

Bibliography

- [1] Katritzky, A. Roy and Denisko, . Olga V. (2023, December 1). heterocyclic compound. Encyclopedia Britannica. <https://www.britannica.com/science/heterocyclic-compound>
- [2] Eicher, T., Hauptmann, S. and Speicher, A. (2003). The Structure of Heterocyclic Compounds. In *The Chemistry of Heterocycles* (eds T. Eicher, S. Hauptmann and A. Speicher). <https://doi.org/10.1002/352760183X.ch1>
- [3] Martínez, A., Vázquez, M.-V., Luis Carreón-Macedo, J., Sansores, L. E., & Salcedo, R. (2003). Benzene fused five-membered heterocycles. A theoretical approach. *Tetrahedron*, 59(34), 6415–6422. [https://doi.org/10.1016/s0040-4020\(03\)01075-5](https://doi.org/10.1016/s0040-4020(03)01075-5)
- [4] McNab, H. (2010). *John A. Joule and Keith Mills Heterocyclic Chemistry*, 5th edn Wiley-Blackwell, 2010, 640 pp. (paperback) ISBN 978-1-4051-3300-5. *Applied Organometallic Chemistry*, 25(2), 162–162. Portico. <https://doi.org/10.1002/aoc.1719>
- [5] Brugnatelli, G. (1818). V. Observations on the various changes which take place on treating uric with nitrous acid, and on a new acid callea “erythric” thence produced. *The Philosophical Magazine*, 52(243), 30–47. <https://doi.org/10.1080/14786441808652000>
- [6] Döbereiner, J. W. (1832). Ueber die medicinische und chemische Anwendung und die vortheilhafte Darstellung der Ameisensäure. *Annalen Der Pharmacie*, 3(2), 141–146. Portico. <https://doi.org/10.1002/jlac.18320030206>
- [7] Runge, F. F. (1834). Ueber einige Produkte der Steinkohlendestillation. *Annalen Der Physik*, 107(5), 65–78. Portico. <https://doi.org/10.1002/andp.18341070502>
- [8] Kekulé, Aug. (1857). Ueber die s. g. gepaarten Verbindungen und die Theorie der mehratomigen Radicale. *Justus Liebigs Annalen Der Chemie*, 104(2), 129–150. Portico. <https://doi.org/10.1002/jlac.18571040202>
- [9] Baeyer, A., & Drewsen, V. (1882). Darstellung von Indigblau aus Orthonitrobenzaldehyd. *Berichte Der Deutschen Chemischen Gesellschaft*, 15(2), 2856–2864. Portico. <https://doi.org/10.1002/cber.188201502274>

- [10] Treibs, A. (1936). Chlorophyll- und Hämin-derivate in organischen Mineralstoffen. *Angewandte Chemie*, 49(38), 682–686. Portico. <https://doi.org/10.1002/ange.19360493803>
- [11] Elson, D., & Chargaff, E. (1952). On the desoxyribonucleic acid content of sea urchin gametes. *Experientia*, 8(4), 143–145. <https://doi.org/10.1007/bf02170221>
- [12] Chargaff, E., Lipshitz, R., & Green, C. (1952). COMPOSITION OF THE DESOXYRIBONUCLEIC ACIDS OF FOUR GENERA OF SEA-URCHIN. *Journal of Biological Chemistry*, 195(1), 155–160. [https://doi.org/10.1016/s0021-9258\(19\)50884-5](https://doi.org/10.1016/s0021-9258(19)50884-5)
- [13] Fleming, A. (1980). On the Antibacterial Action of Cultures of a *Penicillium*, with Special Reference to Their Use in the Isolation of *B. influenzae*. *Clinical Infectious Diseases*, 2(1), 129–139. <https://doi.org/10.1093/clinids/2.1.129>
- [14] Crowfoot, D., Bunn, C. W., Rogers-Low, B. W., & Turner-Jones, A. (1949). XI. The X-Ray Crystallographic Investigation of the Structure of Penicillin. *Chemistry of Penicillin*, 310–366. <https://doi.org/10.1515/9781400874910-012>
- [15] Kyle, R. A. (1982). Gerhard Domagk. *JAMA: The Journal of the American Medical Association*, 247(18), 2581–2581. <https://doi.org/10.1001/jama.247.18.2581>
- [16] Baeyer, A. (1885). Ueber Polyacetylenverbindungen. *Berichte Der Deutschen Chemischen Gesellschaft*, 18(2), 2269–2281. Portico. <https://doi.org/10.1002/cber.18850180296>
- [17] Miyaura, N., Yamada, K., & Suzuki, A. (1979). A new stereospecific cross-coupling by the palladium-catalyzed reaction of 1-alkenylboranes with 1-alkenyl or 1-alkynyl halides. *Tetrahedron Letters*, 20(36), 3437–3440. [https://doi.org/10.1016/s0040-4039\(01\)95429-2](https://doi.org/10.1016/s0040-4039(01)95429-2)
- [18] Heck, R. F., & Nolley, J. P. (1972). Palladium-catalyzed vinylic hydrogen substitution reactions with aryl, benzyl, and styryl halides. *The Journal of Organic Chemistry*, 37(14), 2320–2322. <https://doi.org/10.1021/jo00979a024>
- [19] Milstein, D., & Stille, J. K. (1978). A general, selective, and facile method for ketone synthesis from acid chlorides and organotin compounds catalyzed by palladium. *Journal of the American Chemical Society*, 100(11), 3636–3638. <https://doi.org/10.1021/ja00479a077>

- [20] CLOUGH, J. M., EVANS, D. A., DE FRAINE, P. J., FRASER, T. E. M., GODFREY, C. R. A., & YOULE, D. (1994). ChemInform Abstract: Role of Natural Products in Pesticide Discovery. The β -Methoxyacrylate Fungicides. ChemInform, 25(16). Portico. <https://doi.org/10.1002/chin.199416321>
- [21] Sakamoto, K., & Ohno-Okumura, E. (2009). Syntheses and Functional Properties of Phthalocyanines. Materials, 2(3), 1127–1179. <https://doi.org/10.3390/ma2031127>
- [22] Derkowska-Zielinska, B., Skowronski, L., Biitseva, A., Grabowski, A., Naparty, M. K., Smokal, V., Kysil, A., & Krupka, O. (2017). Optical characterization of heterocyclic azo dyes containing polymers thin films. Applied Surface Science, 421, 361–366. <https://doi.org/10.1016/j.apsusc.2016.12.080>
- [23] Zhao, X., Chaudhry, S. T., & Mei, J. (2017). Heterocyclic Building Blocks for Organic Semiconductors. Heterocyclic Chemistry in the 21st Century - A Tribute to Alan Katritzky, 133–171. <https://doi.org/10.1016/bs.aihch.2016.04.009>
- [24] Elie, M., Renaud, J.-L., & Gaillard, S. (2018). N-Heterocyclic carbene transition metal complexes in light emitting devices. Polyhedron, 140, 158–168. <https://doi.org/10.1016/j.poly.2017.11.045>
- [25] Lindh, L., Gordivska, O., Persson, S., Michaels, H., Fan, H., Chábera, P., Rosemann, N. W., Gupta, A. K., Benesperi, I., Uhlig, J., Prakash, O., Sheibani, E., Kjaer, K. S., Boschloo, G., Yartsev, A., Freitag, M., Lomoth, R., Persson, P., & Wärnmark, K. (2021). Dye-sensitized solar cells based on Fe N-heterocyclic carbene photosensitizers with improved rod-like push-pull functionality. Chemical Science, 12(48), 16035–16053. <https://doi.org/10.1039/d1sc02963k>
- [26] Imatinib mesylate. (2001). American Journal of Health-System Pharmacy, 58(23), 2241–2242. <https://doi.org/10.1093/ajhp/58.23.2241>
- [27] Baeyer, A. (1866). Ueber die Reduction aromatischer Verbindungen mittelst Zinkstaub. Justus Liebigs Annalen Der Chemie, 140(3), 295–296. Portico. <https://doi.org/10.1002/jlac.18661400306>
- [28] Sundberg, R. J. (1996). Introduction. Indoles, 1–6. <https://doi.org/10.1016/b978-012676945-6/50021-1>

- [29] TAYLOR, W. I. (1966). ISOLATION AND CHARACTERIZATION OF INDOLE ALKALOIDS. *Indole Alkaloids*, 5–8. <https://doi.org/10.1016/b978-1-4831-9671-8.50008-6>
- [30] Pino-Rios, R., & Solà, M. (2020). The Relative Stability of Indole Isomers Is a Consequence of the Glidewell-Lloyd Rule. *The Journal of Physical Chemistry A*, 125(1), 230–234. <https://doi.org/10.1021/acs.jpca.0c09549>
- [31] Kumar, S., & Ritika. (2020). A brief review of the biological potential of indole derivatives. *Future Journal of Pharmaceutical Sciences*, 6(1). <https://doi.org/10.1186/s43094-020-00141-y>
- [32] Fischer, E., & Hess, O. (1884). Synthese von Indolderivaten. *Berichte Der Deutschen Chemischen Gesellschaft*, 17(1), 559–568. Portico. <https://doi.org/10.1002/cber.188401701155>
- [33] Madelung, W. (1912). Über eine neue Darstellungsweise für substituierte Indole. I. *Berichte Der Deutschen Chemischen Gesellschaft*, 45(1), 1128–1134. Portico. <https://doi.org/10.1002/cber.191204501160>
- [34] Bartoli, G., Palmieri, G., Bosco, M., & Dalpozzo, R. (1989). The reaction of vinyl grignard reagents with 2-substituted nitroarenes: A new approach to the synthesis of 7-substituted indoles. *Tetrahedron Letters*, 30(16), 2129–2132. [https://doi.org/10.1016/s0040-4039\(01\)93730-x](https://doi.org/10.1016/s0040-4039(01)93730-x)
- [35] Bartoli, G., Bosco, M., Dalpozzo, R., Palmieri, G., & Marcantoni, E. (1991). Reactivity of nitro- and nitroso-arenes with vinyl grignard reagents: synthesis of 2-(trimethylsilyl)indoles. *Journal of the Chemical Society, Perkin Transactions 1*, 11, 2757. <https://doi.org/10.1039/p19910002757>
- [36] Butterworth, P. J. (2005). *Lehninger: principles of biochemistry* (4th edn) D. L. Nelson and M. C. Cox, W. H. Freeman & Co., New York, 1119 pp (plus 17 pp glossary), ISBN 0-7167-4339-6 (2004). *Cell Biochemistry and Function*, 23(4), 293–294. <https://doi.org/10.1002/cbf.1216>
- [37] Spaepen, S., Vanderleyden, J., & Remans, R. (2007). Indole-3-acetic acid in microbial and microorganism-plant signaling. *FEMS Microbiology Reviews*, 31(4), 425–448. <https://doi.org/10.1111/j.1574-6976.2007.00072.x>

- [38] Schiller, G. J., Damon, L. E., Coutre, S. E., Hsu, P., Bhat, G., & Douer, D. (2018). High-Dose Vincristine Sulfate Liposome Injection, for Advanced, Relapsed, or Refractory Philadelphia Chromosome-Negative Acute Lymphoblastic Leukemia in an Adolescent and Young Adult Subgroup of a Phase 2 Clinical Trial. *Journal of Adolescent and Young Adult Oncology*, 7(5), 546–552. <https://doi.org/10.1089/jayao.2018.0041>
- [39] Leneva, I., Kartashova, N., Poromov, A., Gracheva, A., Korchevaya, E., Glubokova, E., Borisova, O., Shtro, A., Loginova, S., Shchukina, V., Khamitov, R., & Faizuloev, E. (2021). Antiviral Activity of Umifenovir In Vitro against a Broad Spectrum of Coronaviruses, Including the Novel SARS-CoV-2 Virus. *Viruses*, 13(8), 1665. <https://doi.org/10.3390/v13081665>
- [40] Sorbera, L.A., Rabasseda, X., Silvestre, J., & Castaner, J. (2001). Vilazodone Hydrochloride. *Drugs of the Future*, 26(3), 0247. <https://doi.org/10.1358/dof.2001.026.03.611242>
- [41] Linck, V. M., Ganzella, M., Herrmann, A. P., Okunji, C. O., Souza, D. O., Antonelli, M. C., & Elisabetsky, E. (2015). Original mechanisms of antipsychotic action by the indole alkaloid alstonine (*Picalima nitida*). *Phytomedicine*, 22(1), 52–55. <https://doi.org/10.1016/j.phymed.2014.10.010>
- [42] Keri, R. S., Patil, M. R., Patil, S. A., & Budagumpi, S. (2015). A comprehensive review in current developments of benzothiazole-based molecules in medicinal chemistry. *European Journal of Medicinal Chemistry*, 89, 207–251. <https://doi.org/10.1016/j.ejmech.2014.10.059>
- [43] Guo, H. Y., Li, J. C., & Shang, Y. L. (2009). A simple and efficient synthesis of 2-substituted benzothiazoles catalyzed by H₂O₂/HCl. *Chinese Chemical Letters*, 20(12), 1408–1410. <https://doi.org/10.1016/j.ccllet.2009.06.037>
- [44] Elderfield, R. C., & McClenachan, E. C. (1960). Pyrolysis of the Products of the Reaction of o-Aminobenzenethiols with Ketones¹. *Journal of the American Chemical Society*, 82(8), 1982–1988. <https://doi.org/10.1021/ja01493a035>
- [45] Sharghi, H., & Asemani, O. (2009). Methanesulfonic Acid/SiO₂ as an Efficient Combination for the Synthesis of 2-Substituted Aromatic and Aliphatic

- Benzothiazoles from Carboxylic Acids. *Synthetic Communications*, 39(5), 860–867. <https://doi.org/10.1080/00397910802431214>
- [46] Chikhale, R., Menghani, S., Babu, R., Bansode, R., Bhargavi, G., Karodia, N., Rajasekharan, M. V., Paradkar, A., & Khedekar, P. (2015). Development of selective DprE1 inhibitors: Design, synthesis, crystal structure and antitubercular activity of benzothiazolylpyrimidine-5-carboxamides. *European Journal of Medicinal Chemistry*, 96, 30–46. <https://doi.org/10.1016/j.ejmech.2015.04.011>
- [47] Irfan, A., Batool, F., Zahra Naqvi, S. A., Islam, A., Osman, S. M., Nocentini, A., Alissa, S. A., & Supuran, C. T. (2019). Benzothiazole derivatives as anticancer agents. *Journal of Enzyme Inhibition and Medicinal Chemistry*, 35(1), 265–279. <https://doi.org/10.1080/14756366.2019.1698036>
- [48] Kashyap, P., Verma, S., Gupta, P., Narang, R., Lal, S., & Devgun, M. (2023). Recent insights into antibacterial potential of benzothiazole derivatives. *Medicinal Chemistry Research*, 32(8), 1543–1573. <https://doi.org/10.1007/s00044-023-03077-z>
- [49] Asiri, Y. I., Alsayari, A., Muhsinah, A. B., Mabkhot, Y. N., & Hassan, M. Z. (2020). Benzothiazoles as potential antiviral agents. *Journal of Pharmacy and Pharmacology*, 72(11), 1459–1480. <https://doi.org/10.1111/jphp.13331>
- [50] Guo, huijie, Luo, X.-Y., Yang, S.-X., Liu, Y., & Mo, C.-F. (2022). Anti-inflammatory effect of BMP326, a novel benzothiazole derivative: Possible involvement of the NF- κ B and MAPKs Signaling Pathways in LPS-induced RAW264.7 macrophages. <https://doi.org/10.21203/rs.3.rs-1589186/v1>
- [51] Nath, R., Shahar Yar, M., Pathania, S., Grover, G., Debnath, B., & Akhtar, M. J. (2021). Synthesis and anticonvulsant evaluation of indoline derivatives of functionalized aryloxadiazole amine and benzothiazole acetamide. *Journal of Molecular Structure*, 1228, 129742. <https://doi.org/10.1016/j.molstruc.2020.129742>
- [52] Jin, Q., Fu, Z., Guan, L., & Jiang, H. (2019). Syntheses of Benzo[d]Thiazol-2(3H)-One Derivatives and Their Antidepressant and Anticonvulsant Effects. *Marine Drugs*, 17(7), 430. <https://doi.org/10.3390/md17070430>

- [53] Rostovtsev, V. V., Green, L. G., Fokin, V. V., & Sharpless, K. B. (2002). A Stepwise Huisgen Cycloaddition Process: Copper(I)-Catalyzed Regioselective “Ligation” of Azides and Terminal Alkynes. *Angewandte Chemie International Edition*, 41(14), 2596–2599. [https://doi.org/10.1002/1521-3773\(20020715\)41:14<2596::aid-anie2596>3.0.co;2-4](https://doi.org/10.1002/1521-3773(20020715)41:14<2596::aid-anie2596>3.0.co;2-4)
- [54] Kalisiak, J., Sharpless, K. B., & Fokin, V. V. (2008). Efficient Synthesis of 2-Substituted-1,2,3-triazoles. *Organic Letters*, 10(15), 3171–3174. <https://doi.org/10.1021/ol8006748>
- [55] Phanindrudu, M., Tiwari, D. K., Aravilli, V. K., Bhardwaj, K. C., Sabapathi, G., Likhar, P. R., & Tiwari, D. K. (2016). Magnetically Recoverable Cu⁰/Fe₃O₄-Catalysed One-Pot Tandem Synthesis of Sulfur-Containing Triazoles from Alkynes and Azide: DMSO Acts as an Alkylating Agent. *European Journal of Organic Chemistry*, 2016(27), 4629–4634. Portico. <https://doi.org/10.1002/ejoc.201600740>
- [56] Chen, Z., Yan, Q., Liu, Z., & Zhang, Y. (2014). Metal-Free C-N- and N-N-Bond Formation: Synthesis of 1,2,3-Triazoles from Ketones, N-Tosylhydrazines, and Amines in One Pot. *Chemistry – A European Journal*, 20(52), 17635–17639. Portico. <https://doi.org/10.1002/chem.201405057>
- [57] Zhang, B. (2019). Comprehensive review on the anti-bacterial activity of 1,2,3-triazole hybrids. *European Journal of Medicinal Chemistry*, 168, 357–372. <https://doi.org/10.1016/j.ejmech.2019.02.055>
- [58] Andreeva, O. V., Garifullin, B. F., Zarubaev, V. V., Slita, A. V., Yesaulkova, I. L., Saifina, L. F., Shulaeva, M. M., Belenok, M. G., Semenov, V. E., & Kataev, V. E. (2020). Synthesis of 1,2,3-triazolyl nucleoside analogues and their antiviral activity. *Molecular Diversity*, 25(1), 473–490. <https://doi.org/10.1007/s11030-020-10141-y>
- [59] Partha, A. D. S. L., Widodo, A. D. W., & Endraswari, P. D. (2022). Evaluation of fluconazole, itraconazole, and voriconazole activity on *Candida albicans*: A case control study. *Annals of Medicine & Surgery*, 84. <https://doi.org/10.1016/j.amsu.2022.104882>
- [60] Alam, M. M. (2021). 1,2,3-Triazole hybrids as anticancer agents: A review. *Archiv Der Pharmazie*, 355(1). Portico. <https://doi.org/10.1002/ardp.202100158>

- [61] Sahu, A., Sahu, P., & Agrawal, R. (2020). A Recent Review on Drug Modification Using 1,2,3-triazole. *Current Chemical Biology*, 14(2), 71–87. <https://doi.org/10.2174/2212796814999200807214519>
- [62] Castanedo, G. M., Seng, P. S., Blaquiere, N., Trapp, S., & Staben, S. T. (2011). Rapid Synthesis of 1,3,5-Substituted 1,2,4-Triazoles from Carboxylic Acids, Amidines, and Hydrazines. *The Journal of Organic Chemistry*, 76(4), 1177–1179. <https://doi.org/10.1021/jo1023393>
- [63] Mangarao, N., Mahaboob Basha, G., Ramu, T., Srinuvasarao, R., Prasanthi, S., & Siddaiah, V. (2014). Brønsted acid-catalyzed simple and efficient synthesis of 1,2,4-triazoles and 1,2,4-oxadiazoles using 2,2,2-trichloroethyl imidates in PEG. *Tetrahedron Letters*, 55(1), 177–179. <https://doi.org/10.1016/j.tetlet.2013.10.147>
- [64] Vidavalur, S., Nakka, M., Tadikonda, R., Rayavarapu, S., & Sarakula, P. (2014). A Simple and Efficient Synthesis of 3,4,5-Trisubstituted/N-Fused 1,2,4-Triazoles via Ceric Ammonium Nitrate Catalyzed Oxidative Cyclization of Amidrazones with Aldehydes Using Polyethylene Glycol as a Recyclable Reaction Medium. *Synthesis*, 47(04), 517–525. <https://doi.org/10.1055/s-0034-1378909>
- [65] Chen, Z., Li, H., Dong, W., Miao, M., & Ren, H. (2016). I₂-Catalyzed Oxidative Coupling Reactions of Hydrazones and Amines and the Application in the Synthesis of 1,3,5-Trisubstituted 1,2,4-Triazoles. *Organic Letters*, 18(6), 1334–1337. <https://doi.org/10.1021/acs.orglett.6b00277>
- [66] Strzelecka, M., & Świątek, P. (2021). 1,2,4-Triazoles as Important Antibacterial Agents. *Pharmaceuticals*, 14(3), 224. <https://doi.org/10.3390/ph14030224>
- [67] Tratat, C. (2020). 1,2,4-Triazole: A Privileged Scaffold for the Development of Potent Antifungal Agents - A Brief Review. *Current Topics in Medicinal Chemistry*, 20(24), 2235–2258. <https://doi.org/10.2174/1568026620666200704140107>
- [68] Wen, X., Zhou, Y., Zeng, J., & Liu, X. (2020). Recent Development of 1,2,4-triazole-containing Compounds as Anticancer Agents. *Current Topics in Medicinal Chemistry*, 20(16), 1441–1460. <https://doi.org/10.2174/1568026620666200128143230>

- [69] Greer, N. D. (2003). Voriconazole: The Newest Triazole Antifungal Agent. *Baylor University Medical Center Proceedings*, 16(2), 241–248. <https://doi.org/10.1080/08998280.2003.11927910>
- [70] Greer, N. D. (2007). Posaconazole (Noxafil): A New Triazole Antifungal Agent. *Baylor University Medical Center Proceedings*, 20(2), 188–196. <https://doi.org/10.1080/08998280.2007.11928283>
- [71] El-Sebaey, S. A. (2020). Recent Advances in 1,2,4-Triazole Scaffolds as Antiviral Agents. *ChemistrySelect*, 5(37), 11654–11680. Portico. <https://doi.org/10.1002/slct.202002830>
- [72] Wang, Y., Su, R., Chen, J., Liu, X., Luo, J., Lao, Y., Huang, P., Shi, J., Jiang, C., Liao, L., & Zhang, J. (2023). Synthesis of 1,3,5-triphenyl-1,2,4-triazole derivatives and their neuroprotection by anti-oxidative stress and anti-inflammation and protecting BBB. *European Journal of Medicinal Chemistry*, 260, 115742. <https://doi.org/10.1016/j.ejmech.2023.115742>
- [73] Parrill, A. L., & Lipkowitz, K. B. (Eds.). (2018). *Reviews in Computational Chemistry, Volume 31. Reviews in Computational Chemistry*. <https://doi.org/10.1002/9781119518068>
- [74] Roy, K., Kar, S., & Das, R. N. (2015). Classical QSAR. *Understanding the Basics of QSAR for Applications in Pharmaceutical Sciences and Risk Assessment*, 81–102. <https://doi.org/10.1016/b978-0-12-801505-6.00003-x>
- [75] Mauri, A., Consonni, V., & Todeschini, R. (2017). Molecular Descriptors. *Handbook of Computational Chemistry*, 2065–2093. https://doi.org/10.1007/978-3-319-27282-5_51
- [76] Vilar, S., & Costanzi, S. (2012). Predicting the Biological Activities Through QSAR Analysis and Docking-Based Scoring. *Membrane Protein Structure and Dynamics*, 271–284. https://doi.org/10.1007/978-1-62703-023-6_16
- [77] Achary, P. G. R. (2020). Applications of Quantitative Structure-Activity Relationships (QSAR) based Virtual Screening in Drug Design: A Review. *Mini-Reviews in Medicinal Chemistry*, 20(14), 1375–1388. <https://doi.org/10.2174/1389557520666200429102334>

- [78] Hsu, H.-H., Hsu, Y.-C., Chang, L.-J., & Yang, J.-M. (2017). An integrated approach with new strategies for QSAR models and lead optimization. *BMC Genomics*, 18(S2). <https://doi.org/10.1186/s12864-017-3503-2>
- [79] Lévêque, L., Tahiri, N., Goldsmith, M.-R., & Verner, M.-A. (2022). Quantitative Structure-Activity Relationship (QSAR) modeling to predict the transfer of environmental chemicals across the placenta. *Computational Toxicology*, 21, 100211. <https://doi.org/10.1016/j.comtox.2021.100211>
- [80] Leonard, J. T., & Roy, K. (2006). On Selection of Training and Test Sets for the Development of Predictive QSAR models. *QSAR & Combinatorial Science*, 25(3), 235–251. Portico. <https://doi.org/10.1002/qsar.200510161>
- [81] Zhao, L., Wang, W., Sedykh, A., & Zhu, H. (2017). Experimental Errors in QSAR Modeling Sets: What We Can Do and What We Cannot Do. *ACS Omega*, 2(6), 2805–2812. <https://doi.org/10.1021/acsomega.7b00274>
- [82] Roy, P. P., Leonard, J. T., & Roy, K. (2008). Exploring the impact of size of training sets for the development of predictive QSAR models. *Chemometrics and Intelligent Laboratory Systems*, 90(1), 31–42. <https://doi.org/10.1016/j.chemolab.2007.07.004>
- [83] Morris, G. M., & Lim-Wilby, M. (2008). Molecular Docking. *Molecular Modeling of Proteins*, 365–382. https://doi.org/10.1007/978-1-59745-177-2_19
- [84] Pinzi, L., & Rastelli, G. (2019). Molecular Docking: Shifting Paradigms in Drug Discovery. *International Journal of Molecular Sciences*, 20(18), 4331. <https://doi.org/10.3390/ijms20184331>
- [85] Barradas-Bautista, D., Rosell, M., Pallara, C., & Fernández-Recio, J. (2018). Structural Prediction of Protein–Protein Interactions by Docking: Application to Biomedical Problems. *Advances in Protein Chemistry and Structural Biology*, 203–249. <https://doi.org/10.1016/bs.apcsb.2017.06.003>
- [86] Zhang, B., Li, H., Yu, K., & Jin, Z. (2022). Molecular docking-based computational platform for high-throughput virtual screening. *CCF Transactions on High Performance Computing*, 4(1), 63–74. <https://doi.org/10.1007/s42514-021-00086-5>

- [87] Prieto-Martínez, F. D., Arciniega, M., & Medina-Franco, J. L. (2018). Acoplamiento Molecular: Avances Recientes y Retos. TIP Revista Especializada En Ciencias Químico-Biológicas, 21. <https://doi.org/10.22201/fesz.23958723e.2018.0.143>
- [88] Hollingsworth, S. A., & Dror, R. O. (2018). Molecular Dynamics Simulation for All. *Neuron*, 99(6), 1129–1143. <https://doi.org/10.1016/j.neuron.2018.08.011>
- [89] Jabbarzadeh Kaboli, P., Ismail, patimah, & Ling, K.-H. (2018). Molecular Dynamics (MD) Simulations, step by step protocol v3. <https://doi.org/10.17504/protocols.io.mztc76n>
- [90] Karplus, M., & Kuriyan, J. (2005). Molecular dynamics and protein function. *Proceedings of the National Academy of Sciences*, 102(19), 6679–6685. <https://doi.org/10.1073/pnas.0408930102>
- [91] Wang, Y., Lupala, C. S., Liu, H., & Lin, X. (2019). Identification of Drug Binding Sites and Action Mechanisms with Molecular Dynamics Simulations. *Current Topics in Medicinal Chemistry*, 18(27), 2268–2277. <https://doi.org/10.2174/1568026619666181212102856>
- [92] Shukla, R., & Tripathi, T. (2020). Molecular Dynamics Simulation of Protein and Protein–Ligand Complexes. *Computer-Aided Drug Design*, 133–161. https://doi.org/10.1007/978-981-15-6815-2_7
- [93] Zhou, M. Y., Liu, J., & Zhang, L. Q. (2023). Structure and properties of polymer/two-dimensional nanomaterials studied via molecular dynamics simulation: a review. *Molecular Systems Design & Engineering*, 8(1), 11–31. <https://doi.org/10.1039/d2me00121g>
- [94] Durrant, J. D., & McCammon, J. A. (2011). Molecular dynamics simulations and drug discovery. *BMC Biology*, 9(1). <https://doi.org/10.1186/1741-7007-9-71>
- [95] Ren, A., Wei, W., Liang, Z., Zhou, M., Liang, T., & Zang, N. (2023). Synthesis and bioactive evaluation of N-((1-methyl-1H-indol-3-yl)methyl)-N-(3,4,5-trimethoxyphenyl)acetamide derivatives as agents for inhibiting tubulin polymerization. *RSC Medicinal Chemistry*, 14(1), 113–121. <https://doi.org/10.1039/d2md00340f>

- [96] Jin, G., Lee, S., Choi, M., Son, S., Kim, G.-W., Oh, J.-W., Lee, C., & Lee, K. (2014). Chemical genetics-based discovery of indole derivatives as HCV NS5B polymerase inhibitors. *European Journal of Medicinal Chemistry*, 75, 413–425. <https://doi.org/10.1016/j.ejmech.2014.01.062>
- [97] Liu, H., Wu, R., Sun, Y., Ye, Y., Chen, J., Luo, X., Shen, X., & Liu, H. (2014). Identification of novel thiadiazoloacrylamide analogues as inhibitors of dengue-2 virus NS2B/NS3 protease. *Bioorganic & Medicinal Chemistry*, 22(22), 6344–6352. <https://doi.org/10.1016/j.bmc.2014.09.057>
- [98] Hawash, M., Kahraman, D. C., Olgac, A., Ergun, S. G., Hamel, E., Cetin-Atalay, R., & Baytas, S. N. (2022). Design and synthesis of novel substituted indole-acrylamide derivatives and evaluation of their anti-cancer activity as potential tubulin-targeting agents. *Journal of Molecular Structure*, 1254, 132345. <https://doi.org/10.1016/j.molstruc.2022.132345>
- [99] Suzdalev, K. F., & Den'kina, S. V. (2011). Synthesis of 1-(oxiran-2-ylmethyl)-1H-indole-3-carbaldehyde and its reaction with active methylene compounds. *Chemistry of Heterocyclic Compounds*, 47(9), 1085–1090. <https://doi.org/10.1007/s10593-011-0878-x>
- [100] Mahmoodi, N. O., Khalili, B., Rezaeianzade, O., & Ghavidast, A. (2016). One-pot multicomponent synthesis of indol-3-yl-hydrazinyl thiazoles as antimicrobial agents. *Research on Chemical Intermediates*, 42(8), 6531–6542. <https://doi.org/10.1007/s11164-016-2478-y>
- [101] Bhambi, D., Salvi, V. K., Jat, J. L., Ojha, S., & Talesara, G. L. (2007). Synthesis and antimicrobial activity of some new indole containing isoxazolines and phthalimidoxy derivatives of thiazolidinone and thiohydantoin. *Journal of Sulfur Chemistry*, 28(2), 155–163. <https://doi.org/10.1080/17415990601154946>
- [102] Pandey, S., Chauhan, S. S., Shivahare, R., Sharma, A., Jaiswal, S., Gupta, S., Lal, J., & Chauhan, P. M. S. (2016). Identification of a diverse indole-2-carboxamides as a potent antileishmanial chemotypes. *European Journal of Medicinal Chemistry*, 110, 237–245. <https://doi.org/10.1016/j.ejmech.2016.01.028>
- [103] Liu, J.-Y., Zhang, H., Feng, B.-M., Jiang, B., Wang, S.-L., & Tu, S.-J. (2012). A multicomponent synthetic strategy for two-carbon-tethered 1,3-oxathiole-indole

- pairs. *Organic & Biomolecular Chemistry*, 10(26), 5036. <https://doi.org/10.1039/c2ob25817j>
- [104] Wang, L., Huang, M., Zhu, X., & Wan, Y. (2013). Polyethylene glycol (PEG-200)-promoted sustainable one-pot three-component synthesis of 3-indole derivatives in water. *Applied Catalysis A: General*, 454, 160–163. <https://doi.org/10.1016/j.apcata.2012.12.008>
- [105] Vikrishchuk, N. I., Suzdalev, K. F., Dranikova, A. Yu., Tkachev, V. V., & Shilov, G. V. (2019). Reactions of 1-Alkyl-2-chloro-1H-indole-3-carbaldehyde with 4-Amino-5-alkyl(aryl)-4H-triazole-3-thioles. *Russian Journal of General Chemistry*, 89(12), 2369–2373. <https://doi.org/10.1134/s1070363219120077>
- [106] Silva, P., de Almeida, M., Silva, J., Albino, S., Espírito-Santo, R., Lima, M., Villarreal, C., Moura, R., & Santos, V. (2020). (E)-2-Cyano-3-(1H-Indol-3-yl)-N-Phenylacrylamide, a Hybrid Compound Derived from Indomethacin and Paracetamol: Design, Synthesis and Evaluation of the Anti-Inflammatory Potential. *International Journal of Molecular Sciences*, 21(7), 2591. <https://doi.org/10.3390/ijms21072591>
- [107] Debnath, B., & Ganguly, S. (2015). Synthesis of some novel (2-oxo-3-(arylimino)indolin-1-yl)-N-aryl acetamides and evaluation as antimicrobial agents. *Toxicological & Environmental Chemistry*, 97(6), 741–753. <https://doi.org/10.1080/02772248.2015.1061524>
- [108] Bharath Rathna Kumar P., Subramaniyan S., Yamini K., Suthakaran R. (2020) Synthesis of some novel 1H-pyrazole derivatives and their antibacterial activity studies. *RASAYAN Journal of Chemistry*, 4(2), 400–404.
- [109] Iškauskienė, M., Kadlecová, A., Voller, J., Janovská, L., Malinauskienė, V., Žukauskaitė, A., & Šačkus, A. (2021). Synthesis of 5-[(1H-indol-3-yl)methyl]-1,3,4-oxadiazole-2(3H)-thiones and their protective activity against oxidative stress. *Archiv Der Pharmazie*, 354(6). Portico. <https://doi.org/10.1002/ardp.202100001>
- [110] Patel, N. B., & Khan, I. H. (2011). Synthesis of 1,2,4-triazole derivatives containing benzothiazoles as pharmacologically active molecule. *Journal of Enzyme*

Inhibition and Medicinal Chemistry, 26(4), 527–534.
<https://doi.org/10.3109/14756366.2010.535794>

- [111] Tariq, S., Kamboj, P., Alam, O., & Amir, Mohd. (2018). 1,2,4-Triazole-based benzothiazole/benzoxazole derivatives: Design, synthesis, p38 α MAP kinase inhibition, anti-inflammatory activity and molecular docking studies. *Bioorganic Chemistry*, 81, 630–641. <https://doi.org/10.1016/j.bioorg.2018.09.015>
- [112] Al-Masoudi, N. A., Aziz, N. M., & Mohammed, A. T. (2009). Synthesis and In Vitro Anti-HIV Activity of Some New Schiff Base Ligands Derived from 5-Amino-4-phenyl-4H-1,2,4-triazole-3-thiol and Their Metal Complexes. *Phosphorus, Sulfur, and Silicon and the Related Elements*, 184(11), 2891–2901. <https://doi.org/10.1080/10426500802591630>
- [113] Tariq, S., Alam, O., & Amir, M. (2018). Synthesis, p38 α MAP kinase inhibition, anti-inflammatory activity, and molecular docking studies of 1,2,4-triazole-based benzothiazole-2-amines. *Archiv Der Pharmazie*, 351(3–4). Portico. <https://doi.org/10.1002/ardp.201700304>
- [114] Subba Rao, A. V., Swapna, K., Shaik, S. P., Lakshma Nayak, V., Srinivasa Reddy, T., Sunkari, S., Shaik, T. B., Bagul, C., & Kamal, A. (2017). Synthesis and biological evaluation of cis -restricted triazole/tetrazole mimics of combretastatin-benzothiazole hybrids as tubulin polymerization inhibitors and apoptosis inducers. *Bioorganic & Medicinal Chemistry*, 25(3), 977–999. <https://doi.org/10.1016/j.bmc.2016.12.010>
- [115] Patel, V. M., Patel, N. B., Chan-Bacab, M. J., & Rivera, G. (2018). Synthesis, biological evaluation and molecular dynamics studies of 1,2,4-triazole clubbed Mannich bases. *Computational Biology and Chemistry*, 76, 264–274. <https://doi.org/10.1016/j.compbiolchem.2018.07.020>
- [116] Al-Sanea, M. M., Hamdi, A., Mohamed, A. A. B., El-Shafey, H. W., Moustafa, M., Elgazar, A. A., Eldehna, W. M., Ur Rahman, H., Parambi, D. G. T., Elbargisy, R. M., Selim, S., Bukhari, S. N. A., Magdy Hendawy, O., & Tawfik, S. S. (2023). New benzothiazole hybrids as potential VEGFR-2 inhibitors: design, synthesis, anticancer evaluation, and in silico study. *Journal of Enzyme Inhibition and Medicinal Chemistry*, 38(1). <https://doi.org/10.1080/14756366.2023.2166036>

- [117] Liu, D.-C., Zhang, H.-J., Jin, C.-M., & Quan, Z.-S. (2016). Synthesis and Biological Evaluation of Novel Benzothiazole Derivatives as Potential Anticonvulsant Agents. *Molecules*, 21(3), 164. <https://doi.org/10.3390/molecules21030164>
- [118] Kuberkar, S. V., Bhosale, V. N., Vartale, S. P., & Badne, S. G. (2005). Synthesis and some novel reactions of 8-chloro-2H-[1,2,4]triazino[3,4-b][1,3]benzothiazole-3,4-dione and 6-chloro-2-hydrazino-1,3-benzothiazole. *Journal of Chemical Research*, 2005(10), 632–635. <https://doi.org/10.3184/030823405774663084>
- [119] Sever, B., Altıntop, M. D., Demir, Y., Pekdoğan, M., Akalın Çiftçi, G., Beydemir, Ş., & Özdemir, A. (2021). An extensive research on aldose reductase inhibitory effects of new 4H-1,2,4-triazole derivatives. *Journal of Molecular Structure*, 1224, 129446. <https://doi.org/10.1016/j.molstruc.2020.129446>
- [120] Wu, W.-N., Jiang, Y.-M., Fei, Q.-, & Du, H.-T. (2019). Synthesis and fungicidal activity of novel 1,2,4-triazole derivatives containing a pyrimidine moiety. *Phosphorus, Sulfur, and Silicon and the Related Elements*, 194(12), 1171–1175. <https://doi.org/10.1080/10426507.2019.1633321>
- [121] Akhter, N., Batool, S., Khan, S. G., Rasool, N., Anjum, F., Rasul, A., Adem, Ş., Mahmood, S., Rehman, A. ur, Nisa, M. un, Razzaq, Z., Christensen, J. B., Abourehab, M. A. S., Shah, S. A. A., & Imran, S. (2023). Bio-Oriented Synthesis and Molecular Docking Studies of 1,2,4-Triazole Based Derivatives as Potential Anti-Cancer Agents against HepG2 Cell Line. *Pharmaceuticals*, 16(2), 211. <https://doi.org/10.3390/ph16020211>
- [122] Kiani, A., Shahlaei, M., Rahpeyma, M., & Adibi, H. (2021). Synthesis of (Z)-3-((5-(benzylthio)-4H-1,2,4-triazol-3-yl)imino)-5-haloindolin-2-one derivatives: combined spectroscopic and computational investigations on the level and activity of matrix metalloproteinases 2 and 9 in cancer cell lines. *Journal of the Iranian Chemical Society*, 18(7), 1781–1800. <https://doi.org/10.1007/s13738-020-02150-3>
- [123] Patel, K. R., Brahmhatt, J. G., Pandya, P. A., Daraji, D. G., Patel, H. D., Rawal, R. M., & Baran, S. K. (2021). Design, synthesis and biological evaluation of novel 5-(4-chlorophenyl)-4-phenyl-4H-1,2,4-triazole-3-thiols as an anticancer agent. *Journal of Molecular Structure*, 1231, 130000. <https://doi.org/10.1016/j.molstruc.2021.130000>

- [124] Abdelrehim, E. M. (2021). Synthesis and Screening of New [1,3,4]Oxadiazole, [1,2,4]Triazole, and [1,2,4]Triazolo[4,3-b][1,2,4]triazole Derivatives as Potential Antitumor Agents on the Colon Carcinoma Cell Line (HCT-116). *ACS Omega*, 6(2), 1687–1696. <https://doi.org/10.1021/acsomega.0c05718>
- [125] Mirjafary, Z., Mohammad Karbasi, M., Hesamzadeh, P., Shaker, H. R., Amiri, A., & Saeidian, H. (2022). Novel 1,2,3-Triazole-Based Benzothiazole Derivatives: Efficient Synthesis, DFT, Molecular Docking, and ADMET Studies. *Molecules*, 27(23), 8555. <https://doi.org/10.3390/molecules27238555>
- [126] Aouad, M. R., Soliman, M. A., Alharbi, M. O., Bardaweel, S. K., Sahu, P. K., Ali, A. A., Messali, M., Rezki, N., & Al-Soud, Y. A. (2018). Design, Synthesis and Anticancer Screening of Novel Benzothiazole-Piperazine-1,2,3-Triazole Hybrids. *Molecules*, 23(11), 2788. <https://doi.org/10.3390/molecules23112788>
- [127] Kaushik, C. P., & Chahal, M. (2020). Synthesis and antibacterial activity of benzothiazole and benzoxazole-appended substituted 1,2,3-triazoles. *Journal of Chemical Sciences*, 132(1). <https://doi.org/10.1007/s12039-020-01844-8>
- [128] Rezki, N. (2016). A Green Ultrasound Synthesis, Characterization and Antibacterial Evaluation of 1,4-Disubstituted 1,2,3-Triazoles Tethering Bioactive Benzothiazole Nucleus. *Molecules*, 21(4), 505. <https://doi.org/10.3390/molecules21040505>
- [129] Aouad, M. R., Khan, D. J. O., Said, M. A., Al-Kaff, N. S., Rezki, N., Ali, A. A., Bouqellah, N., & Hagar, M. (2021). Novel 1,2,3-Triazole Derivatives as Potential Inhibitors against Covid-19 Main Protease: Synthesis, Characterization, Molecular Docking and DFT Studies. *ChemistrySelect*, 6(14), 3468–3486. Portico. <https://doi.org/10.1002/slct.202100522>
- [130] Singh, P., Swain, B., Thacker, P. S., Sigalapalli, D. K., Purnachander Yadav, P., Angeli, A., Supuran, C. T., & Arifuddin, M. (2020). Synthesis and carbonic anhydrase inhibition studies of sulfonamide based indole-1,2,3-triazole chalcone hybrids. *Bioorganic Chemistry*, 99, 103839. <https://doi.org/10.1016/j.bioorg.2020.103839>
- [131] Sayahi, M. H., Zareei, S., Halimi, M., Alikhani, M., Moazzam, A., Mohammadi-Khanaposhtani, M., Mojtavavi, S., Faramarzi, M. A., Rastegar, H., Taslimi, P., Ibrahim, E. H., Ghramh, H. A., Larijani, B., & Mahdavi, M. (2024). Design,

- synthesis, in vitro, and in silico anti- α -glucosidase assays of N-phenylacetamide-1,2,3-triazole-indole-2-carboxamide derivatives as new anti-diabetic agents. *Scientific Reports*, 14(1). <https://doi.org/10.1038/s41598-024-66201-y>
- [132] Emadi, M., Mosavizadeh-Marvest, F., Asadipour, A., Pourshojaei, Y., Hosseini, S., Mojtabavi, S., Faramarzi, M. A., Larijani, B., Mohammadi-Khanaposhtani, M., & Mahdavi, M. (2023). Indole-carbohydrazide linked phenoxy-1,2,3-triazole-N-phenylacetamide derivatives as potent α -glucosidase inhibitors: design, synthesis, in vitro α -glucosidase inhibition, and computational studies. *BMC Chemistry*, 17(1). <https://doi.org/10.1186/s13065-023-00971-w>
- [133] Liu, K., Ding, Y., & Kang, C. (2020). Synthesis and Antiproliferative Activity of New N-Acylhydrazone Derivatives Containing Benzothiazole and Indole Based Moiety. *Pharmaceutical Chemistry Journal*, 54(4), 345–352. <https://doi.org/10.1007/s11094-020-02215-w>
- [134] Suryapeta, S., Papigani, N., Banothu, V., Dubey, P. K., Mukkanti, K., & Pal, S. (2020). Synthesis, biological evaluation, and docking study of a series of 1,4-disubstituted 1,2,3-triazole derivatives with an indole-triazole-peptide conjugate. *Journal of Heterocyclic Chemistry*, 57(8), 3126–3141. Portico. <https://doi.org/10.1002/jhet.4020>
- [135] Report on antimalarial drug efficacy, resistance and response: 10 years of surveillance (2010-2019). Geneva: World Health Organization. 2020
- [136] Kanwal, Khan, K. M., Chigurupati, S., Ali, F., Younus, M., Aldubayan, M., Wadood, A., Khan, H., Taha, M., & Perveen, S. (2021). Indole-3-acetamides: As Potential Antihyperglycemic and Antioxidant Agents; Synthesis, In Vitro α -Amylase Inhibitory Activity, Structure–Activity Relationship, and In Silico Studies. *ACS Omega*, 6(3), 2264–2275. <https://doi.org/10.1021/acsomega.0c05581>
- [137] Sarkar, N., De, S., Das, M., Saha, T., Banerjee, S., Kumar, S. K. A., & Kuo, Y.-C. (2023). Insights of Indole: A Novel Target in Medicinal Chemistry (A Review). *Russian Journal of General Chemistry*, 93(7), 1791–1841. <https://doi.org/10.1134/s1070363223070216>
- [138] Danilenko, A. V., Volov, A. N., Volov, N. A., Platonova, Y. B., & Savilov, S. V. (2023). Design, synthesis and biological evaluation of novel indole-3-carboxylic

- acid derivatives with antihypertensive activity. *Bioorganic & Medicinal Chemistry Letters*, 90, 129349. <https://doi.org/10.1016/j.bmcl.2023.129349>
- [139] Mokariya, J. A., Patel, R. C., Rajani, D. P., & Patel, M. P. (2023). Synthesis of novel indole-oxindole clubbed 1,2,3-triazole hybrids: antimicrobial evaluation and molecular docking study. *Research on Chemical Intermediates*, 49(7), 2933–2953. <https://doi.org/10.1007/s11164-023-05024-4>
- [140] Sabt, A., Eldehna, W. M., Ibrahim, T. M., Bekhit, A. A., & Batran, R. Z. (2023). New antileishmanial quinoline linked isatin derivatives targeting DHFR-TS and PTR1: Design, synthesis, and molecular modeling studies. *European Journal of Medicinal Chemistry*, 246, 114959. <https://doi.org/10.1016/j.ejmech.2022.114959>
- [141] Long, S., Duarte, D., Carvalho, C., Oliveira, R., Santarém, N., Palmeira, A., Resende, D. I. S. P., Silva, A. M. S., Moreira, R., Kijjoa, A., Cordeiro da Silva, A., Nogueira, F., Sousa, E., & Pinto, M. M. M. (2022). Indole-Containing Pyrazino[2,1-b]quinazoline-3,6-diones Active against Plasmodium and Trypanosomatids. *ACS Medicinal Chemistry Letters*, 13(2), 225–235. <https://doi.org/10.1021/acsmchemlett.1c00589>
- [142] Pacheco, P. A. F., & Santos, M. M. M. (2022). Recent Progress in the Development of Indole-Based Compounds Active against Malaria, Trypanosomiasis and Leishmaniasis. *Molecules*, 27(1), 319. <https://doi.org/10.3390/molecules27010319>
- [143] Fernandez, L. S., Buchanan, M. S., Carroll, A. R., Feng, Y. J., Quinn, R. J., & Avery, V. M. (2008). Flinderoles A–C: Antimalarial Bis-indole Alkaloids from *Flindersia* Species. *Organic Letters*, 11(2), 329–332. <https://doi.org/10.1021/ol802506n>
- [144] Rottmann, M., McNamara, C., Yeung, B. K. S., Lee, M. C. S., Zou, B., Russell, B., Seitz, P., Plouffe, D. M., Dharia, N. V., Tan, J., Cohen, S. B., Spencer, K. R., González-Páez, G. E., Lakshminarayana, S. B., Goh, A., Suwanarusk, R., Jegla, T., Schmitt, E. K., Beck, H.-P., ... Diagana, T. T. (2010). Spiroindolones, a Potent Compound Class for the Treatment of Malaria. *Science*, 329(5996), 1175–1180. <https://doi.org/10.1126/science.1193225>
- [145] Turner, H. (2016). Spiroindolone Nitd609 is a Novel Antimalarial Drug that Targets the P-type Atpase PfATP4. *Future Medicinal Chemistry*, 8(2), 227–238. <https://doi.org/10.4155/fmc.15.177>

- [146] Luthra, T., Nayak, A. K., Bose, S., Chakrabarti, S., Gupta, A., & Sen, S. (2019). Indole based antimalarial compounds targeting the melatonin pathway: Their design, synthesis and biological evaluation. *European Journal of Medicinal Chemistry*, 168, 11–27. <https://doi.org/10.1016/j.ejmech.2019.02.019>
- [147] Chauhan, M., Saxena, A., & Saha, B. (2021). An insight in anti-malarial potential of indole scaffold: A review. *European Journal of Medicinal Chemistry*, 218, 113400. <https://doi.org/10.1016/j.ejmech.2021.113400>
- [148] Yuvaniyama, J., Chitnumsub, P., Kamchonwongpaisan, S., Vanichtanankul, J., Sirawaraporn, W., Taylor, P., Walkinshaw, M. D., & Yuthavong, Y. (2003). Insights into antifolate resistance from malarial DHFR-TS structures. *Nature Structural & Molecular Biology*, 10(5), 357–365. <https://doi.org/10.1038/nsb921>
- [149] Sahu, S., Ghosh, S. K., Gahtori, P., Pratap Singh, U., Bhattacharyya, D. R., & Bhat, H. R. (2019). In silico ADMET study, docking, synthesis and antimalarial evaluation of thiazole-1,3,5-triazine derivatives as Pf-DHFR inhibitor. *Pharmacological Reports*, 71(5), 762–767. <https://doi.org/10.1016/j.pharep.2019.04.006>
- [150] Vippagunta, S. R., Dorn, A., Matile, H., Bhattacharjee, A. K., Karle, J. M., Ellis, W. Y., Ridley, R. G., & Vennerstrom, J. L. (1999). Structural Specificity of Chloroquine–Hematin Binding Related to Inhibition of Hematin Polymerization and Parasite Growth. *Journal of Medicinal Chemistry*, 42(22), 4630–4639. <https://doi.org/10.1021/jm9902180>
- [151] Vanichtanankul, J., Taweechai, S., Yuvaniyama, J., Vilaivan, T., Chitnumsub, P., Kamchonwongpaisan, S., & Yuthavong, Y. (2011). Trypanosomal Dihydrofolate Reductase Reveals Natural Antifolate Resistance. *ACS Chemical Biology*, 6(9), 905–911. <https://doi.org/10.1021/cb200124r>
- [152] Smith, G. F. (1954). Indoles. Part I. The formylation of indole and some reactions of 3-formylindole. *Journal of the Chemical Society (Resumed)*, 3842. <https://doi.org/10.1039/jr9540003842>
- [153] Xia, S., Wang, L.-Y., Sun, H.-Z., Yue, H., Wang, X.-H., Tan, J.-L., Wang, Y., Hou, D., He, X.-Y., Mun, K.-C., Kumar, B. P., Zuo, H., & Shin, D.-S. (2013). Synthesis of N-Azaaryl Anilines: An Efficient Protocol via Smiles Rearrangement. *Bulletin*

- of the Korean Chemical Society, 34(2), 394–398.
<https://doi.org/10.5012/bkcs.2013.34.2.394>
- [154] Bosc, N., Felix, E., Arcila, R., Mendez, D., Saunders, M. R., Green, D. V. S., Ochoada, J., Shelat, A. A., Martin, E. J., Iyer, P., Engkvist, O., Verras, A., Duffy, J., Burrows, J., Gardner, J. M. F., & Leach, A. R. (2021). MAIP: a web service for predicting blood-stage malaria inhibitors. *Journal of Cheminformatics*, 13(1).
<https://doi.org/10.1186/s13321-021-00487-2>
- [155] Rieckmann, K. H., Campbell, G. H., Sax, L. J., & Ema, J. E. (1978). DRUG SENSITIVITY OF PLASMODIUM FALCIPARUM. *The Lancet*, 311(8054), 22–23. [https://doi.org/10.1016/s0140-6736\(78\)90365-3](https://doi.org/10.1016/s0140-6736(78)90365-3)
- [156] Desjardins, R.E., in *Handbook of Experimental Pharmacology*, Springer Berlin Heidelberg, 1984, p. 179
- [157] Trager, W., & Jensen, J. B. (1976). Human Malaria Parasites in Continuous Culture. *Science*, 193(4254), 673–675. <https://doi.org/10.1126/science.781840>
- [158] Lambros, C., & Vanderberg, J. P. (1979). Synchronization of Plasmodium falciparum Erythrocytic Stages in Culture. *The Journal of Parasitology*, 65(3), 418. <https://doi.org/10.2307/3280287>
- [159] Singh, J.J.S., *Indian Journal of Malariology*, 1956, vol. 10, p. 117
- [160] Panjarathinam, R., *Text Book of Medical Parasitology. Orient Longman Pvt. Ltd*, 2007
- [161] Dallakyan, S., & Olson, A. J. (2014). Small-Molecule Library Screening by Docking with PyRx. *Chemical Biology*, 243–250. https://doi.org/10.1007/978-1-4939-2269-7_19
- [162] O’Boyle, N. M., Banck, M., James, C. A., Morley, C., Vandermeersch, T., & Hutchison, G. R. (2011). Open Babel: An open chemical toolbox. *Journal of Cheminformatics*, 3(1). <https://doi.org/10.1186/1758-2946-3-33>
- [163] Yuthavong, Y., Tarnchompoo, B., Vilaivan, T., Chitnumsub, P., Kamchonwongpaisan, S., Charman, S. A., McLennan, D. N., White, K. L., Vivas, L., Bongard, E., Thongphanchang, C., Tawechai, S., Vanichtanankul, J., Rattanajak, R., Arwon, U., Fantauzzi, P., Yuvaniyama, J., Charman, W. N., & Matthews, D. (2012). Malarial dihydrofolate reductase as a paradigm for drug

- development against a resistance-compromised target. Proceedings of the National Academy of Sciences, 109(42), 16823–16828. <https://doi.org/10.1073/pnas.1204556109>
- [164] Trott, O., & Olson, A. J. (2009). AutoDock Vina: Improving the speed and accuracy of docking with a new scoring function, efficient optimization, and multithreading. Journal of Computational Chemistry, 31(2), 455–461. Portico. <https://doi.org/10.1002/jcc.21334>
- [165] Ferlay J, Ervik M, Lam F, Laversanne M, Colombet M, Mery L, Piñeros M, Znaor A, Soerjomataram I, Bray F (2024). Global Cancer Observatory: Cancer Today. Lyon, France: International Agency for Research on Cancer. Available from: <https://gco.iarc.who.int/today>, accessed 08 August 2024.
- [166] World Health Organization. (2024, February 1). Global cancer burden growing, amidst mounting need for services [News release]. Lyon, France; Geneva, Switzerland. <https://www.who.int/news/item/global-cancer-burden-growing-amidst-mounting-need-for-services>
- [167] Kumar, P., & Aggarwal, R. (2015). An overview of triple-negative breast cancer. Archives of Gynecology and Obstetrics, 293(2), 247–269. <https://doi.org/10.1007/s00404-015-3859-y>
- [168] Orrantia-Borunda E, Anchondo-Nuñez P, Acuña-Aguilar LE, Gómez-Valles FO, Ramírez-Valdespino CA. Subtypes of Breast Cancer. In: Mayrovitz HN. editor. Breast Cancer. Brisbane (AU): Exon Publications. Online first 22 Jun 2022.
- [169] Qian, S., Wei, Z., Yang, W., Huang, J., Yang, Y., & Wang, J. (2022). The role of BCL-2 family proteins in regulating apoptosis and cancer therapy. Frontiers in Oncology, 12. <https://doi.org/10.3389/fonc.2022.985363>
- [170] García-Aranda, M., Pérez-Ruiz, E., & Redondo, M. (2018). Bcl-2 Inhibition to Overcome Resistance to Chemo- and Immunotherapy. International Journal of Molecular Sciences, 19(12), 3950. <https://doi.org/10.3390/ijms19123950>
- [171] Manjunath, M., Ravindran, F., Sharma, S., Siddiqua, H., Raghavan, S. C., & Choudhary, B. (2024). Disarib, a Specific BCL2 Inhibitor, Induces Apoptosis in Triple-Negative Breast Cancer Cells and Impedes Tumour Progression in Xenografts by Altering Mitochondria-Associated Processes. International Journal of Molecular Sciences, 25(12), 6485. <https://doi.org/10.3390/ijms25126485>
- [172] Irfan, A., Batool, F., Zahra Naqvi, S. A., Islam, A., Osman, S. M., Nocentini, A., Alissa, S. A., & Supuran, C. T. (2019). Benzothiazole derivatives as anticancer agents. Journal of Enzyme Inhibition and Medicinal Chemistry, 35(1), 265–279. <https://doi.org/10.1080/14756366.2019.1698036>

- [173] Paoletti, N., & Supuran, C. T. (2024). Benzothiazole derivatives in the design of antitumor agents. *Archiv Der Pharmazie. Portico*. <https://doi.org/10.1002/ardp.202400259>
- [174] Wang, X., Zhao, M., Chang, Y., Guan, S., Li, M., Yang, H., & Sun, M. (2024). Identification of novel benzothiazole derivatives as inhibitors of NEDDylation pathway to inhibit the progression of gastric cancer. *Bioorganic & Medicinal Chemistry Letters*, 100, 129647. <https://doi.org/10.1016/j.bmcl.2024.129647>
- [175] Wu, B.-W., Huang, W.-J., Liu, Y.-H., Liu, Q.-G., Song, J., Hu, T., Chen, P., & Zhang, S.-Y. (2024). Design, synthesis and biological evaluation of 1,2,3-triazole benzothiazole derivatives as tubulin polymerization inhibitors with potent anti-esophageal cancer activities. *European Journal of Medicinal Chemistry*, 265, 116118. <https://doi.org/10.1016/j.ejmech.2023.116118>
- [176] Ewes, W. A., Tawfik, S. S., Almatary, A. M., Ahmad Bhat, M., El-Shafey, H. W., Mohamed, A. A. B., Haikal, A., El-Magd, M. A., Elgazar, A. A., Balaha, M., & Hamdi, A. (2024). Identification of Benzothiazoles Bearing 1,3,4-Thiadiazole as Antiproliferative Hybrids Targeting VEGFR-2 and BRAF Kinase: Design, Synthesis, BIO Evaluation and In Silico Study. *Molecules*, 29(13), 3186. <https://doi.org/10.3390/molecules29133186>
- [177] Alamoudi, W. M. (2024). Molecular modeling and cytotoxic activity of newly synthesized benzothiazole-thiazole conjugates. *Journal of Saudi Chemical Society*, 28(4), 101897. <https://doi.org/10.1016/j.jscs.2024.101897>
- [178] Chen, Y., Zhang, K., Tan, J., Fan, Z., Fu, Y., Li, X., Liu, B., & Wang, G. (2024). Design, synthesis, and pharmacological evaluation of novel benzothiazole derivatives targeting LCK in acute lymphoblastic leukemia. *Bioorganic Chemistry*, 144, 107180. <https://doi.org/10.1016/j.bioorg.2024.107180>
- [179] Rathod, B., & Kumar, K. (2022). Synthetic and Medicinal Perspective of 1,2,4-Triazole as Anticancer Agents. *Chemistry & Biodiversity*, 19(11). Portico. <https://doi.org/10.1002/cbdv.202200679>
- [180] El-Sherief, H. A. M., Youssif, B. G. M., Abbas Bukhari, S. N., Abdelazeem, A. H., Abdel-Aziz, M., & Abdel-Rahman, H. M. (2018). Synthesis, anticancer activity and molecular modeling studies of 1,2,4-triazole derivatives as EGFR inhibitors. *European Journal of Medicinal Chemistry*, 156, 774–789. <https://doi.org/10.1016/j.ejmech.2018.07.024>
- [181] Turkey, A., Sherbiny, F. F., Bayoumi, A. H., Ahmed, H. E. A., & Abulkhair, H. S. (2020). Novel 1,2,4-triazole derivatives: Design, synthesis, anticancer evaluation, molecular docking, and pharmacokinetic profiling studies. *Archiv Der Pharmazie*, 353(12). Portico. <https://doi.org/10.1002/ardp.202000170>
- [182] Pitucha, M., Janeczko, M., Klimek, K., Fornal, E., Wos, M., Pachuta-Stec, A., Ginalska, G., & Kaczor, A. A. (2020). 1,2,4-Triazolin-5-thione derivatives with

- anticancer activity as CK1 γ kinase inhibitors. *Bioorganic Chemistry*, 99, 103806. <https://doi.org/10.1016/j.bioorg.2020.103806>
- [183] Youssef, M. F., Nafie, M. S., Salama, E. E., Boraei, A. T. A., & Gad, E. M. (2022). Synthesis of New Bioactive Indolyl-1,2,4-Triazole Hybrids As Dual Inhibitors for EGFR/PARP-1 Targeting Breast and Liver Cancer Cells. *ACS Omega*, 7(49), 45665–45677. <https://doi.org/10.1021/acsomega.2c06531>
- [184] Alam, M. M. (2024). New 1,2,4-triazole based eugenol derivatives as antiCOX-2 and anticancer agents. *Journal of Umm Al-Qura University for Applied Sciences*. <https://doi.org/10.1007/s43994-024-00127-z>
- [185] Ismail, H. S., Khalil, A., Taha, R. A., Lasheen, D. S., & Abou El Ella, D. A. (2023). Design, molecular modelling and synthesis of novel benzothiazole derivatives as BCL-2 inhibitors. *Scientific Reports*, 13(1). <https://doi.org/10.1038/s41598-023-41783-1>
- [186] Philoppes, J. N., & Lamie, P. F. (2019). Design and synthesis of new benzoxazole/benzothiazole-phthalimide hybrids as antitumor-apoptotic agents. *Bioorganic Chemistry*, 89, 102978. <https://doi.org/10.1016/j.bioorg.2019.102978>
- [187] Xuejiao, S., Yong, X., Ningyu, W., Lidan, Z., Xuanhong, S., Youzhi, X., Tinghong, Y., Yaojie, S., Yongxia, Z., & Luoting, Y. (2013). A Novel Benzothiazole Derivative YLT322 Induces Apoptosis via the Mitochondrial Apoptosis Pathway In Vitro with Anti-Tumor Activity in Solid Malignancies. *PLoS ONE*, 8(5), e63900. <https://doi.org/10.1371/journal.pone.0063900>
- [188] Zhao, P.-L., Ma, W.-F., Duan, A.-N., Zou, M., Yan, Y.-C., You, W.-W., & Wu, S.-G. (2012). One-pot synthesis of novel isoindoline-1,3-dione derivatives bearing 1,2,4-triazole moiety and their preliminary biological evaluation. *European Journal of Medicinal Chemistry*, 54, 813–822. <https://doi.org/10.1016/j.ejmech.2012.06.041>
- [189] Kulabaş, N., Tatar, E., Bingöl Özakpınar, Ö., Özsvacı, D., Pannecouque, C., De Clercq, E., & Küçükgülzel, İ. (2016). Synthesis and antiproliferative evaluation of novel 2-(4H-1,2,4-triazole-3-ylthio)acetamide derivatives as inducers of apoptosis in cancer cells. *European Journal of Medicinal Chemistry*, 121, 58–70. <https://doi.org/10.1016/j.ejmech.2016.05.017>
- [190] Ghobish, S. A., Mohamed, K. O., Farag, N., & Farag, D. B. (2024). Novel indolyl 1,2,4-triazole derivatives as potential anti-proliferative agents: in silico studies, synthesis, and biological evaluation. *RSC Medicinal Chemistry*, 15(1), 293–308. <https://doi.org/10.1039/d3md00524k>
- [191] Anthwal, A., Thakur, B. K., Rawat, M. S. M., Rawat, D. S., Tyagi, A. K., & Aggarwal, B. B. (2014). Synthesis, Characterization and In Vitro Anticancer Activity of C-5 Curcumin Analogues with Potential to Inhibit TNF- α -Induced NF- κ B Activation. *BioMed Research International*, 2014, 1–10. <https://doi.org/10.1155/2014/524161>

- [192] Cuddihy, A. R., & O'Connell, M. J. (2003). Cell-cycle responses to DNA damage in G2. *International Review of Cytology*, 99–140. [https://doi.org/10.1016/s0074-7696\(02\)22013-6](https://doi.org/10.1016/s0074-7696(02)22013-6)
- [193] Senturk, E., & Manfredi, J. J. (2012). p53 and Cell Cycle Effects After DNA Damage. *P53 Protocols*, 49–61. https://doi.org/10.1007/978-1-62703-236-0_4
- [194] Mc Gee, M. M. (2015). Targeting the Mitotic Catastrophe Signaling Pathway in Cancer. *Mediators of Inflammation*, 2015(1). Portico. <https://doi.org/10.1155/2015/146282>
- [195] Fährrolfes, R., Bietz, S., Flachsenberg, F., Meyder, A., Nittinger, E., Otto, T., Volkamer, A., & Rarey, M. (2017). ProteinsPlus: a web portal for structure analysis of macromolecules. *Nucleic Acids Research*, 45(W1), W337–W343. <https://doi.org/10.1093/nar/gkx333>
- [196] Volkamer, A., Kuhn, D., Grombacher, T., Rippmann, F., & Rarey, M. (2012). Combining Global and Local Measures for Structure-Based Druggability Predictions. *Journal of Chemical Information and Modeling*, 52(2), 360–372. <https://doi.org/10.1021/ci200454v>
- [197] Monks, A., Scudiero, D., Skehan, P., Shoemaker, R., Paull, K., Vistica, D., Hose, C., Langley, J., Cronise, P., Vaigro-Wolff, A., Gray-Goodrich, M., Campbell, H., Mayo, J., & Boyd, M. (1991). Feasibility of a High-Flux Anticancer Drug Screen Using a Diverse Panel of Cultured Human Tumor Cell Lines. *JNCI Journal of the National Cancer Institute*, 83(11), 757–766. <https://doi.org/10.1093/jnci/83.11.757>
- [198] Boyd, M. R. (1997). The NCI In Vitro Anticancer Drug Discovery Screen. *Anticancer Drug Development Guide*, 23–42. https://doi.org/10.1007/978-1-4615-8152-9_2
- [199] Shoemaker, R. H. (2006). The NCI60 human tumour cell line anticancer drug screen. *Nature Reviews Cancer*, 6(10), 813–823. <https://doi.org/10.1038/nrc1951>
- [200] Gerlier, D., & Thomasset, N. (1986). Use of MTT colorimetric assay to measure cell activation. *Journal of Immunological Methods*, 94(1–2), 57–63. [https://doi.org/10.1016/0022-1759\(86\)90215-2](https://doi.org/10.1016/0022-1759(86)90215-2)
- [201] Mosmann, T. (1983). Rapid colorimetric assay for cellular growth and survival: Application to proliferation and cytotoxicity assays. *Journal of Immunological Methods*, 65(1–2), 55–63. [https://doi.org/10.1016/0022-1759\(83\)90303-4](https://doi.org/10.1016/0022-1759(83)90303-4)
- [202] ATCC. MTT Cell Proliferation Assay Instruction Guide. ATCC, VA, USA. Retrieved from <https://www.atcc.org>
- [203] Pozarowski, P., & Darzynkiewicz, Z. (2004). Analysis of Cell Cycle by Flow Cytometry. *Checkpoint Controls and Cancer*, 301–312. <https://doi.org/10.1385/1-59259-811-0:301>
- [204] Ormerod, M. G., Tribukait, B., & Giaretti, W. (1998). Consensus Report of the Task Force on Standardisation of DNA Flow Cytometry in Clinical Pathology. *Analytical Cellular Pathology*, 17(2), 103–110. Portico. <https://doi.org/10.1155/1998/842306>

- [205] Koopman, G., Reutelingsperger, C. P., Kuijten, G. A., Keehnen, R. M., Pals, S. T., & van Oers, M. H. (1994). Annexin V for flow cytometric detection of phosphatidylserine expression on B cells undergoing apoptosis. *Blood*, 84(5), 1415–1420.
- [206] Vermes, I., Haanen, C., Steffens-Nakken, H., & Reutellingsperger, C. (1995). A novel assay for apoptosis Flow cytometric detection of phosphatidylserine expression on early apoptotic cells using fluorescein labelled Annexin V. *Journal of Immunological Methods*, 184(1), 39–51. [https://doi.org/10.1016/0022-1759\(95\)00072-i](https://doi.org/10.1016/0022-1759(95)00072-i)
- [207] Radtke, A. J., Kandov, E., Lowekamp, B., Speranza, E., Chu, C. J., Gola, A., Thakur, N., Shih, R., Yao, L., Yaniv, Z. R., Beuschel, R. T., Kabat, J., Croteau, J., Davis, J., Hernandez, J. M., & Germain, R. N. (2020). IBEX: A versatile multiplex optical imaging approach for deep phenotyping and spatial analysis of cells in complex tissues. *Proceedings of the National Academy of Sciences*, 117(52), 33455–33465. <https://doi.org/10.1073/pnas.2018488117>
- [208] Radtke, A. J., Chu, C. J., Yaniv, Z., Yao, L., Marr, J., Beuschel, R. T., Ichise, H., Gola, A., Kabat, J., Lowekamp, B., Speranza, E., Croteau, J., Thakur, N., Jonigk, D., Davis, J. L., Hernandez, J. M., & Germain, R. N. (2022). IBEX: an iterative immunolabeling and chemical bleaching method for high-content imaging of diverse tissues. *Nature Protocols*, 17(2), 378–401. <https://doi.org/10.1038/s41596-021-00644-9>
- [209] Pettersen, E. F., Goddard, T. D., Huang, C. C., Couch, G. S., Greenblatt, D. M., Meng, E. C., & Ferrin, T. E. (2004). UCSF Chimera—A visualization system for exploratory research and analysis. *Journal of Computational Chemistry*, 25(13), 1605–1612. Portico. <https://doi.org/10.1002/jcc.20084>
- [210] Shapovalov, M. V., & Dunbrack, R. L. (2011). A Smoothed Backbone-Dependent Rotamer Library for Proteins Derived from Adaptive Kernel Density Estimates and Regressions. *Structure*, 19(6), 844–858. <https://doi.org/10.1016/j.str.2011.03.019>
- [211] Kagami, L., Wilter, A., Diaz, A., & Vranken, W. (2023). The ACPYPE web server for small-molecule MD topology generation. *Bioinformatics*, 39(6). <https://doi.org/10.1093/bioinformatics/btad350>
- [212] BIOVIA, Dassault Systèmes, BIOVIA Discovery Studio Visualizer 2024, San Diego: Dassault Systèmes, 2024
- [213] Azzam, R. A., Elboshi, H. A., & Elgemeie, G. H. (2022). Synthesis, Physicochemical Properties and Molecular Docking of New Benzothiazole Derivatives as Antimicrobial Agents Targeting DHPS Enzyme. *Antibiotics*, 11(12), 1799. <https://doi.org/10.3390/antibiotics11121799>

- [214] Berendsen, H. J. C., van der Spoel, D., & van Drunen, R. (1995). GROMACS: A message-passing parallel molecular dynamics implementation. *Computer Physics Communications*, 91(1–3), 43–56. [https://doi.org/10.1016/0010-4655\(95\)00042-e](https://doi.org/10.1016/0010-4655(95)00042-e)
- [215] Malde, A. K., Zuo, L., Breeze, M., Stroet, M., Poger, D., Nair, P. C., Oostenbrink, C., & Mark, A. E. (2011). An Automated Force Field Topology Builder (ATB) and Repository: Version 1.0. *Journal of Chemical Theory and Computation*, 7(12), 4026–4037. <https://doi.org/10.1021/ct200196m>
- [216] Sankara Rao, N., Nagesh, N., Lakshma Nayak, V., Sunkari, S., Tokala, R., Kiranmai, G., Regur, P., Shankaraiah, N., & Kamal, A. (2019). Design and synthesis of DNA-intercalative naphthalimide-benzothiazole/cinnamide derivatives: cytotoxicity evaluation and topoisomerase-II α inhibition. *MedChemComm*, 10(1), 72–79. <https://doi.org/10.1039/c8md00395e>
- [217] Tariq, S., Alam, O., & Amir, M. (2018). Synthesis, p38 α MAP kinase inhibition, anti-inflammatory activity, and molecular docking studies of 1,2,4-triazole-based benzothiazole-2-amines. *Archiv Der Pharmazie*, 351(3–4). Portico. <https://doi.org/10.1002/ardp.201700304>
- [218] Azzam, R. A., Osman, R. R., & Elgemeie, G. H. (2020). Efficient Synthesis and Docking Studies of Novel Benzothiazole-Based Pyrimidinesulfonamide Scaffolds as New Antiviral Agents and Hsp90 α Inhibitors. *ACS Omega*, 5(3), 1640–1655. <https://doi.org/10.1021/acsomega.9b03706>
- [219] Mor, S., & Sindhu, S. (2019). Synthesis, Type II diabetes inhibitory activity, antimicrobial evaluation and docking studies of indeno[1,2-c]pyrazol-4(1H)-ones. *Medicinal Chemistry Research*, 29(1), 46–62. <https://doi.org/10.1007/s00044-019-02457-8>
- [220] Thakkar, S. S., Thakor, P., Ray, A., Doshi, H., & Thakkar, V. R. (2017). Benzothiazole analogues: Synthesis, characterization, MO calculations with PM6 and DFT, in silico studies and in vitro antimalarial as DHFR inhibitors and antimicrobial activities. *Bioorganic & Medicinal Chemistry*, 25(20), 5396–5406. <https://doi.org/10.1016/j.bmc.2017.07.057>
- [221] Delmas, F., Avellaneda, A., Di Giorgio, C., Robin, M., De Clercq, E., Timon-David, P., & Galy, J.-P. (2004). Synthesis and antileishmanial activity of (1,3-benzothiazol-

- 2-yl) amino-9-(10H)-acridinone derivatives. *European Journal of Medicinal Chemistry*, 39(8), 685–690. <https://doi.org/10.1016/j.ejmech.2004.04.006>
- [222] Xu, F., Kwon, J.-Y., Kim, J.-H., Kim, H. U., Lim, J. M., Cho, H., Lee, C., Lee, J., Lee, J.-I., & Hwang, D.-H. (2012). Highly efficient yellow and white phosphorescent organic light-emitting diodes using a benzothiazole-liganded new iridium complex. *Synthetic Metals*, 162(15–16), 1421–1428. <https://doi.org/10.1016/j.synthmet.2012.06.009>
- [223] Doble, A. (1996). The pharmacology and mechanism of action of riluzole. *Neurology*, 47(6_suppl_4). https://doi.org/10.1212/wnl.47.6_suppl_4.233s
- [224] Johnson, B. K., Colvin, C. J., Needle, D. B., Mba Medie, F., Champion, P. A. D., & Abramovitch, R. B. (2015). The Carbonic Anhydrase Inhibitor Ethoxzolamide Inhibits the Mycobacterium tuberculosis PhoPR Regulon and Esx-1 Secretion and Attenuates Virulence. *Antimicrobial Agents and Chemotherapy*, 59(8), 4436–4445. <https://doi.org/10.1128/aac.00719-15>
- [225] Hatfield, S. M., Hartley, L. W., & Schmidtke, J. R. (1982). The immunomodulatory action of frentizole, a novel immunosuppressive agent. *Immunopharmacology*, 5(2), 169–179. [https://doi.org/10.1016/0162-3109\(82\)90047-9](https://doi.org/10.1016/0162-3109(82)90047-9)
- [226] Lieberman, A., Ranhosky, A., & Korts, D. (1997). Clinical evaluation of pramipexole in advanced Parkinson's disease: Results of a double-blind, placebo-controlled, parallel-group study. *Neurology*, 49(1), 162–168. <https://doi.org/10.1212/wnl.49.1.162>
- [227] Gao, X., Liu, J., Zuo, X., Feng, X., & Gao, Y. (2020). Recent Advances in Synthesis of Benzothiazole Compounds Related to Green Chemistry. *Molecules*, 25(7), 1675. <https://doi.org/10.3390/molecules25071675>
- [228] Dai, J., Tian, S., Yang, X., & Liu, Z. (2022). Synthesis methods of 1,2,3-/1,2,4-triazoles: A review. *Frontiers in Chemistry*, 10. <https://doi.org/10.3389/fchem.2022.891484>
- [229] Shrestha, S. K., Garzan, A., & Garneau-Tsodikova, S. (2017). Novel alkylated azoles as potent antifungals. *European Journal of Medicinal Chemistry*, 133, 309–318. <https://doi.org/10.1016/j.ejmech.2017.03.075>

- [230] Han, M. İ., Bekçi, H., Uba, A. I., Yıldırım, Y., Karasulu, E., Cumaoğlu, A., Karasulu, H. Y., Yelekçi, K., Yılmaz, Ö., & Küçükgül, Ş. G. (2019). Synthesis, molecular modeling, in vivo study, and anticancer activity of 1,2,4-triazole containing hydrazide–hydrazones derived from (S)-naproxen. *Archiv Der Pharmazie*, 352(6). Portico. <https://doi.org/10.1002/ardp.201800365>
- [231] Tatar, E. (2015). Synthesis and biological evaluation of some new 1,3,4-thiadiazole and 1,2,4-triazole derivatives from L-methionine as antituberculosis and antiviral agents. *MARMARA PHARMACEUTICAL JOURNAL*, 2(19), 88–88. <https://doi.org/10.12991/mpj.2015199639>
- [232] Liu, J., Liu, Q., Yang, X., Xu, S., Zhang, H., Bai, R., Yao, H., Jiang, J., Shen, M., Wu, X., & Xu, J. (2013). Design, synthesis, and biological evaluation of 1,2,4-triazole bearing 5-substituted biphenyl-2-sulfonamide derivatives as potential antihypertensive candidates. *Bioorganic & Medicinal Chemistry*, 21(24), 7742–7751. <https://doi.org/10.1016/j.bmc.2013.10.017>
- [233] Paprocka, R., Wiese, M., Eljaszewicz, A., Helmin-Basa, A., Gzella, A., Modzelewska-Banachiewicz, B., & Michalkiewicz, J. (2015). Synthesis and anti-inflammatory activity of new 1,2,4-triazole derivatives. *Bioorganic & Medicinal Chemistry Letters*, 25(13), 2664–2667. <https://doi.org/10.1016/j.bmcl.2015.04.079>
- [234] Semenov, A. V., Semenova, E. V., & Balakireva, O. I. (2022). Heterocyclic Resveratrol Analogs: Synthesis and Physiological Activity. Part 2: Analogs Obtained by the Replacement of Ethylene Fragments with Heterocyclic Residues. *Russian Journal of Bioorganic Chemistry*, 48(1), 27–45. <https://doi.org/10.1134/s1068162022010113>
- [235] Belyaeva, E. R., Myasoedova, Yu. V., Ishmuratova, N. M., & Ishmuratov, G. Yu. (2022). Synthesis and Biological Activity of N-Acylhydrazones. *Russian Journal of Bioorganic Chemistry*, 48(6), 1123–1150. <https://doi.org/10.1134/s1068162022060085>
- [236] Mirjafary, Z., Mohammad Karbasi, M., Hesamzadeh, P., Shaker, H. R., Amiri, A., & Saeidian, H. (2022). Novel 1,2,3-Triazole-Based Benzothiazole Derivatives:

- Efficient Synthesis, DFT, Molecular Docking, and ADMET Studies. *Molecules*, 27(23), 8555. <https://doi.org/10.3390/molecules27238555>
- [237] Kaushik, C. P., & Chahal, M. (2020). Synthesis and antibacterial activity of benzothiazole and benzoxazole-appended substituted 1,2,3-triazoles. *Journal of Chemical Sciences*, 132(1). <https://doi.org/10.1007/s12039-020-01844-8>
- [238] Yadav, P., Kumar Yadav, J., Dixit, A. K., Agarwal, A., & Kumar Awasthi, S. (2019). Insight into the interaction of benzothiazole tethered triazole analogues with human serum albumin: Spectroscopy and molecular docking approaches. *Luminescence*, 34(8), 812–822. Portico. <https://doi.org/10.1002/bio.3676>
- [239] Rezki, N., Almeahadi, M. A., Ihmaid, S., Shehata, A. M., Omar, A. M., Ahmed, H. E. A., & Aouad, M. R. (2020). Novel scaffold hopping of potent benzothiazole and isatin analogues linked to 1,2,3-triazole fragment that mimic quinazoline epidermal growth factor receptor inhibitors: Synthesis, antitumor and mechanistic analyses. *Bioorganic Chemistry*, 103, 104133. <https://doi.org/10.1016/j.bioorg.2020.104133>
- [240] Tariq, S., Kamboj, P., Alam, O., & Amir, Mohd. (2018). 1,2,4-Triazole-based benzothiazole/benzoxazole derivatives: Design, synthesis, p38 α MAP kinase inhibition, anti-inflammatory activity and molecular docking studies. *Bioorganic Chemistry*, 81, 630–641. <https://doi.org/10.1016/j.bioorg.2018.09.015>
- [241] Tariq, S., Alam, O., & Amir, M. (2018). Synthesis, p38 α MAP kinase inhibition, anti-inflammatory activity, and molecular docking studies of 1,2,4-triazole-based benzothiazole-2-amines. *Archiv Der Pharmazie*, 351(3–4). Portico. <https://doi.org/10.1002/ardp.201700304>
- [242] Murray, C. J. L., Ikuta, K. S., Sharara, F., Swetschinski, L., Robles Aguilar, G., Gray, A., Han, C., Bisignano, C., Rao, P., Wool, E., Johnson, S. C., Browne, A. J., Chipeta, M. G., Fell, F., Hackett, S., Haines-Woodhouse, G., Kashef Hamadani, B. H., Kumaran, E. A. P., McManigal, B., ... Naghavi, M. (2022). Global burden of bacterial antimicrobial resistance in 2019: a systematic analysis. *The Lancet*, 399(10325), 629–655. [https://doi.org/10.1016/s0140-6736\(21\)02724-0](https://doi.org/10.1016/s0140-6736(21)02724-0)
- [243] Global antimicrobial resistance and use surveillance system (GLASS) report. 2022
- [244] WHO publishes list of bacteria for which new antibiotics are urgently needed. 2017

- [245] WHO fungal priority pathogens list to guide research, development and public health action. Geneva: World Health Organization. 2022
- [246] Kashyap, P., Verma, S., Gupta, P., Narang, R., Lal, S., & Devgun, M. (2023). Recent insights into antibacterial potential of benzothiazole derivatives. *Medicinal Chemistry Research*, 32(8), 1543–1573. <https://doi.org/10.1007/s00044-023-03077-z>
- [247] Kumar, S., Khokra, S. L., & Yadav, A. (2021). Triazole analogues as potential pharmacological agents: a brief review. *Future Journal of Pharmaceutical Sciences*, 7(1). <https://doi.org/10.1186/s43094-021-00241-3>
- [248] Kumarasiri, M., Fisher, J. F., & Mobashery, S. (2013). Penicillin-Binding Protein 5 of *Escherichia coli*. *Handbook of Proteolytic Enzymes*, 3474–3480. <https://doi.org/10.1016/b978-0-12-382219-2.00770-5>
- [249] Nicola, G., Tomberg, J., Pratt, R. F., Nicholas, R. A., & Davies, C. (2010). Crystal Structures of Covalent Complexes of β -Lactam Antibiotics with *Escherichia coli* Penicillin-Binding Protein 5: Toward an Understanding of Antibiotic Specificity. *Biochemistry*, 49(37), 8094–8104. <https://doi.org/10.1021/bi100879m>
- [250] Chalkha, M., Nour, H., Chebbac, K., Nakkabi, A., Bahsis, L., Bakhouch, M., Akhazzane, M., Bourass, M., Chtita, S., Bin Jordan, Y. A., Augustyniak, M., Bourhia, M., Aboul-Soud, M. A. M., & El Yazidi, M. (2022). Synthesis, Characterization, DFT Mechanistic Study, Antimicrobial Activity, Molecular Modeling, and ADMET Properties of Novel Pyrazole-isoxazoline Hybrids. *ACS Omega*, 7(50), 46731–46744. <https://doi.org/10.1021/acsomega.2c05788>
- [251] Agwom, F. M. (2019). In Silico Studies, Comparative Synthesis and Antibacterial Activity of Some Imine Derivatives of Isonicotinic Hydrazide. *Organic & Medicinal Chemistry International Journal*, 8(5). <https://doi.org/10.19080/omcij.2019.08.555747>
- [252] Coleman, J. P., & Smith, C. J. (2007). Microbial Nucleic Acid and Protein Synthesis. *XPharm: The Comprehensive Pharmacology Reference*, 1–4. <https://doi.org/10.1016/b978-008055232-3.60226-0>
- [253] Durcik, M., Cotman, A. E., Toplak, Ž., Možina, Š., Skok, Ž., Szili, P. E., Czikkely, M., Maharramov, E., Vu, T. H., Piras, M. V., Zidar, N., Ilaš, J., Zega, A., Trontelj,

- J., Pardo, L. A., Hughes, D., Huseby, D., Berruga-Fernández, T., Cao, S., ... Peterlin Mašič, L. (2023). New Dual Inhibitors of Bacterial Topoisomerases with Broad-Spectrum Antibacterial Activity and In Vivo Efficacy against Vancomycin-Intermediate *Staphylococcus aureus*. *Journal of Medicinal Chemistry*, 66(6), 3968–3994. <https://doi.org/10.1021/acs.jmedchem.2c01905>
- [254] Gropp, K., Schild, L., Hube, B., Zipfel, P. F., & Skerka, C. (2009). Secreted aspartic proteinases (Saps) of *Candida albicans* degrade host complement. *Molecular Immunology*, 46(14), 2835–2836. <https://doi.org/10.1016/j.molimm.2009.05.235>
- [255] Naglik, J. R., Challacombe, S. J., & Hube, B. (2003). *Candida albicans* Secreted Aspartyl Proteinases in Virulence and Pathogenesis. *Microbiology and Molecular Biology Reviews*, 67(3), 400–428. <https://doi.org/10.1128/mmbr.67.3.400-428.2003>
- [256] Aljohny, B. O., Rauf, A., Anwar, Y., Naz, S., & Wadood, A. (2021). Antibacterial, Antifungal, Antioxidant, and Docking Studies of Potential Dinaphthodiospyrrols from *Diospyros lotus* Linn Roots. *ACS Omega*, 6(8), 5878–5885. <https://doi.org/10.1021/acsomega.0c06297>
- [257] CLSI. *Methods for Dilution Antimicrobial Susceptibility Tests for Bacteria That Grow Aerobically; Approved Standard—Ninth Edition*. CLSI document M07-A9. Wayne, PA: Clinical and Laboratory Standards Institute. 2012.
- [258] Eberhardt, J., Santos-Martins, D., Tillack, A. F., & Forli, S. (2021). AutoDock Vina 1.2.0: New Docking Methods, Expanded Force Field, and Python Bindings. *Journal of Chemical Information and Modeling*, 61(8), 3891–3898. <https://doi.org/10.1021/acs.jcim.1c00203>
- [259] Daina, A., & Zoete, V. (2016). A BOILED-Egg To Predict Gastrointestinal Absorption and Brain Penetration of Small Molecules. *ChemMedChem*, 11(11), 1117–1121. Portico. <https://doi.org/10.1002/cmdc.201600182>
- [260] Xiong, G., Wu, Z., Yi, J., Fu, L., Yang, Z., Hsieh, C., Yin, M., Zeng, X., Wu, C., Lu, A., Chen, X., Hou, T., & Cao, D. (2021). ADMETlab 2.0: an integrated online platform for accurate and comprehensive predictions of ADMET properties. *Nucleic Acids Research*, 49(W1), W5–W14. <https://doi.org/10.1093/nar/gkab255>

- [261] Ali, R., & Siddiqui, N. (2013). Biological Aspects of Emerging Benzothiazoles: A Short Review. *Journal of Chemistry*, 2013(1). Portico. <https://doi.org/10.1155/2013/345198>
- [262] Matin, M. M., Matin, P., Rahman, Md. R., Ben Hadda, T., Almalki, F. A., Mahmud, S., Ghoneim, M. M., Alruwaily, M., & Alshehri, S. (2022). Triazoles and Their Derivatives: Chemistry, Synthesis, and Therapeutic Applications. *Frontiers in Molecular Biosciences*, 9. <https://doi.org/10.3389/fmolb.2022.864286>
- [263] Mei, X., Liu, Y., Huang, H., Du, F., Huang, L., Wu, J., Li, Y., Zhu, S., & Yang, M. (2019). Benzothiazole inhibits the growth of *Phytophthora capsici* through inducing apoptosis and suppressing stress responses and metabolic detoxification. *Pesticide Biochemistry and Physiology*, 154, 7–16. <https://doi.org/10.1016/j.pestbp.2018.12.002>
- [264] Sultana, R., Abid, O.-R., Sultana, N., Fakhar-e-Alam, M., Siddique, M. H., Atif, M., Nawaz, M., Wadood, A., Rehman, A. U., Farooq, W. A., Shafeeq, S., & Afzal, M. (2022). Potential enzyme inhibitor triazoles from aliphatic esters: Synthesis, enzyme inhibition and docking studies. *Journal of Saudi Chemical Society*, 26(6), 101565. <https://doi.org/10.1016/j.jscs.2022.101565>
- [265] Li, X., Lin, Y., Wang, Q., Yuan, Y., Zhang, H., & Qian, X. (2011). The novel anti-tumor agents of 4-triazol-1,8-naphthalimides: Synthesis, cytotoxicity, DNA intercalation and photocleavage. *European Journal of Medicinal Chemistry*, 46(4), 1274–1279. <https://doi.org/10.1016/j.ejmech.2011.01.050>
- [266] Péraldi-Roux, S., Bayle, M., M’Kadmi, C., Damian, M., Vaillé, J., Fernandez, G., Cornejo, M. P., Marie, J., Banères, J.-L., Ben Haj Salah, K., Fehrentz, J.-A., Cantel, S., Perello, M., Denoyelle, S., Oiry, C., & Neasta, J. (2022). Design and characterization of a triazole-based growth hormone secretagogue receptor modulator inhibiting the glucoregulatory and feeding actions of ghrelin. *Biochemical Pharmacology*, 202, 115114. <https://doi.org/10.1016/j.bcp.2022.115114>
- [267] El-Sherief, H. A. M., Youssif, B. G. M., Bukhari, S. N. A., Abdel-Aziz, M., & Abdel-Rahman, H. M. (2018). Novel 1,2,4-triazole derivatives as potential

- anticancer agents: Design, synthesis, molecular docking and mechanistic studies. *Bioorganic Chemistry*, 76, 314–325. <https://doi.org/10.1016/j.bioorg.2017.12.013>
- [268] Todorov, L., & Kostova, I. (2023). 1,2,3-Triazoles and their metal chelates with antimicrobial activity. *Frontiers in Chemistry*, 11. <https://doi.org/10.3389/fchem.2023.1247805>
- [269] Balcı, N., Çelik, H., Türkan, F., Çelebioğlu, N., Çelik, T., & Bursal, E. (2023). Schiff Base Synthesis with a New Reliable Method and Investigation of Their Inhibition Effects on Glutathione S-Transferase and Cholinesterase Enzymes. *ChemistrySelect*, 8(18). Portico. <https://doi.org/10.1002/slct.202204566>
- [270] Kumar, R., Singh, B., Gahlyan, P., Kumar, R., & Pani, B. (2023). Recent developments on the colorimetric and fluorometric detection of 3d block metal ions using Schiff base probes. *Journal of Molecular Structure*, 1289, 135859. <https://doi.org/10.1016/j.molstruc.2023.135859>
- [271] Isika, D. K., & Sadik, O. A. (2022). Selective Structural Derivatization of Flavonoid Acetamides Significantly Impacts Their Bioavailability and Antioxidant Properties. *Molecules*, 27(23), 8133. <https://doi.org/10.3390/molecules27238133>
- [272] Hullatti, K., & Telagari, M. (2015). In-vitro α -amylase and α -glucosidase inhibitory activity of *Adiantum caudatum* Linn. and *Celosia argentea* Linn. extracts and fractions. *Indian Journal of Pharmacology*, 47(4), 425. <https://doi.org/10.4103/0253-7613.161270>
- [273] Konus, M., Çetin, D., Kızıllkan, N. D., Yılmaz, C., Fidan, C., Algso, M., Kavak, E., Kivrak, A., Kurt-Kızıldoğan, A., Otur, Ç., Mutlu, D., Abdelsalam, A. H., & Arslan, S. (2022). Synthesis and biological activity of new indole based derivatives as potent anticancer, antioxidant and antimicrobial agents. *Journal of Molecular Structure*, 1263, 133168. <https://doi.org/10.1016/j.molstruc.2022.133168>
- [274] Sumit, Kumar, A., & Mishra, A. K. (2021). Advancement in Pharmacological Activities of Benzothiazole and its Derivatives: An Up to Date Review. *Mini-Reviews in Medicinal Chemistry*, 21(3), 314–335. <https://doi.org/10.2174/1389557520666200820133252>

- [275] Agalave, S. G., Maujan, S. R., & Pore, V. S. (2011). Click Chemistry: 1,2,3-Triazoles as Pharmacophores. *Chemistry – An Asian Journal*, 6(10), 2696–2718. Portico. <https://doi.org/10.1002/asia.201100432>
- [276] Kumar, S., Khokra, S. L., & Yadav, A. (2021). Triazole analogues as potential pharmacological agents: a brief review. *Future Journal of Pharmaceutical Sciences*, 7(1). <https://doi.org/10.1186/s43094-021-00241-3>