Bench-to-Bedside:
Anticancer drug-loaded Polymeric Implants for Brain Cancer Treatment and Nanocoating of Medical Devices

Assoc. Prof. Norased Nasongkla, Ph.D.

Professor in Material Engineering *was approved by Mahidol University Council on Jan 17, 2024. This is in the process of being considered and submitted to His Majesty the King for the appointment.*

Leader: Tissue Engineering and Drug Delivery Systems Research Track
Director: Biopolymers and Nanoengineering for Drug Delivery and Molecular Imaging Laboratory (BioNEDD.org)
Director: Laboratory for Biocompatibility Testing of Medical Devices ISO17025 (BiocompatLab.com)

Department of Biomedical Engineering
Faculty of Engineering
Mahidol University
Wisdom of the Land

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BioNEDD Lab

BioNEDD.org

Biopolymers and NanoEngineering for Drug Delivery and Molecular Imaging Laboratory (BioNEDD)

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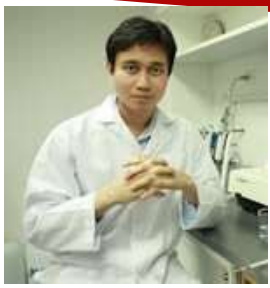
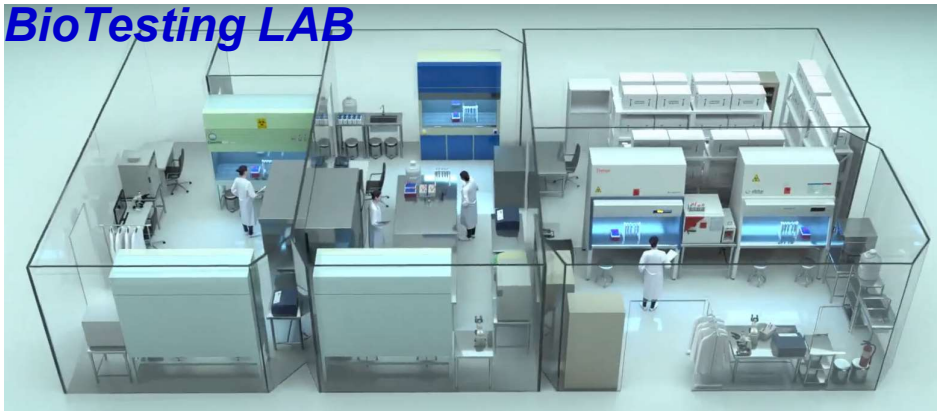


PERCH



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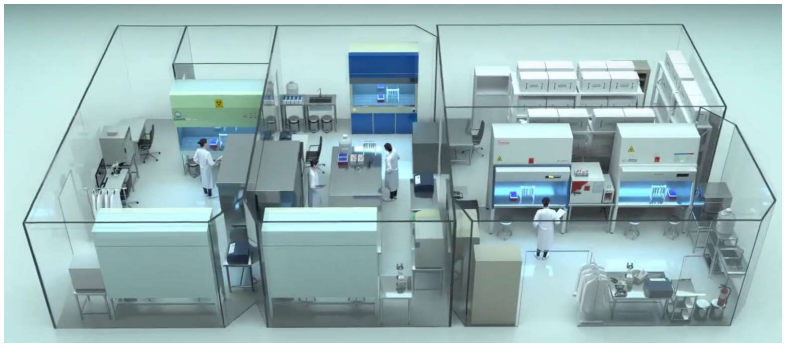
Funding and Scholarship

- Mahidol University
- Center of Excellence for Innovation in Chemistry (PERCH-CIC)
- The Royal Golden Jubilee Ph.D. Program (RGJ- Ph.D.)
- Thailand Toray Science Foundation (TTSF)
- Thailand Research Fund (TRF)
- National Research Council of Thailand (NRCT)

BioNEDD in Healthcare Innovation Ecosystem

Laboratory for Biocompatibility
Testing of Medical Devices



Reskill Upskill Newskill

- Competency Test: Cell, Microbial culture
- Short course: 2 Days & 5 Days
  - ISO10993-1 to 23
  - Wound healing
  - Biomaterials:
    - Metal, Ceramic, Polymer
    - Microstructure
    - Processing & Manufacturing

Testing & Standard

- Cytotoxicity (ISO 10993-5)
- Hemolysis (ISO 10993-4, ASTM F756-17)
- Bioburden testing (ISO11737-1)
- Sterility (ISO11737-2)
- Antibacterial susceptibility: Disc diffusion (Zone) (CLSI M02)
- Antibacterial susceptibility: Dilution method (MIC) (CLSI M07)
- Leachable and degradation product (ISO 10993)
- Heavy metal analysis
- Custom test

R & D

- Nano-coating of Medical Devices
- New Biodegradable polymer
- Surface modification
- Drug Delivery System
- Nanoparticle fabrication

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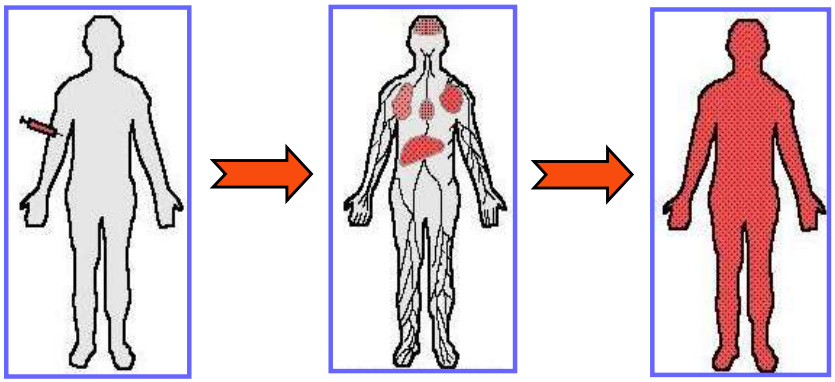
BioNEDD: Research Mission

Conventional chemotherapy

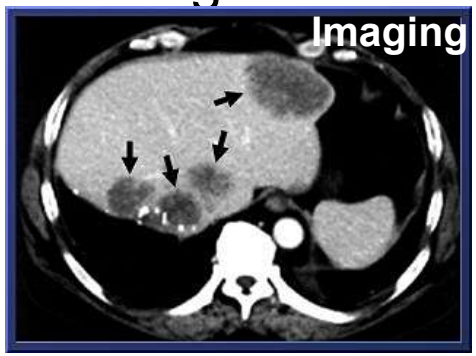


Injection into blood stream

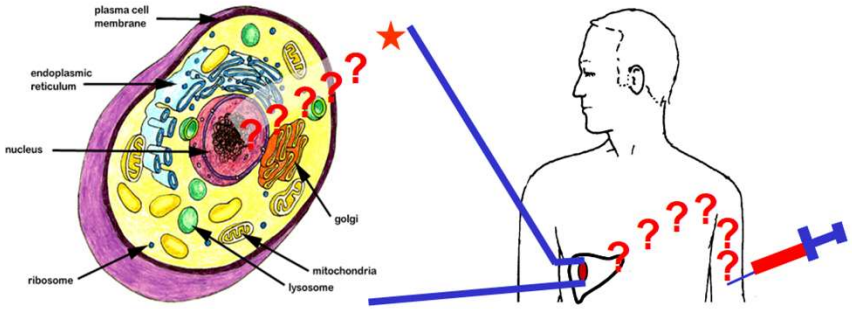
Kidneys,bladder,lungs, Liver

Muscle, fat, skin, etc…

Effective targeted therapy



Targeted drug delivery



Overcome poor drug pharmacokinetics and can efficiently deliver therapeutic agents to their molecular targets to achieve cancer-specific therapy.

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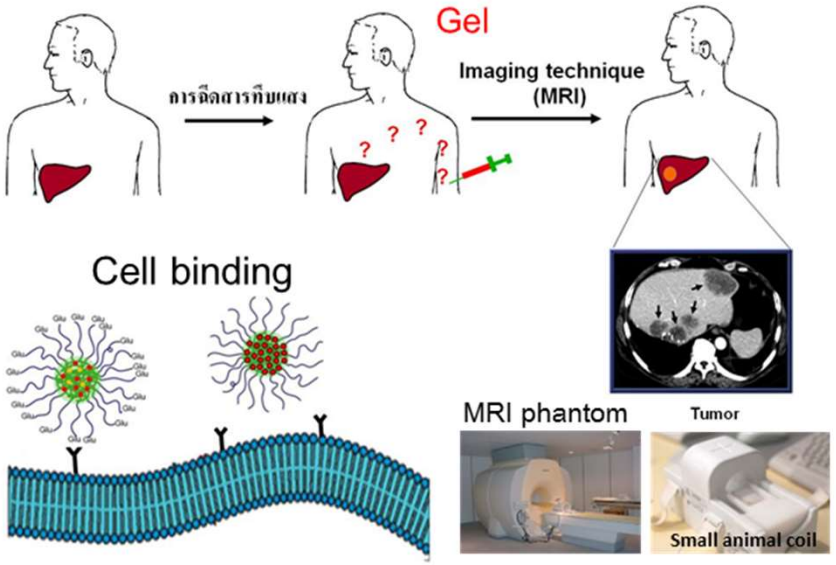
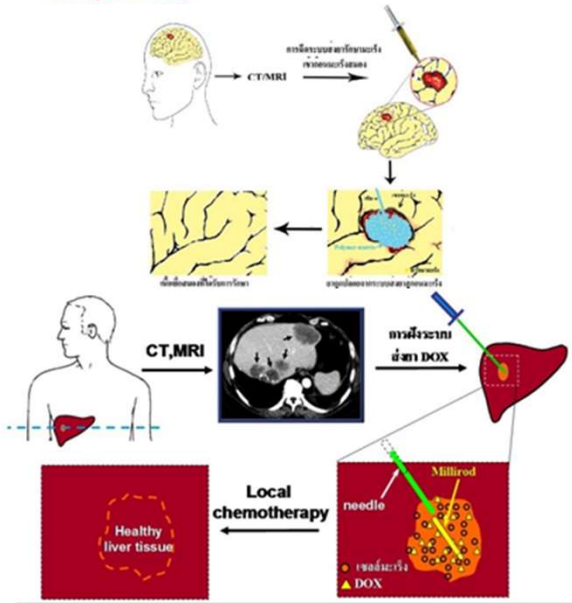
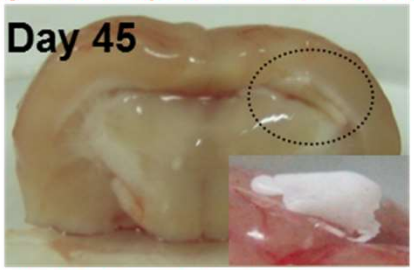
Nanomedicine



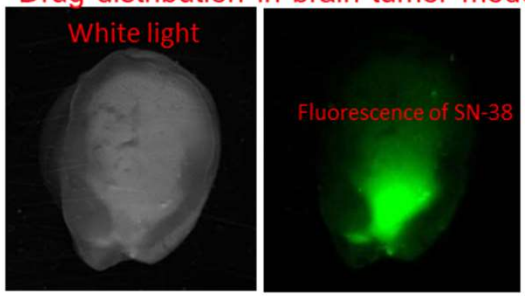
Implants ระบบส่งยารักษาโรคมะเร็งสมอง



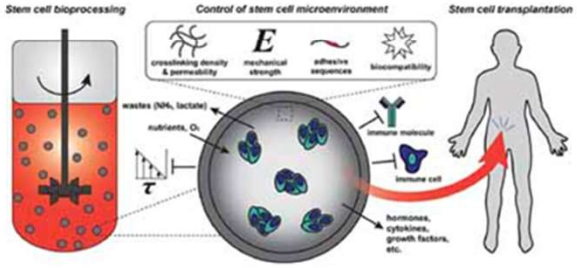
Polymer implant in rat brain

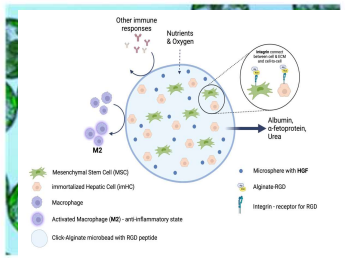


Drug distribution in brain tumor model



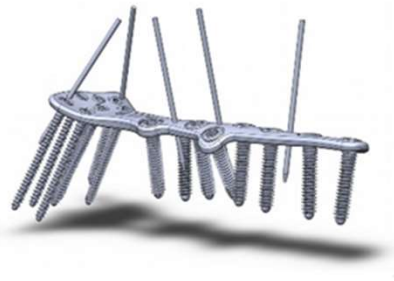
Tissue Engineering/Cell bioreactor



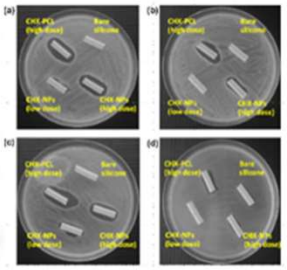


Nanocoating/Medical Device coating

Catheter



Orthopedic devices



BioNEDD Project status:

Antibacterial medical devices & Drug Delivery System

	Cytotoxicity	Hemolysis	Irritation	Sensitization	Implantation...	Clinical
Bedsheet	☐	☐	☐	☐	☐	☐
Bone plate	☑	☑	☐	☐	☐	☐
Schanz pin *(ISO13485)*	☑	☑	☑	☑	☐	☐
EVD *(ISO13485)*	☑	☑	☑	☑	☑	☐
				Pyro, acute, subacute, geno		
Catheter *(Commercialized for animals)*	☑	☑	☑	☑	☑	☐
Dental implant *(ISO13485)*	☑	☑	☑	☑	☑	☐
				Pyro, acute, subacute, geno		
Wound dressing Gel *(ISO13485)*	☑	☑	☑	☑	☑	☐
				Pyro, acute, subacute,		
Brain implant *(GMP)*	☑	☑	☑	☑	☑	☑

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BioMED Lab

Brain Implant for Cancer Therapy:

Minimum invasive delivery of SN-38 for high-grade gliomas therapy via injectable drug delivery system

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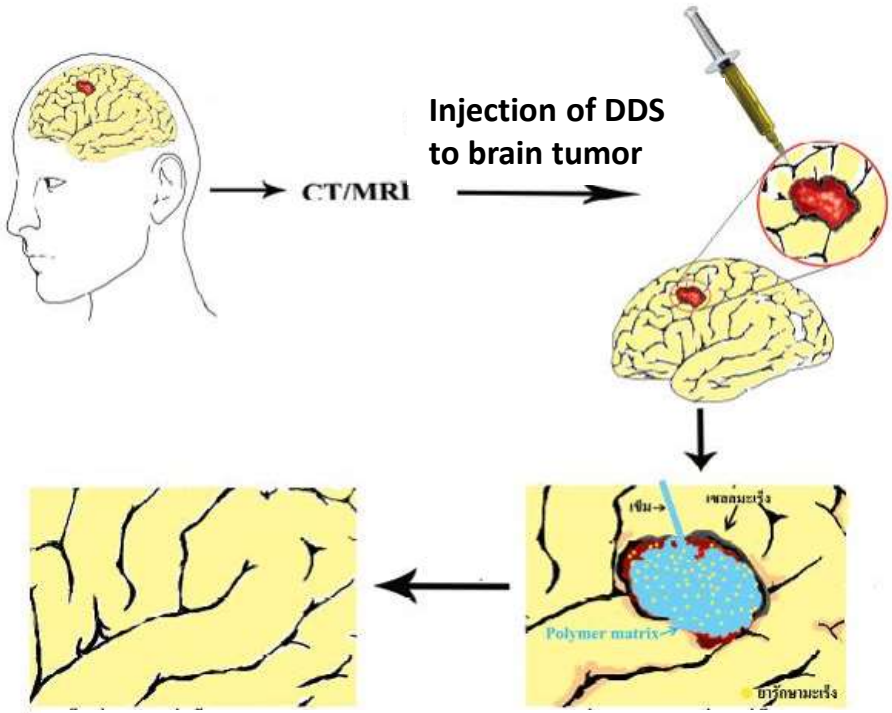
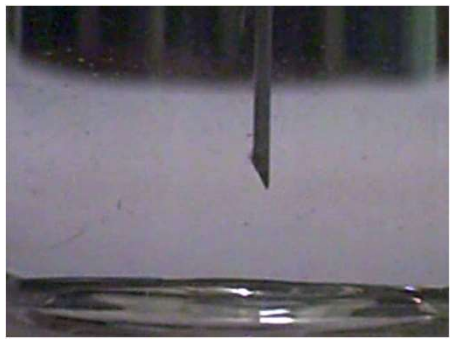
Injectable DDS for Brain Cancer Therapy

Minimum invasive delivery of SN-38 for high-grade gliomas therapy via injectable drug delivery system



Healthy brain tissues

Drugs release in brain tumor



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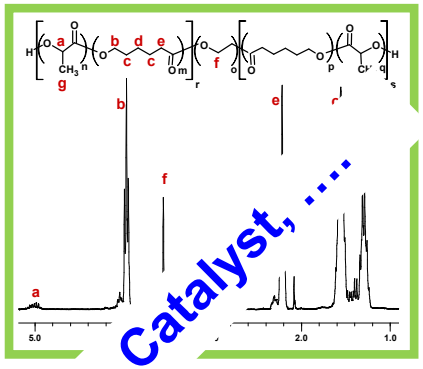
Time Line of Polymeric Depots as SN-38 Carrier for Brain Cancer Chemotherapy

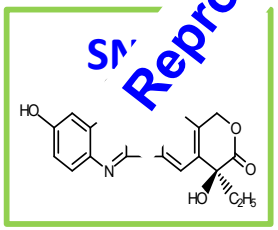


Catalyst, ...

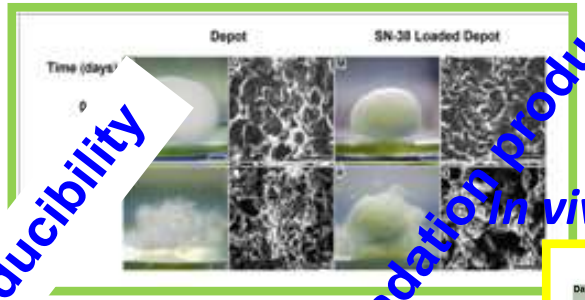
Polymerization

Drug

SN



Reproducibility



Degradation product

Characterization

In vivo formation

Drug distribution in tissues

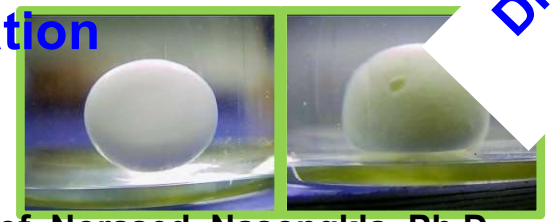
Antitumor

Antitumor efficacy

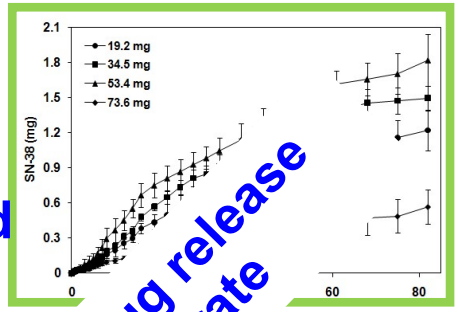
2022-24: 2nd Clinical study

2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2016 | 2024

Depot formation



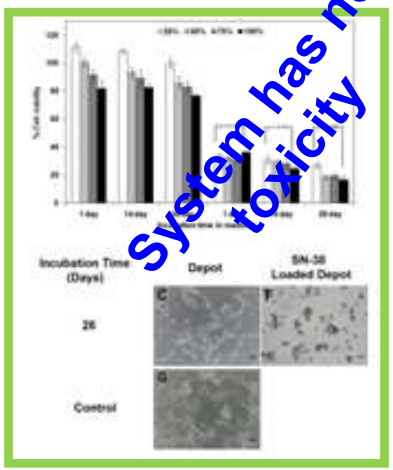
Drug-Loaded Depot



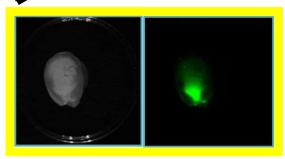
Drug release rate

Release Study

In vitro testing



System has no toxicity



Distribution and toxicity Study

2020: 1st Clinical study

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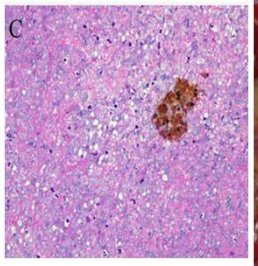
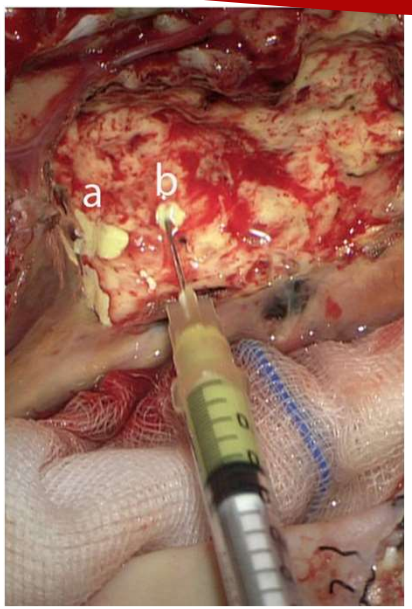
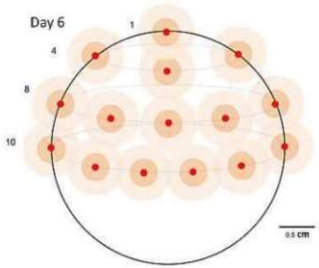
Boongird A (2011), Khamlao W (2012), Nasongkla N (2012), Manaspon C (2012)

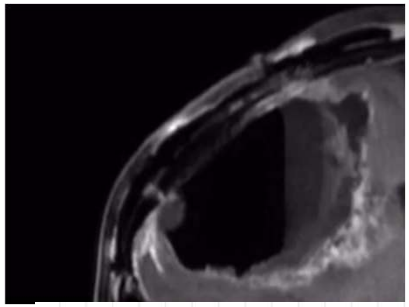
Brain cancer chemotherapy

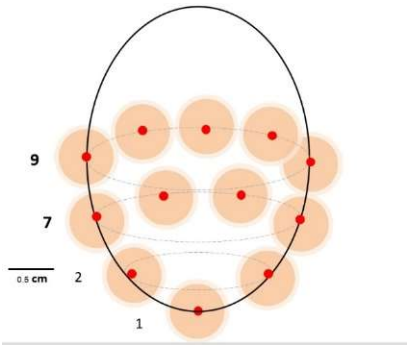


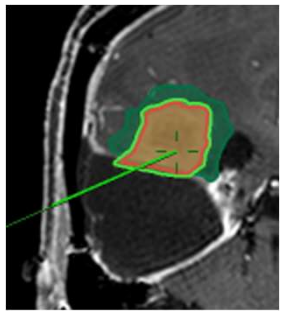


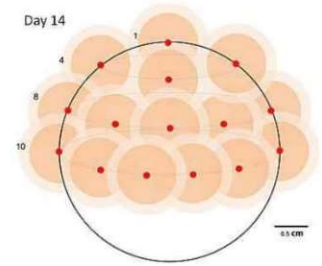
GMP production
- **Sterility**
- **Endotoxin**

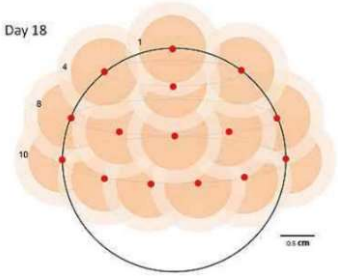


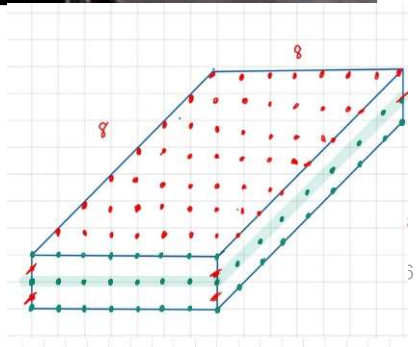












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BioMEDD Lab

Nano-Coating technology:
Antimicrobial-loaded NPs for medical device coating

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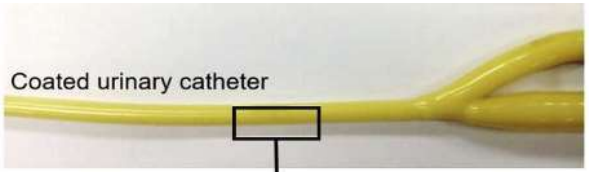
Nano-coating Technology



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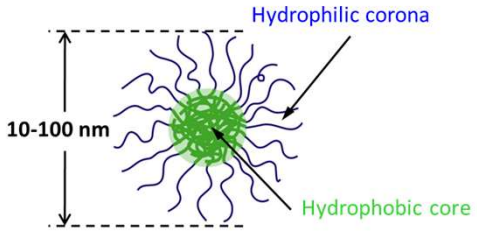

Micelle

Bone plate

Schanz pin

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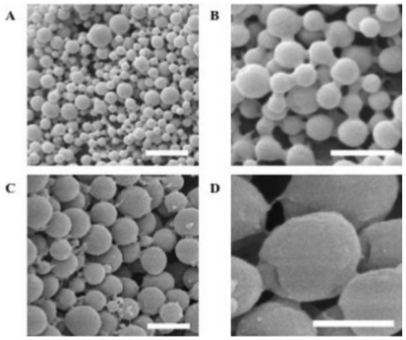

Nanosphere

Dental implant

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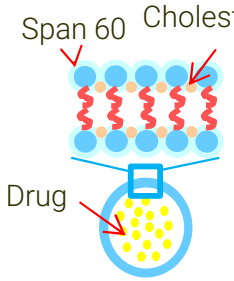

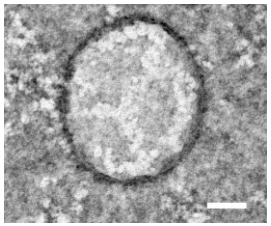

Niosome

Spray coater

Dip coater

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Antibacterial EVD

PLOS ONE

RESEARCH ARTICLE

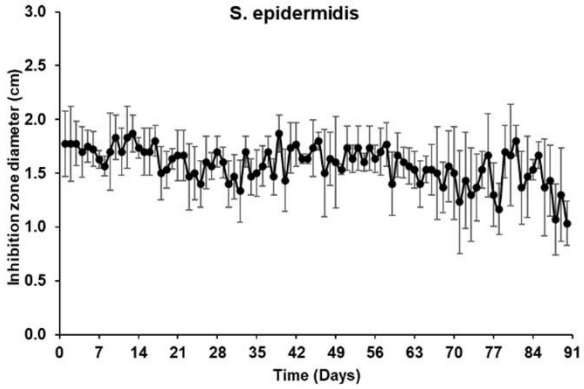
Antibacterial and biocompatibility studies of triple antibiotics-impregnated external ventricular drainage: *In vitro* and *in vivo* evaluation

Norased Nasongkla[1]*, Nattarat Wongsuwan[1], Aniroot Meemai[2], Adisorn Apasuthirat[2], Atthaporn Boongird[3]

Long antibacterial activity

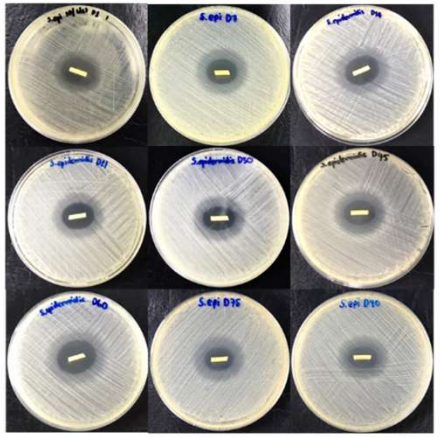
Antibacterial testing

- Agar diffusion assay



Inhibition zone of impregnated EVDs against S. epidermidis.

S. epidermidis



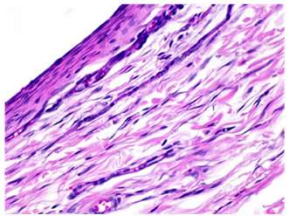
Inhibition zone of impregnated EVDs against *S. epidermidis* after, from top-left to bottom-right 1, 7, 14, 21, 30, 45, 60, 75, and 90 days.

Implantation in New Zealand White rabbits for 30 days

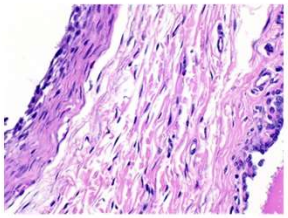
No drug leakage in tissues

No Inflammatory

Testing groups	Inflammatory cell (cells)
Rabbit implanted with bare EVD	3.8 ± 1.0
Rabbit implanted with impregnated EVD	3.8 ± 1.8



Rabbit tissue after implanted with impregnated EVD



Rabbit tissue after implanted with bare EVD

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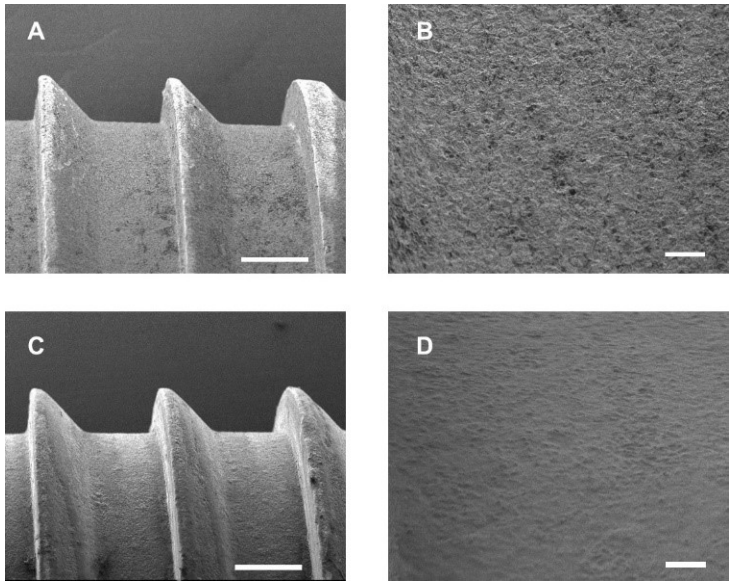
Antibacterial Dental Implant

Nano-coating of dental implant



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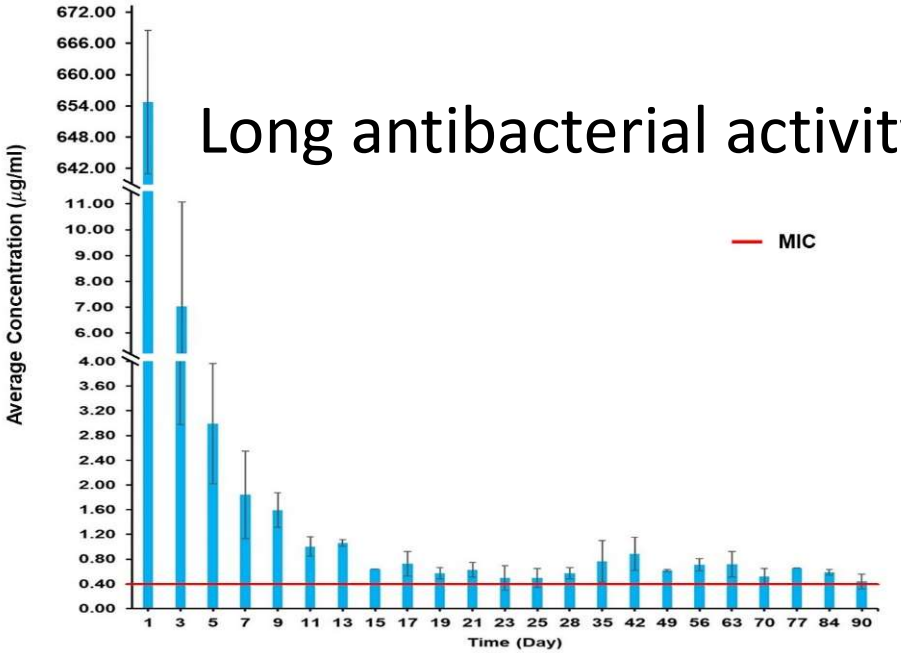
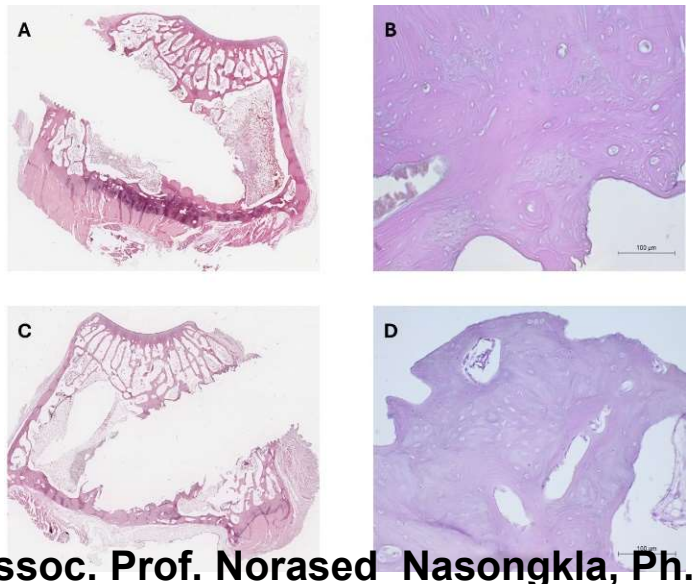
Journal of Drug Delivery Science and Technology
journal homepage: www.elsevier.com/locate/jddst

Development of dental implant coating with minocycline-loaded niosome for antibacterial application

Long antibacterial activity



No evidence of any inflammatory responses



No Irritation & Sensitization

Animal No.	Polar extract	Polar Vehicle	Non-Polar extract	Non-Polar Vehicle
1	0.000	0.000	0.000	0.000
2	0.000	0.000	0.000	0.000
3	0.000	0.000	0.000	0.000
Mean	0.000	0.000	0.000	0.000

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Antibacterial Schanz Pin

INTERNATIONAL JOURNAL OF PHARMACEUTICS

BioMedD Lab

ORTHOPEASIA

Title; *In vitro* and *in vivo* evaluation of the layer-by-layer Vancomycin (VCM) with Poly(ε-caprolactone) (PCL) nanosphere-coated Schanz pins for prolonged release

Napossorn Patiyananuwat[a,b,+], Marjan Safarzadeh[a,+], Thanaphat Chartpitak[a], Kongkhet Riansuwan[c], Winit Ritshima[d], Norased Nasongkla[a,b,*]

Long antibacterial activity

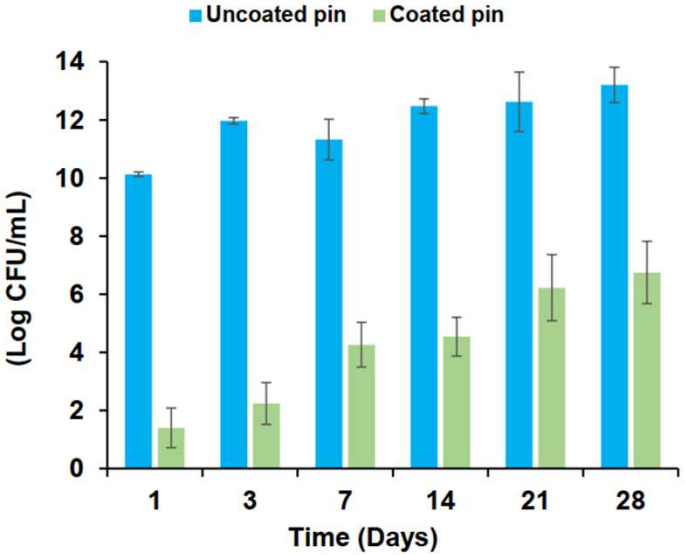

Figure 6. Bacterial concentrations (S. aureus) of uncoated and coated Schanz Pin

No Irritation & Sensitization

Animal No.	Polar extract	Polar Vehicle	Non-Polar extract	Non-Polar Vehicle
1	0.000	0.000	0.000	0.000
2	0.000	0.000	0.000	0.000
3	0.000	0.000	0.000	0.000
Mean	0.000	0.000	0.000	0.000

Assoc. Prof. Norased Nasongkla, Ph.D.

Antibacterial & Wound Healing Gel

BioNEDD Lab

ZnNano

NOVATEC Healthcare

BLUGEL

ISO 13485

Antibacterial & Wound Healing Gel

Physical Tests

- Viscosity Test
- Viscoelasticity Test
- Homogeneity Test
- Macroscopic and Physical Stability Test
- pH Measurement
- Fluid Affinity Test
- SEM-EDS

BioCompatibility

- Anti-bacteria Test
- Cytotoxicity Test
- Hemolysis Test
- Wound Healing Test
- Pyrogenicity
- Acute, subacute toxicity
- Implantation

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BioNEDD Project status:

Antibacterial medical devices & Drug Delivery System

	Cytotoxicity	Hemolysis	Irritation	Sensitization	Implantation...	Clinical
Bedsheet	☐	☐	☐	☐	☐	☐
Bone plate	☑	☑	☐	☐	☐	☐
Schanz pin *(ISO13485)*	☑	☑	☑	☑	☐	☐
EVD *(ISO13485)*	☑	☑	☑	☑	☑	☐
Catheter *(Commercialized for animals)*	☑	☑	☑	☑	☑	☐
Dental implant *(ISO13485)*	☑	☑	☑	☑	☑	☐
Wound dressing Gel *(ISO13485)*	☑	☑	☑	☑	☑	☐
Brain implant *(GMP)*	☑	☑	☑	☑	☑	☑

Pyro, acute, subacute, geno

Pyro, acute, subacute, geno

Pyro, acute, subacute,

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Healthcare Innovation Ecosystem

Laboratory for Biocompatibility
Testing of Medical Devices

Reskill Upskill Newskill

- Competency Test: Cell, Microbial culture
- Short course: 2 Days & 5 Days
  - ISO10993-1 to 23
  - Wound healing
  - Biomaterials:
    - Metal, Ceramic, Polymer
    - Microstructure
    - Processing & Manufacturing

Testing & Standard

- Cytotoxicity (ISO 10993-5)
- Hemolysis (ISO 10993-4, ASTM F756-17)
- Bioburden testing (ISO11737-1)
- Sterility (ISO11737-2)
- Antibacterial susceptibility: Disc diffusion (Zone) (CLSI M02)
- Antibacterial susceptibility: Dilution method (MIC) (CLSI M07)
- Leachable and degradation product (ISO 10993)
- Heavy metal analysis
- Custom test

R & D

- Nano-coating of Medical Devices
- New Biodegradable polymer
- Surface modification

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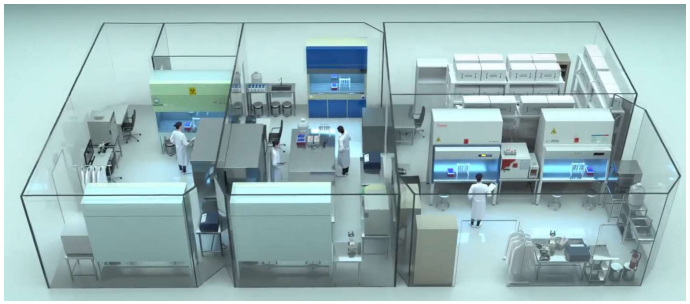
Laboratory for Biocompatibility Testing of Medical Devices
ISO17025 (Biocompatlab.com)

หมายเลขทะเบียน 1325/63



"World-class biocompatibility testing laboratory for medical device industry"

- Cytotoxicity
- Hemolysis
- Bioburden testing
- Sterility
- Antibacterial susceptibility: Disc diffusion (Zone)
- Antibacterial susceptibility: Dilution method (MIC)
- Leachable and degradation product
- Heavy metal analysis

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- Assoc. Prof. Dr. Salunya Tancharoen, Dent MU
- Asst. Prof. Panya Sunintaboon, Chemistry, MU
- WINIT RITSHIMA
- Adisorn Apasuthirat

Laboratory for Biocompatibility Testing of Medical Devices

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Mahidol University
Faculty of Medicine Ramathibodi Hospital

SIRIRAJ ORTHOPAEDICS

BioMedD Lab

PERCH-CIC PERDO

MU DENT
FACULTY OF DENTISTRY MAHIDOL UNIVERSITY

NOVATEC Healthcare

ORTHOPEASIA

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BioNEDD Lab

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National Research University Initiative
and Research Promotion in
Higher Education Project
Office of Higher Education Commission
Ministry of Education

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