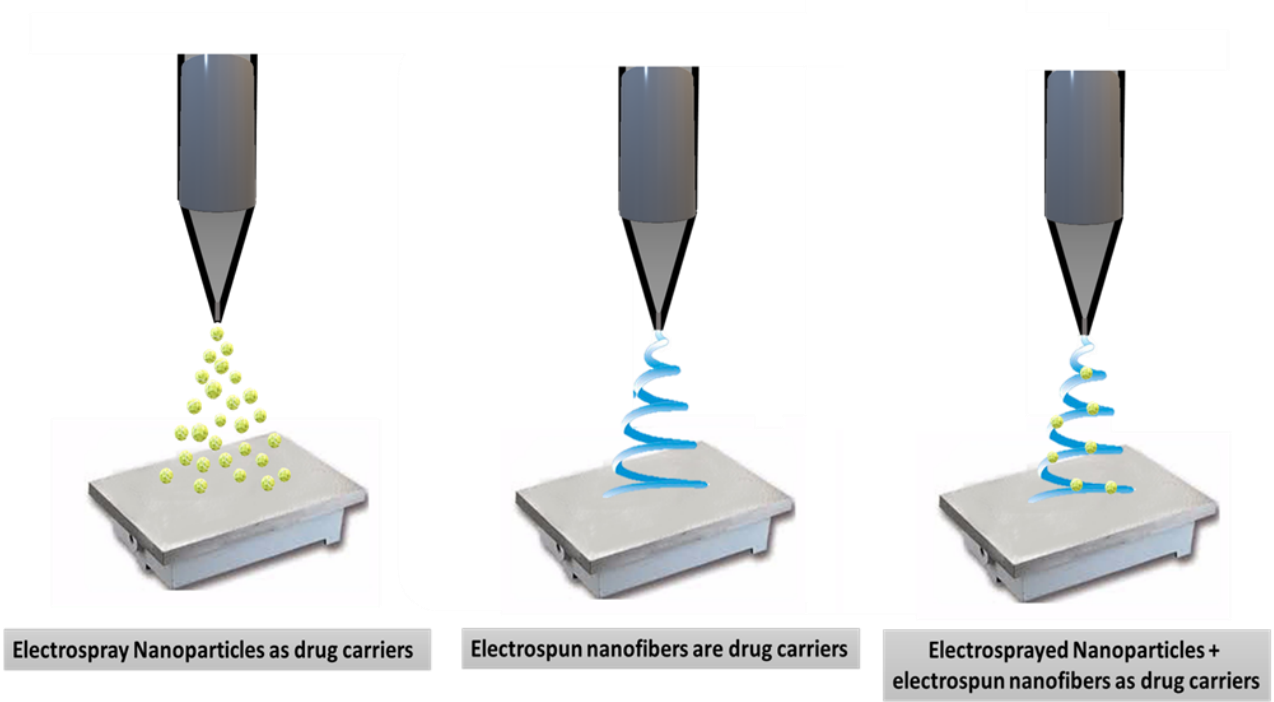
Jie Cheng, *et.al.,2017, Biomaterials*,114, 121-143

List of potential drug delivery applications of electrospun nanocarriers

Morphology	Polymer materials system	Drug types	Applications	Ref.
Particles	PLGA	Doxorubicin	Antineoplastic drugs	[1]
Particles in fiber	PHB	hydroxyapatite nanoparticle	Antineoplastic drugs	[2]
Fiber	Chitosan, PEO	Insulin	Transbuccal insulin delivery	[3]
Fiber	PVP	Carvedilol	Buccal delivery of Carvediol	[4]
Particles	triglyceride tristearin	Superparamagnetic iron oxide nanoparticles and fluorophore	Theranostic agent	[5]
Particles	Lactose	Dry powder inhaler	Pulmonary drug delivery	[6]
Particles	Alginate	Silica supraparticles	Long term drug delivery	[7]
Fiber	PCL	Metronidazole/ciprofloxacin	Antimicrobial	[8]
Particles in fiber	PLGA	$NaYF_4:Eu^{3+}$	Antineoplastic drugs	[9]
Fiber	PCNU	Antimicrobial oligomer (AO)	Antimicrobial	[10]
Fiber	Poly(methyl vinyl ether-alt-maleic ethyl monoester)	Salicylic acid/methyl salicylate capsaicin	Psoriatic lesions treatment	[11]
Particles	PLGA	Curcumin	Antineoplastic drugs	[12]

Conclusion

- In conclusion, it is clear that the electrospinning method by the generation of desired nanofibers and nanoparticles possesses excellent potential in pharmaceutical applications.
- However, optimization of the different factors is crucial to generate nanocarriers with the desired function and morphology for drug delivery application.
- Also, the electrospinning approach is an effective strategy for sustainable drug release, target delivery, and encapsulation of drugs.
- Moreover, there are drawbacks to this system for the commercialization of nanocarriers for drug delivery. Therefore, further studies, standardization, and understanding of public health concern are required to develop marketable products.



Electrospray Nanoparticles as drug carriers

Electrospun nanofibers are drug carriers

Electrosprayed Nanoparticles + electrospun nanofibers as drug carriers

Thank You

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3. Lancina, M.G.; Shankar, R.K.; Yang, H. Chitosan nanofibers for transbuccal insulin delivery. *J. Biomed. Mater. Res. - Part A* **2017**, *105*, 1252–1259.

4. Chen, J.; Pan, H.; Yang, Y.; Xiong, S.; Duan, H.; Yang, X.; Pan, W. Self-assembled liposome from multi-layered fibrous mucoadhesive membrane for buccal delivery of drugs having high first-pass metabolism. *Int. J. Pharm.* **2018**, *547*, 303–314.

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