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The Future of Nanotechnology and Quantum Dots for the Treatment of COVID-19

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Today, drugs and vaccines for treating coronavirus disease 2019 (COVID-19) are being developed in Russia, China, the USA, Canada, Turkey, Germany, the UK, and Indonesia. Not all drugs for treating COVID-19 have the same functions or target the same aspects of severe acute respiratory syndrome coronavirus type 2 (SARS-CoV-2), the cause of COVID-19. Very recently, some vaccines have been reported to effectively protect against COVID-19. Clinical vaccine trials are in phase 3 in several countries, including Indonesia, Turkey, Chile and Brazil.

A virus is an intracellular parasite with a very simple structure. Viruses lack their own metabolism and thus require a host to replicate. That is why washing one's hands with soap is the first step in preventing the spread of viruses with a lipid membrane, such as SARS-CoV-2. Soap effectively destroys such viruses because they are self-assembled structures. However, soap cannot be used to destroy the virus within a host because the same process that destroys the virus also destroys human cells.

At the moment, much research in the area of nanotechnology is ongoing. Quantum dots (QDs) have been incorporated in many nanotechnological treatments, including drug delivery, bioimaging of cancer cells, and cancer diagnosis and treatment. Many researchers are investigating the use of new materials to treat COVID-19; possible therapies employ modified graphenes and QDs, among others. QDs are multifunctional crystalline semiconductors on a nanometer scale. Based on our studies, this QDs has fewer coordinating molecules on the surface. Nanometer-sized QDs are thermodynamically unstable but can be kept in a colloidal form to maintain stability. Due to their unique optical properties, QDs have significant potential for biomedical applications, including biomedical imaging, biosensors, drug delivery, clinical diagnosis, photodynamic therapy, DNA hybridization, and RNA profiling. Very recently, the potential of QDs for targeting virus cells has received attention. This function could be used to inhibit the activity of COVID-19.

The use of QDs to treat COVID-19 still needs more evaluation and investigation. QDs

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can be functioned and coated with other molecules to improve their drug delivery profile. The chemical functionality of the surface of a QD can also be controlled by a capping agent such as Schiff base compound, which provides colloidal stability, prevents agglomeration and uncontrolled growth, increases solubility, and extends the exciton lifetime of QDs.

The development of QDs and of nanostructured semiconductor crystals (which are usually under 10 nm in size) has opened new horizons in nanoscience and nanotechnology. QDs have been used in a wide range of applications in various fields, including biochemistry, physical chemistry, biomedicine, medicine, pharmaceuticals, microscopy, and engineering. QDs are also a powerful imaging probe for diagnostics and prognostics.

The development and manufacture of bioengineering and medical equipment and devices has become more efficient, and computational modelling and simulations are now used to gather insights into new products.

To address the above issues, the 5th International Symposium on Biomedical Engineering (ISBE) was held 28–29 July 2020 via online conference. The ISBE is an annual event organized by the Research Center for Biomedical Engineering, Universitas Indonesia (RCBE UI). From the papers presented there, 19 have been selected for publication in *IJTech*. These 19 papers are summarized below.

The first paper, by N. Tunjung, P. Kreshanti, Y.R. Saharman, Y. Whulanza, S. Supriadi, M. Chalid, M.I. Anggraeni, A.R.A.H. Hamid, and C.L. Sukasah, clinically evaluates flocked swabs that were manufactured locally in a developing country in response to the COVID-19 pandemic. Six parameters of the swab stick (comfort, smoothness, flexibility, durability, applicability, and breakpoint performance) received satisfactory scores, with averages of 4.14–4.16. Four parameters of the flocked-fiber tip (fiber adherence, thickness, symmetricity, and sample collection sufficiency) received acceptable scores, with averages of 3.6–3.75. This study concludes that locally made flocked swabs are satisfactory and clinically applicable for testing and diagnosing COVID-19.

The second paper, by Y. Whulanza, S. Supriadi, M. Chalid, P. Kreshanti, A.A. Agus, P. Napitupulu, J. Supriyanto, E. Rivai, and A. Purnomo, proposes new acceptance criteria for the national flocked swab for biological specimens. This study developed a swab stick with a stiffness around 400 MPa, a deflection of 15N, a density of 1.5–2.5 Dtex, a water contact angle of 78 degrees, and adsorption of around 25–35mL of liquid water. No solvent or any toxic substance was detected around the flocked swab during residue testing. The product has been formally registered under the trade name Sterilized Nasopharynx Swab Stick HS 19.

The third paper, by E.A. Krisanti, D. Lazuardi, K.K. Kiresya, K. Mulia**,** describes the xanthones were extracted from the pericarp of soursop fruit and encapsulated in chitosan-alginate microparticles using the ionic gelation method. The microparticles were then formulated into antioxidant supplement tablets via direct compression. The potential of these tablets to deliver xanthones to the gastrointestinal tract was then tested. If targeted release to a specific area in the gastrointestinal tract is preferable, the composition of the excipients of that formulation should be modified accordingly.

The fourth paper, by M. Sahlan, M.N.H.A. Faris, R. Aditama, K. Lischer, A.C. Khayrani, and D.K. Pratami, describes the antidiabetic activity of South Sulawesi propolis compounds, which was tested using molecular docking on Autodock Vina. Only two flavonoids showed 100% interaction similarity with the re-docked native ligand as well as AMP natural inhibition. These two compounds were Broussoflavonol F and Glyasperin A, which had docking scores of -9 kcal/mol and -8.2 kcal/mol, respectively. This indicates that both compounds can be used as an FBPase inhibitor to treat diabetes mellitus.

The fifth paper, by K. Lischer, K.P. Tansil, M.J. Ginting, M. Sahlan, A. Wijanarko, and M. Yohda, describes the isolation of thermophilic bacteria from the Batu Kuwung hot springs; the bacteria's DNA pol I gene was then cloned to Escherichia coli. The recombinant plasmid contains the right gene. This was confirmed via digestion that used the same restriction enzymes to identify the restriction areas from the gene cloning and the products of digestion, which aligned with the theoretical gene size (2637 *bp*), despite the slight shift of the position of whole bands. The resulting protein expression assay, measured using SDS-PAGE, suggests a significant overexpression of proteins around the target protein molecular weight of 9965 *kDa*.

The sixth paper, by M.Y.A. Ramadhan, A.F.P. Harahap, C.N. Sari, Y. Muharam, W.W. Purwanto, D. Tristantini, and M. Gozan, proposes a design for a plant that can be used to produce a healthy, herbal base for ice cream. This highly nutritious product could be a healthier alternative snack to improve public health. They found that herbal ice cream made from *Gynura procumbens* could help improve public health, provide a healthier alternative snack, and improve the national economy. The proposed plant has a relatively short payback period (2.24 years) and breakeven point; other costs are not prohibitive.

The seventh paper, by Dianursanti, A.R. Siregar, Y. Maeda, T. Yoshino, and T. Tanaka, aims to increase carotenoid yield and provide new data on the optimum conditions for carotenoid extraction from *Chlorella vulgaris.* Several solvents with varying polarities (ethanol, acetone, and diethyl ether) and several solvent-to-solid ratios (1:30, 1:50, and 1:100) were tested. The paper identifies the solvent and solid-to-solvent ratio that provides the highest carotenoid yield from *C. vulgaris* via ultrasound extraction. The highest carotenoid yield was achieved with ethanol as an extraction solvent and a solid-to-solvent ratio of 1:100 (g/mL).

The eighth paper, by C.V. Sibuea, J.A. Pawitan, R. Antarianto, C.O.M. Jasirwan, I.R. Sianipar, E. Luviah, R.W. Nurhayati, W. Mubarok, and N.F. Mazfufah, describes the reconstruction of liver organoids using primary rat hepatocytes, a hepatic stellate cell line (LX2), human umbilical cord-mesenchymal stem cells (UC-MSCs), and human umbilical cord blood (UCB)-CD34+ hematopoietic stem/progenitor cells. The authors found a simple, economic solution by using William's E medium supplemented with platelet lysate, ITS, and dexamethasone. This provided an optimal culture medium for reconstructing a liver organoid. This combination of cellular components and culture medium provides a suitable microenvironment that mimics the *in vivo* microenvironment of the liver; this medium was able to maintain liver organoid function until day 14.

The ninth paper, by A.H. Dewi, D.K. Yulianto, I.D. Ana, Rochmadi, and W. Siswomihardjo, loaded cinnamaldehyde in hydrogel $CaCO_3$ was incorporated into plaster of Paris (POP). The effects on surface topography, contact angle, and surface roughness were measured. Cinnamaldehyde, an anti-inflammatory agent, was successfully loaded to hydrogel $CaCO_3$ before the hydrogel was incorporated into the POP to form a POP- hydrogel $CaCO_3$ composite. Adding cinnamaldehyde to the hydrogel increased the contact angle, but the angle remained under 90^o (hydrophilic). The increased contact angle and surface roughness may influence blood protein adsorption and cell attachment.

The tenth paper, by S.F. Rahman and G.W. Hardi, describes the development of a graphene oxide/poly (3,4-ethylene-dioxythiophene): poly (4-styrenesulfonate) (GO/PEDOT: PSS) composite film using electropolymerization on the surface of a working electrode. The GO-PEDOT: PSS, a transducer, was deposited on a commercially available screen-printed carbon electrode. The modified electrode exhibits high performance and a low detection limit; the method shows promise for modifying electrode material to function as an electrochemical sensor. The electropolymerization of GO/PEDOT: PSS on the surface of the electrode results in a detection limit of 1 μA and a wide linear range (1–1,000 μM). This composite electrode was used to detect rapid-current response DA.

The eleventh paper, by H. Rahman, M. Rizkinia, and Basari, presents a framework for a novel image reconstruction algorithm. The framework consists of a controller and an image reconstructor for a portable, microwave-based brain tumor detector; the system is open source and multi-platform. The algorithm results in a better reconstruction, qualitatively and quantitatively, than algorithms based on full sampling or on CS. The proposed SLR-CS algorithm uses color and size in the image reconstruction to differentiate tumor from tissue. Quantitatively, this method results in higher similarity to the reference image and fewer errors than existing methods, according to SSIM and MSE parameters.

The twelfth paper, by R. Maharani, R.E. Edison, M.F. Ihsan, and W.P. Taruno, introduces a novel average subtraction technique for processing a reconstructed image of the brain obtained using brain ECVT. The technique demonstrates distinctive differences in the electrical activity of the intracranial region in tumor cases compared to normal brains. The technique may lead to better detection of brain tumors using ECVT electrical activity scans. Further quantification of this difference in electrical activity is still needed as the electrical activity may also vary in the presence of brain stimulation or other abnormalities that could affect brain electricity.

The thirteenth paper, by Rizal, R. Syaidah, Evelyn, A.M. Hafizh, and J. Frederich, examines the differentiation capacity of Wharton's jelly-mesenchymal stem cells (WJ-MSCs) that are isolated using explantation. WJ-MSC cells were grown in Wharton's jelly, and the isolated cells were adhered in T25 plastic flasks. Wharton's jelly is one of the best sources for mesenchymal stem cells; WJ-MSCs have characteristics of both embryonic and adult stem cells. This study found that the isolated WJ-MSCs generated high-quality stem cells that meet the criteria for mesenchymal stem cells. The capacity must still be quantified, and more work is needed to better determine the quality of stem cells and their role in engineering bone tissue.

The fourteenth paper, by M. Genisa, S. Shuib, Z.A. Rajion, D. Mohamad, and E.M. Arief, examines the implant stability of pre- and post-crown placement. During the healing process, osseointegration was monitored and correlated with bone quality and quantity using resonance frequency analysis (RFA) and cone beam computed tomography (CBCT). The study reports that the degree of implant stability correlates with the success of implant treatment. Implant stability increased from stage 1 to stage 2 in increments of 68.85 to 77.80 on the ISQ scale; from stage 2 to stage 3, it increased in increments of 77.80 to 82.17 on the ISQ scale. Implant stability is not significantly related to bone density. The available space for the implant site – that is, the bone height of the mandible and cortical thickness – correlates strongly with implant stability.

The fifteenth paper, by N.A.N. Izmin, F. Hazwani, A.H. Abdullah, and M. Todo, investigates the correlation of risk of bone fracture in resurfacing hip arthroplasty (RHA) with varus and valgus placement of implants. The study finds that varus placement of a resurfacing hip implant should be avoided to sustain bone longevity. Valgus placement of an RHA implant might help prevent fracture. Valgus placement reduces the possibility of fracture by 44% and 34% compared to varus and straight placement.

The sixteenth paper, by I. Nunut, Y. Whulanza and S. Kassegne, tests a beeswax printing technology in a paper-based microfluidic system. Experimental and analytical models were developed to validate the findings. The beeswax printer allows a fine profile of approximately 0.5 mm – 2.0 mm wide and 30 μm – 150 μm thick.

The seventeenth paper, by M.A. Ahmad, N.N.M.E. Zulkifli, S. Shuib, S.H. Sulaiman, and A.H. Abdullah, uses a finite element method to analyze proximal cement fixation in total hip arthroplasty. Stress and strain distribution and displacement of the cemented total hip arthroplasty during stair climbing were successfully analyzed using the finite element method. They found that the von Mises stress did not exceed the yield strengths of 115MPa, 205MPa, and 29 MPa, respectively.

The eighteenth paper, by M. Irsyad, M.H. Nadhif, A.J. Rahyussalim, H. Assyarify, and M.S. Utomo, proposes material selection techniques for polymer hubs of novel spinal stem cell introducers using the finite element and weighted property methods. They found that introducers made of AISI SS304 with PC, PE, PP, and PS hubs are mechanically strong enough to survive the equivalent forces of accidental fall and a surgeon's grip. The translated vMS and MTR were categorized into three values according to the three separate cases. These values were identified as the three most important properties in WPM. The PC-hub received the highest WPM score and is thus recommended as a hub material.

The nineteenth paper, by M.H. Nadhif, H. Assyarify, A.K. Waafi, and Y. Whulanza, investigates the mechanical functionalities of bioreactors used for tissue engineering. This paper finds that the efficacy of a bioreactor can be determined by investigating the biomechanical and histological properties of the engineered tissues. A seven-step framework is proposed to facilitate the improvement of the mechanical functionalities of future tissue engineering bioreactors.

We hope this special edition of *IJTech* includes findings and insight that lead to new knowledge. We invite you to join us by sending your research for consideration.

Kind regards,

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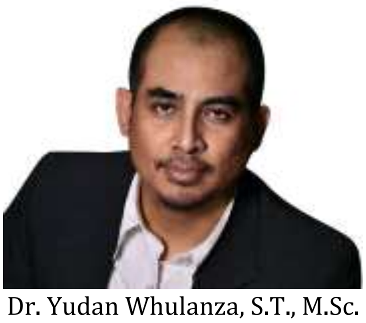

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