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A SHORT REVIEW ON ORGANIC HETEROCYCLIC COMPOUNDS AS CHEMOSENSORS FOR METAL CA TIONS (2017-2020)

Manoj V. Patil[a], Ashok A. Patil[a] and Prashant A. Patil*[b]

[a] P.G. Research Centre, Department of Chemistry, JET's Z. B. Patil College, Deopur, Dhule (M.S)– 424002 India
[b] Department of Chemistry, S. S. V. P. S's L. K. Dr. P. R. Ghogrey Science College, Deopur, Dhule (M.S.)-424005 India.
(E-mail address of Corresponding authors: prashantchem5@gmail.com)

Abstract:
Metal cations have two sides; they are useful for living organisms and toxic for the ecosystem. There is a high risk of contamination has been increased because of the continuous discharge of non-degradable and crude industrial waste in sewage. This crude and non-degradable waste exists for a long time in the environment. In recent years, advanced technology of chemosensors help to improve living standards and it increases new challenges with respect to environmental safety as uncontrolled industrialization and urbanization without proper discharge control and pollution decreases have put human life at risk. Organic chemosensors can be used to detect a variety of metal cations. Organic chemosensors convert chemical data into analytically relevant signals that may also be seen with the naked eye. Organic chemosensors are capable of detecting metal cations with excellent selectivity and sensitivity at a reasonable cost. This review covers of research publications of over recent 3 years (2017-2020).

Keywords: Organic Chemosensor, molecular chemosensor, metal cation,

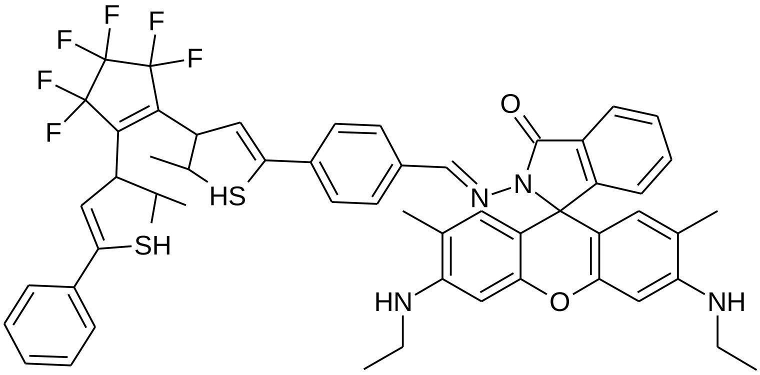
Introduction:

Metal ions, also known as transition elements, play a significant part in the human life cycle, as well as biological and environmental processes. The scientist has spent the last two to three years interacting with freshly created chemosensors for the detection of various metal ions. Metal ions include Na, K, Fe, Mn, Mg, Co, Cu, Zn, and others. These metal ions are needed in the right amounts by the human organism. A variety of donor sites have been disclosed for the detection of metal ions using colorimetric and fluorescence techniques in a number of recently designed organic chemosensors. Heteroatoms like nitrogen, sulphur, and oxygen are found in organic chemosensors. Chelating ligands for metal ions rely on these heteroatoms.

Organic chemosensor for detection of Fe^{2+} and Fe^{3+} metal ions

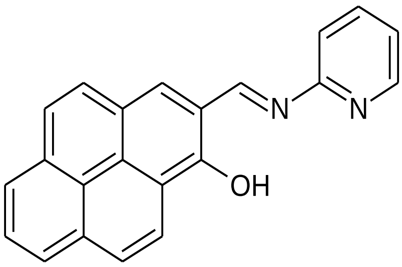
Human metabolic activities, such as oxygen transport, require iron. Iron helps us breathe by supplying oxygen and removing carbon dioxide from our bodies. Iron is the most advantageous metal for the creation of blood. Iron is required for the formation of haemoglobin in human blood. Haemoglobin is a protein that transports blood from the lungs to the tissues and converts blood sugar into energy.

Compound 1 was synthesised by Huitao Xu et al using Schiff base condensation and a new diarylethene derivative with rhodamine 6G. From colourless (no fluorescence) to bright pink (strong fluorescence) shifting showed a quick response to Fe^{3+}, with the solution shifting in presence of 10.0 Equiv. of metal ions in the absorption spectra of compound 1, at 531 nm. Fe^{3+}, Cr^{3+}, and Al^{3+} were able to induce significant absorptions; Compared to Cr^{3+} and Al3+, Fe^{3+} produced a substantially higher absorption peak[1-6].



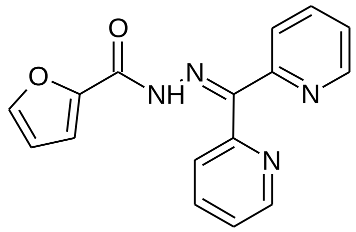
Compound 1

Yuxin Guo et al synthesized pyrene-based chemosensor i.e. Compound 2. Pyrene and its derivative are highly effective fluorophores towards small organic molecules, simple inorganic anions, and sensing of metal ions. Yuxin et al prepared a pyrene-based chemosensor by using aldehyde substituted pyrene and aminopyridine resulting in a Schiff base structure. When this Schiff-based structure attaches to pyrene fluorophore, the absorption spectra will alter or the fluorescence will be quenched. Using fluorescence spectra in DMF–HEPES buffer (2:8, v/v, pH = 7.4) solution, the selectivity of Compound 2 (10 M) to various metal ions was examined. According to emission spectra, unbound Compound 2 fluoresced strongly at 370 nm under a 305 nm excitation wavelength[8].



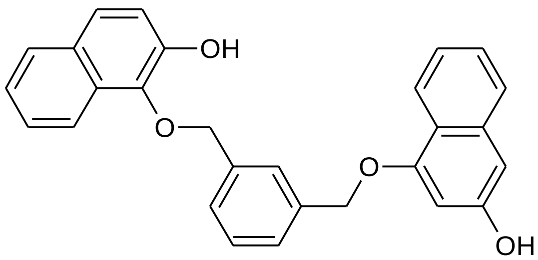
Compound 2

Using 2-furoic hydrazide and di-2-pyridyl ketone in ethanol, Minuk Yang et al synthesized Compound 3, a new chemosensor. Fe (II) was gradually added to Compound 3 to give it the potential to operate as a probe. When Fe (II) was introduced a blue tint was produced via a novel molecular absorption at 640 nm. The blue colour was observed after Fe (II) was added to the sensor is specific to Fe (II); no blue colour was observed for Fe (III) including other metals[9-10].



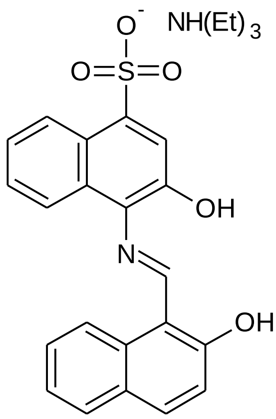
Compound 3

N. Bhuvanesh and colleagues created a chemosensor based on Naphthalene i.e. Compound 4. That is capable of detecting Fe^{2+}. A condensation reaction between 2-Hydroxynaphthaldehyde and m-xylene dibromide was used to make compound 4. This method detects Fe^{2+} ions in compound 4, which has a limit of detection is 48.21 X 10-9 M. Fe^{2+} is recognised by the chemosensor Compound 4 over other Fe^{3+} including other transition metal ions,. The chemosensor Compound 4 recognised Fe^{2+} via a With a "turn-off" response, reverse the PET process.. Chemosensor Compound 4 selectively detects Fe^{2+} over other potentially competing metal ions such as Fe^{3+} by using fluorescence "switch on-off" reactions with the reverse PET process and structural changes. Compound 4 was successfully implemented in microbial Bioimaging and Fe^{2+} detection of aqueous sample analysis. As a result, the chemosensor Compound 4 might be employed to detect Fe^{2+} ions in biological, therapeutic, and environmental monitoring applications[11].



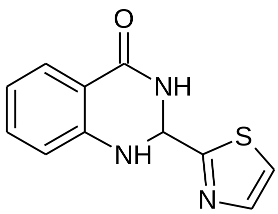
Compound 4

A sulfonate-based chemosensor for sensing Fe^{2+} and Fe^{3+} was created by Tae Geun Jo and colleagues. Compound 5 was synthesised from 1-Amino-2-naphthol-4-sulfonic acid and 2-Hydroxy naphthaldehyde in methanol using TEA as a base, yielding 34.4 %. 1H NMR and 13C NMR both verified it. Compound 5 was studied for fluorescence sensing ability towards different metal ions (Al^{3+}, Ga^{3+}, In^{3+}, Zn^{2+}, Cd^{2+}, Cu^{2+}, Fe^{2+}, Fe^{3+}, Mg^{2+}, Cr^{3+}, Co^{2+}, Ni^{2+}, Na^{+}, K^{+}, Ca^{2+}, Mn^{2+} and Pb^{2+}). Based on excitation at 380 nm, Cu^{2+}, Fe^{2+}, Fe^{3+}, and Al^{3+} ions showed significant spectrum alterations, with Compound 1 emitting fluorescence at 442 nm. Compound 5 allowed for Cu^{2+} and Fe^{3+} analysis with low limits of detection (1.25 mM for Cu2+ and 3.96 mM for Fe3+), which were much lower expected than WHO and EPA recommended values[12].



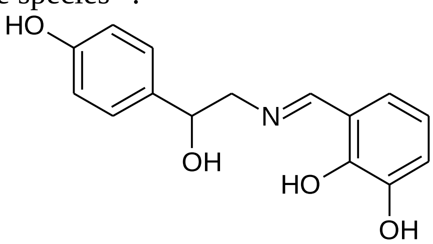
Compound 5

Compound 6 was developed by Pravin R. Dongre et al as a quinazolinone-based chemosensor. Compound 6 was created by combining isatoic anhydride (1 mmol), ammonium acetate (8 mmol), and 2-Thiazolecarboxaldehyde. Changes in fluorescence characteristics revealed high sensitivity and selectivity for Fe^{3+} over other ecologically and physiologically relevant metal ions, which was reversible with the addition of EDTA. When compared to other ecologically and physiologically important metal ions, Compound 6 shows a remarkable fluorescence turn-on-off preference for Fe^{3+}, which is extremely selective and sensitive. DFT simulations theoretically supported this anticipated sensing process, resulting in a technique that was simple to use, highly selective, and suitable for detecting Fe^{3+} in pharmaceutical and water samples[13-15].



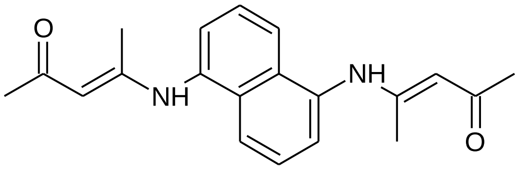
Compound 6

Compound 7 was created by combining octopamine and 2,3-dihydroxybenzaldehyde, according to Ji Hye Kang et al. Compound 1 was isolated with a yield of 70.2 % and validated by 1H and 13C NMR. Compound 7 is an innovative chemosensor for the detection of the colorimetric response of iron. Compound 7 was used to detect the iron, which changed color from pale yellow to brown. Using compound 7 as a chemosensor, the limit of detection for Fe^{3+} and Fe^{2+} were determined to be 0.25 and 0.55 M respectively, which are significantly lower than the EPA's drinking water guideline (5.37 μM). To investigate Compound 7's sensing properties, a UV-vis titration experiment was performed toward Fe^{3+}. As indicated by data, absorbance at 290 and 420 nm redshifted to 335 and 500 nm, respectively, up to 0.75 Equivalent of Fe^{3+}, with a clear isosbestic point at 271 nm. It was discovered that Compound 7 and Fe^{3+} constituted a single species[16].



Compound 7

Compound 8 is naphthalene diamine-based produced by G. Tamil Selvan et al as a chemosensor. The Schiff base synthetic reaction of naphthalene-1,5-diamine with acetylacetone in ethanol produced compound 8. ^{1}H NMR and ^{13}C NMR were used to confirm compound 8. Compound 8 is used in the detection of Fe2+. After adding Fe2+ ion to Compound 8, the absorption spectra intensity was remarkably high. Compound 8 has a 1:1 stoichiometry with iron metal ions. A hyperchromic shift was seen when the concentration of Compound 8 was increased, with the creation of a new absorbance band at 330 nm [17-23].

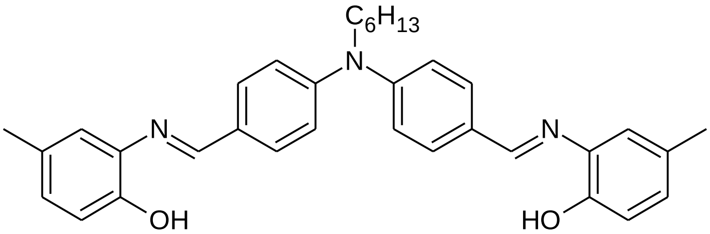


Compound 8

Organic Chemosensor for detection of Cu^{2+} metal ions

After iron, copper is the next common trace metal within a human body. Copper levels in the body range from 75 to 100 mg/kg. It's found mostly in the liver and throughout the human body, with little amounts found in the brain, heart, kidneys, and muscles. Copper is essential for the efficient functioning of a number of critical enzymes and hence plays a crucial part in human metabolism. Myelin, hemoglobin, and melanin are all made with copper, as is thyroid gland activity. The skin, blood vessels, epithelial tissue, and connective tissue all require copper to function properly. Copper has antioxidant and pro-oxidant properties. When the body produces free radicals naturally, they may break cell membrane, interact with genetic factor, and cause a range of health issues and illnesses. Copper as an antioxidant, it scavenges or neutralises harmful free radicals, possibly reducing or avoiding some of the harm they inflict.

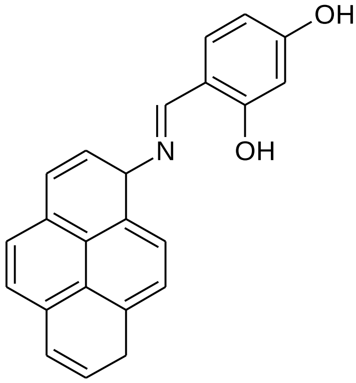
Compound 9 was created by Zohreh Parsaee et al as a sensing copper metal. A new Schiff base based on diphenyl (Compound 9) was successfully synthesized as a manufactured strip for in aqueous conditions; copper (II) ions can be detected. A new and significant absorption peak formed in the 400-500 cm1-nm area with the addition of Cu2+ ions (0.1 mM). The new peak is the result of a complex between receptor Compound 9 and copper salt. By altering the colour from yellow to pink, compound 9 exhibited impressive selectivity for Cu^{2+} over competitor cations, the formation of a binuclear copper complex can explain this [24].



Compound 9

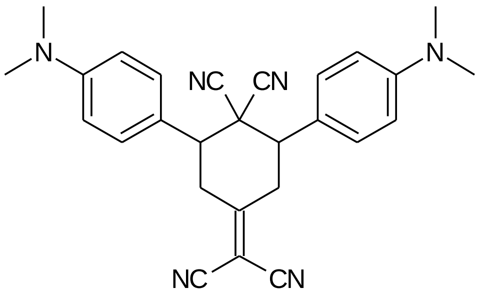
Subrata Dalbera and et al synthesized a Compound 10 i.e. pyrene-based chemosensor for detection of Copper. This Compound 10 is extremely picky and sensitive towards Cu^{2+}. Compound 10 detects Cu^{2+} in an aqueous solution of ions with the naked eye. It detects the Cu2+ ion by significantly reducing its fluorescence intensity, Combined fluorescence spectroscopy with time resolution confirms the occurrence of static quenching. The chemosensor Compound 10, The absorption peaks at 384 nm are seen in this yellow-coloured sample; in the presence of 1.5 equivalent Cu^{2+} ion the yellow color of the solution changes to brown, as indicated by absorption spectra. The detection threshold for Compound 10 for Cu^{2+}

ion has been reported. as 0.503 µM. They anticipate that these findings will help in the creation of metal ion chemosensors[25-31].



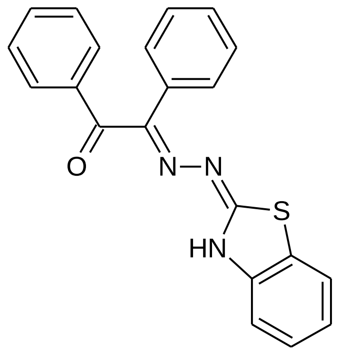
Compound 10

Sayed M. Saland et al. developed Compound 11 as a novel optical chemosensor for detecting copper metal ions. This novel fluorescent chemosensor i.e. Compound 11, with a significant Stokes shift, new optical characteristics (about 170 nm) approximately. This novel chemosensor i.e. Compound 11 was synthesized by coupling of dimethyl amino benzaldehyde and malononitrile in presence of sodium acetate in acetone, resulting 79 % yield. 1H NMR, FTIR, and elemental analyses were used to confirm the findings. The Stokes shift of Compound 11 probes was 170 nm. Compound 11 was able to With remarkable selectivity and sensitivity, detect Cu (II) ions, with a detection threshold (LOD) of 2.3 x 107 M. Cu (II) and Compound 11's sensing mechanism was linked to Cu (II) with two cyano groups form a complex[32-33].



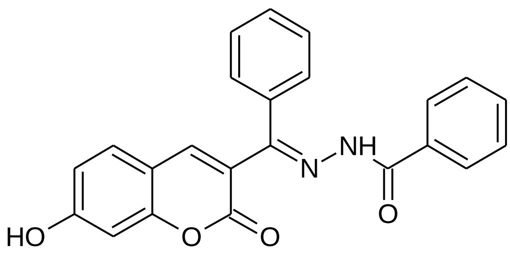
Compound 11

Compound 12 is a hydrazone-based chemosensor developed by Shao-Min Shi and colleagues to detect Cu^{2+} ions. Compound 12 changes color from colorless to pink when it recognizes Cu^{2+} above other metal ions. The combination of hydrazinobenzothiazole with benzil in ethanol was used to make compound 12. NMR and ESI-MS were used to confirm it. Cu^{2+} (0–5 Equiv.) When Compound 12 was introduced to a solution, the absorbance peaks at 358 nm diminished over time. New absorption bands at 524 nm, with a prominent isosbestic point at 400 nm, developed. Cu^{2+} coordination-enhanced LMCT (ligand-to-metal charge transfer might explain the redshift from 358 to 524 nm. Color alterations from colorless to pink occurred as a result of Cu^{2+} recognition. Cu^{2+} as an analytical detection limit of 10.0 M by the naked eye, indicating that chemosensor compound 12 has a lot of potential in colorimetric Cu^{2+} detection[34-36].



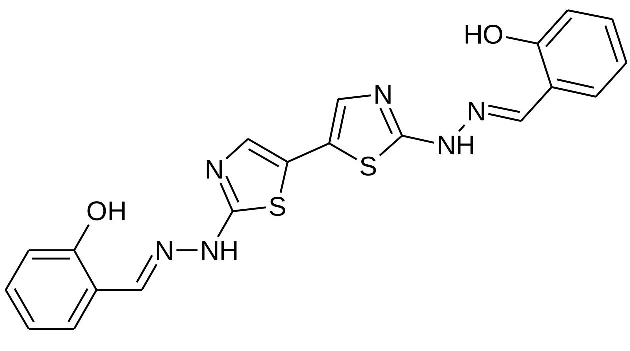
Compound 12

Compound 13 is a probe developed by Hongqi Li et al for the copper ions detection. It also detects arginine, lysine, and Cu^{2+}, as well as Al^{3+} fluorescently. Compound 13 was synthesized from 3-benzoyl-7-hydroxychromen-2-one and benzohydrazide in the presence of ethanol, yielding 72 %. ^{1}H NMR, ^{I}R, and ^{13}CNMR all verified it. When various metal ions were added to solution of Compound 13, only Cu^{2+} ion induced a new strong absorption band at 418 nm with a colour change from colourless to yellow. Its indicating the potential of Compound 13 for highly selective and sensitive detection of Cu^{2+} ion by the naked eye over other metal ions (Cr^{3+}, Hg^{2+}, Zn^{2+}, Ni^{2+}, Co^{2+}, K^{+}, Li^{+}, Al^{3+}, Fe^{2+}, Sr^{2+}, Ag^{+} and Fe^{3+}) [37-46].



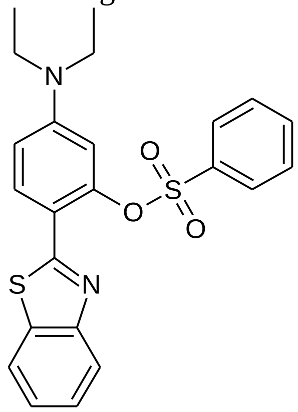
Compound 13

Zhaodong Jia et al prepared a Compound 14 i.e. a thiazolyl-hydrazone-based chemosensor probe for sensing of Cu^{2+}. After attaching to the Cu^{2+} cation, the Compound 14 solution changes yellow from colorless, its develops a new strong absorption peak at 414 nm. Compound 14 was made with a 53 % yield by combining 2-(2-hydroxybenzylidene) hydrazine-1-carbothioamide with 1, 4-dibromobutanedione in the presence of ethanol. Mass, 1H NMR, and 13CNMR all verified it. The major result with Compound 14 is that when titrated with a new absorption band at around 414 nm emerges when Cu^{2+} metal ions are present. The UV–Vis spectrometer has the limit of detection of 0.75 M and the naked eye has the limit of detection of 20 M, which is useful for detecting tiny amounts of Cu^{2+} ion[47-49].



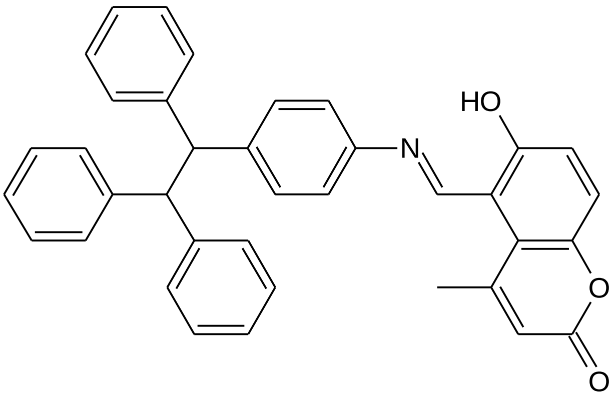
Compound 14

Compound 15 discovered by Won Sik Na et al, is a simple and selective benzothiazole-based chemosensor for detecting Cu^{2+}. When Cu^{2+} was added to the emission spectra of receptor Compound 15, it caused significant fluorescence quenching, indicating its strong selectivity in the presence of other metals. Due to the paramagnetic nature of copper ions, with the addition of Cu^{2+}, significant fluorescence quenching was observed[50].



Compound 15

Compound 16 was developed by Ying Wang et al. as a new coumarin-based derivative for detecting a Cu^{2+} metal ion. The Maillard process was used to make compound 16 in high yield using 8-formyl-7- hydroxy-4-methyl coumarin and 1-(40 -aminophenyl)-1, 2,2-triphenylethene in absolute ethanol. NMR, HRMS, and FTIR all verified this.. For detecting Cu^{2+}, compound 16 acts as a fluorescent probe with great sensitivity and selectivity Cu^{2+} has a lower detection limit .0.36 mM than other elements.[51].

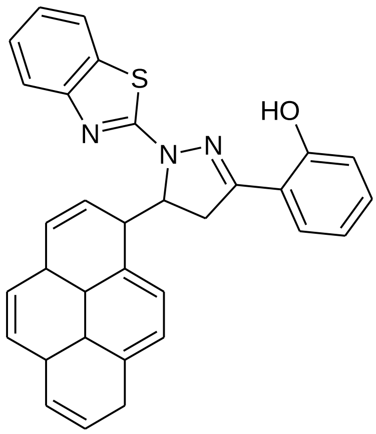


Compound 16

Organic Chemosensor for detection of Al^{3+} metal ions

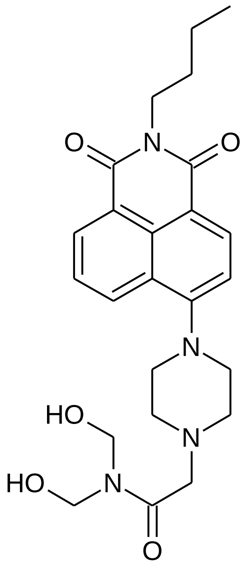
Aluminium is one of the maximum generic metals on the planet, as it can be determined in practically every food, along with meats, fish, cereals, dairy merchandise, veggies, coffee, tea, cheese, tender drinks, and culmination. Aluminum is absorbed into the human body and then transported to the kidneys thru the bloodstream. After that, it changed into soon expelled; nevertheless, when aluminium is stored within the body, it has a damaging impact. It changed into discovered in the general public of renal failure patients that is why doctors counseled using aluminium-unfastened water for dialysis. The eu meals safety Authority (EPSA) has set up a tolerated weekly consumption inside the human frame of 1mg/Kg of frame weight. Neurotoxin is another term for aluminium. Aluminum is used in antacids, antiperspirants, cosmetics, and meals additives, as well as in mirrors, telescope mirrors, electrical transmission lines, pyrotechnics, and explosives.

Compound 17 is a two-pyrene attached pyrazoline compound created by Rangasamy Manjunath and et al for an detection of Al^{3+}. Compound 17 was created by 1-(2-Hydroxyphenyl)-3-(pyrene-1-yl) prop-2-en-1-one and 1-phenyl-3-(pyrene-1-yl)prop-2-en-1-one with NaOH and 2-hydrazinobenzothiazole with ethanol. UV-visible and fluorescence spectrophotometers were used to analyze the physical characteristics of compound 17. It develops a reaction that is very specific and sensitive to the Al^{3+} metal ions. It may also be recognized with the unaided eye and used as a chemosensor for Al^{3+} metal ions. The addition of the Al^{3+} ion to Compound 17 causes a sudden shift in hue from colourless to green with bright fluorescence. The significance of compound 17 fluorescence imaging investigations of Al^{3+} metal ions in live cells in biological systems is demonstrated[52].



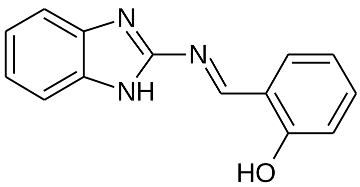
Compound 17

Compound 18 is a two-pyrene attached pyrazoline. Compound 18 was designed and synthesized by Xue-Jiao Sun and colleagues as a unique Al3+ chemosensor. When exposed to UV, the probe Compound 18 showed a brilliant Green fluorescence with a colour change to colorless from yellow. Compound 18 was prepared by using naphthalimide derivative and d 2-amino-propane1, 3-diol in presence of triethylamine in ethanol. By using column chromatography to purify the crude product, a 46 % yield was achieved. 1HNMR and 13C NMR both verified it. When Al3+ was added to compound 18, a new band at 378 nm formed, replacing the big absorbance band at 399 nm and the intensity gradually increased before stabilising until the amount of Al3+ added was established. Compound 18 has a 1:1 ratio is a measure of binding with Al^{3+} The compound 18 - Al^{3+} complex was also employed as a Detection of ClO with a fluorescent “turn-off” chemosensor, with the limit of detection of 2.34×10^{-8} M[53].



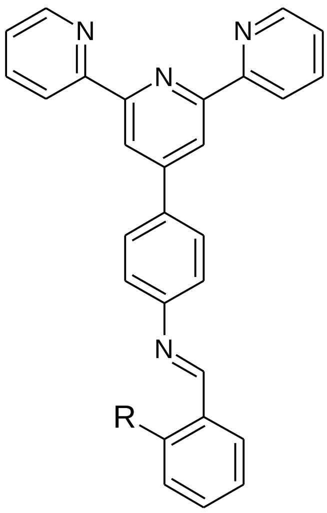
Compound 18

Wei Cao and colleagues created compound 19 for Al^{3+} sensing. In dimethyl sulfoxide (DMSO), compound 19 exhibits a remarkable selectivity for Al(III). Compound 19 was synthesized by using a mixture of salicylaldehyde with 2-aminobenzimidazole in 2-Propanol, resulting 43.7% yield. Compound 19 absorption spectra showed a band centered at 375 nm, which arises from π–π* transition. When increasing numbers of metal ions were added, this band shrank with a corresponding increase in a new peak. The well-defined isosbestic points found also hint at a clear conversion of Compound 19 to the Mn^{+} complex[54].



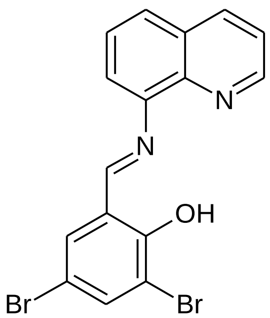
Compound 19

Jiacheng Liu and colleagues developed a pyridine-based Schiff bases provide a very selective fluorescence chemosensor for detection Al^{3+} metal ions (Compound 20 and 21). Compound 20 and Compound 21 were prepared by using 4'-Amine-2,2',6',2''-terpyridines, and salicylaldehyde in presence of methanol, resulting in 82.4 % yield. The results were validated using FTIR, ^{1}HNMR, and ^{13}CNMR. The sensing property of Compound 20 and Compound 21 and their derivatives FTIR, UV-Vis fluorescence, and ^{1}HNMR tests were used to investigate the substance. Upon addition of Al3+metal ions, the Compound 20 and Compound 21 show remarkable 'off-on' fluorescence[55].

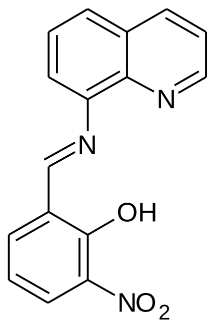


R = H, - Compound 20
R = OH, - Compound 21

Pravat Ghorai et al synthesized a 8-aminoquinoline based on two chemosensors i.e. Compound 22 and Compound 23 for detection of Al^{3+} metal ions. Compound 22 and was prepared by using 8-aminoquinoline and 3,5-dibromo-salicylaldehyde, resulting 88 % yield. IR, 1HNMR, and 13CNMR all verified it. Compound 23 was prepared by using 8-aminoquinoline and 3-Nitrosalicylaldehyde. IR, ^{1}HNMR, and ^{13}CNMR all verified it. Two chemosensors based on quinoline were disclosed by Pravat Ghorai and colleagues (Compound 22 and Compound 23) for Al^{3+} metal ions detection. The chemosensors' UV-Vis spectra (Compound 22 and Compound 23) are investigated in a pH 7.4 HEPES buffer containing 10 mM HEPES. The absorption bands of Compound 22 are 480 nm and 340 nm, respectively. whereas Compound 23 has absorption bands around 450 nm and 325 nm. The limit of detection of Compound 22 and Compound 23 against Al^{3+} ions is 1.50 × 10-7 M, The findings indicate that the probes might be utilised to detect Al^{3+} ions in biological systems[56].



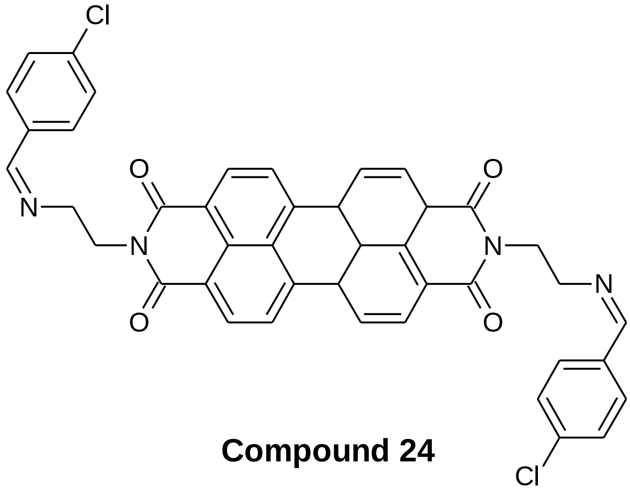
Compound 22



Compound 23

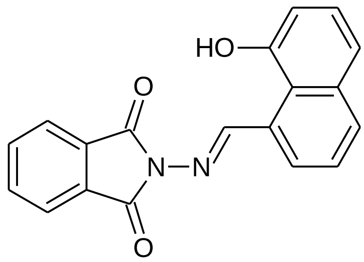
Yan Liu et al prepared a perylene-based chemosensor i.e. Compound 24 for detection of Al^{3+}. The probe i.e. Compound 24 with great selectivity and sensitivity, displayed an significant fluorescence amplification in the Al^{3+} is present in DMF. Due to the Lewis acid nature of Al^{3+}, the imine link in Compound 24 was hydrolyzed, and an amine derivative with intense fluorescence was occurred. It resulted in a Fluorescence emission of Compound 24 in a bright "lit-on" yellow solution, allowing Al^{3+} to be detected with the naked eye under UV and natural light at 365 nm. FTIR, ^{1}H NMR, and HRMS tests all supported this process. As a result, compound 24 reactions to Al^{3+} metal ions in the DMF solution was "off–on. All of these demonstrated a high level of selectivity of Compound 24, Al^{3+} is preferred above other cations.

Al^{3+} hydrolyzed compound 24 C=N, resulting in a return to the intermediate compound., which resulted in noticeable color shifts from colorless to yellow and non-fluorescent to fluorescent to the human eye[57].



Compound 24

Compound 25 was created by Chia-Lin Li et al. in Plant Systems and Aqueous Solution for Detecting Al^{3+} Ion. Compound 25 was prepared by 2-hydroxy-1- naphthaldehyde and 2-aminoisoindoline-1,3-dione in presence of acetic acid in dry ethanol, resulting in an 80 % yield. 1H NMR and 13C NMR both verified it. Fluorescence spectroscopy was employed to determine the fluorescence intensity in more detail. At 495 nm, the fluorescence emission spectra were measured. The fluorescence intensity rose when the Al3+ concentration was raised from 25 to 100 M. Compound L, the probe, detected Al^{3+} rapidly, selectively, and sensitively. Compound 25 may be used to identify heavy metals Al^{3+} contamination in plant samples[58].

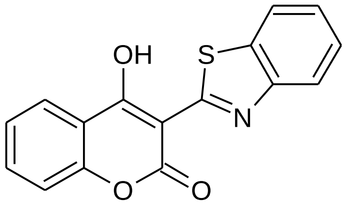


Compound 25

Organic Chemosensors for detection of zinc metal ions

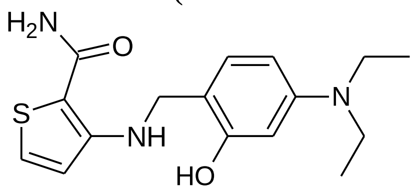
Zinc, a nutrient found in the human body. Zinc helps to immune system and metabolism function in the human body. It is also an important factor for wound healing sense of taste and smell in the human body. With a variety of diets, the human body gets enough zinc. Growth retardation, lack of appetite, and reduced immunological function are all symptoms of zinc deficiency. In severe cases, hair loss, diarrhea, impotence, hypogonadism, delayed sexual maturation, and eye and skin lesions. Due to this to taking a high amount of zinc is unsafe for the human body. It may cause fever, coughing, stomach pain, fatigue, and many other problems. If taking zinc as a supplement, causes developing prostate cancer. Zinc supplements takes helpful when it has taken one hour before or two hours after meals.

Mohammad Zareh Jonaghani and colleagues developed a chemosensor based on 4-hydroxycoumarin for the detection of Zn^{2+}. Compound 26 was prepared by using 4-hydroxy coumarin and phenyl isothiocyanate in presence of triethylamine in DMSO, resulting in a 80% yield. It was confirmed by using IR, 1H NMR, and 13C NMR. A new absorbance peak at 361 nm was observed after the addition of Zn2+ metal ions., with shoulders at 378 nm and 349 nm, showing a significant interaction with the Zn^{2+} ion. Zn2+ can be detected in living biological samples and water resources using this method. It is detectable with the naked eye[59].



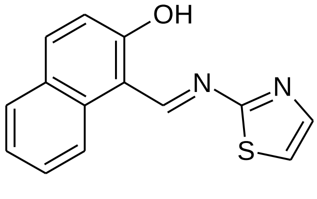
Compound 26

Min Seon Kim and colleagues developed Compound 27, a new Zn^{2+} detection chemosensor based on fluorescent "turn-on". Compound 27 was created in ethanol by combining 3-aminothiophene-2-carboxamide and 4-diethylaminosalicylaldehyde, resulting 72 % yield. 1H NMR and 13C NMR used to verified it.. The peak of 370 nm and 470 nm rose continually as Zn^{2+} was added to Compound 27, but that of 430 nm declined. There were two isosbestic points (380 nm and 447 nm), indicating that Compound 27 and Zn^{2+} are bound together to create a single product. Compound 27 uses fluorescence enhancement to preferentially sense Zn^{2+}. With Zn2+, compound 27 exhibits a 1:1 binding ratio. The limit of detection for Zn2+ is 2.55 (0.5) M, which is lower than the 76 M limit (i.e. WHO standard)[60].



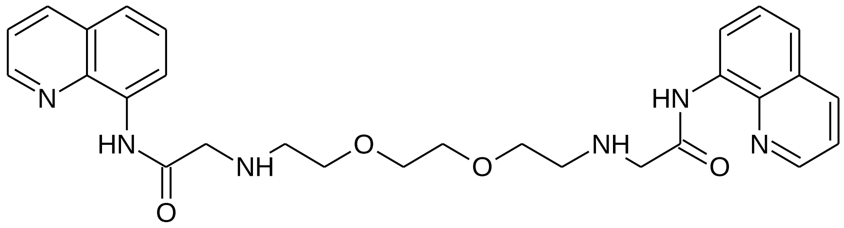
Compound 27

Ayman A. A. Aziz developed Compound 28, a new fluorescent chemosensor for very sensitive and discriminating trace amounts of zinc. It can be detected via fluorescent enhancement. Compound 28 was prepared using 2-aminothiazole and 2-hydroxy1-naphthaldehyde in presence of acetic acid in methanol in the microwave, resulting in 86 % yield. 1H NMR, IR, and 13C NMR all verified it. Absorption in a new form signal developed at 469 nm with a color shift of Compound 28 from With the addition of 5.0 M Zn2+, the colour changes to orange from yellow. The binding ratio of Compound 28 and Zn^{2+} is 1:2. Zn^{2+} has a limit of detection is 0.0311 M, allowing zinc ions to be detected in biological and environmental samples[61].



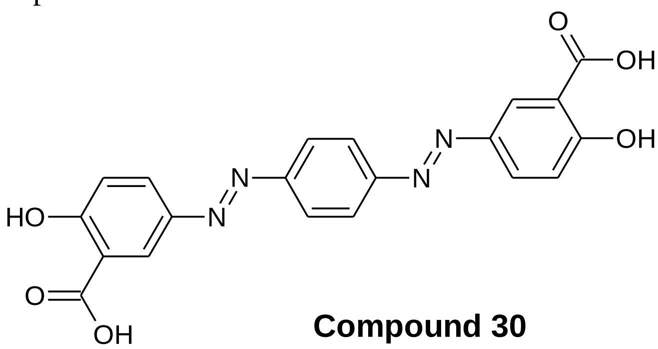
Compound 28

Ju Byeong Chae and colleagues developed a quinoline–based chemosensor for Zn^{2+} detection using fluorescent "turn–on" technology. Compound 29 was prepared by using 2,2′-(ethane-1,2-diylbis(oxy))bis(ethan-1-amine) and d 2- chloro-N-(quinolin-8-yl)acetamide in presence of triethylamine in acetonitrile, resulting 58 % yield. ^{1}HNMR, Mass, and ^{13}CNMR all verified it.. Compound 29 has a low LOD (0.27 M) and might be employed for fluorescence "turn-on" identification of zinc ions. The fluorescence imaging of Hela cells and zebrafish was used to apply it to living organisms[62].

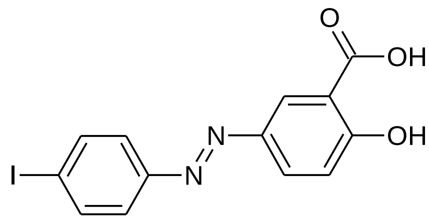


Compound 29

For the detection of Zn^{2+}, Mathappan Mariyappan et al produced a salicylate-based azo derivative, i.e. Compound 30 and Compound 31, which caused selective fluorescence enhancement over other competing cations. Compound 30 was prepared by using 1,4-diaminobenzene, sodium nitrate, salicylic acid in presence of NaOH, resulting 69 % yield.. Compound 31 was prepared by using, 4-iodoaniine, sodium nitrate, salicylic acid in presence of NaOH, resulting 65 % yield. ^{1}H NMR, Mass, IR, and ^{13}C NMR were all used to validated both. Compounds 30 and 31 have two different absorption spectra. Compound 30 had bands at 283 and 363 nm, whereas Compound 31 exhibited bands at 286 and 304 nm. Compound 30 has a bathochromic shift compared to Compound 31, which might be attributable to the presence of an azo group[63]

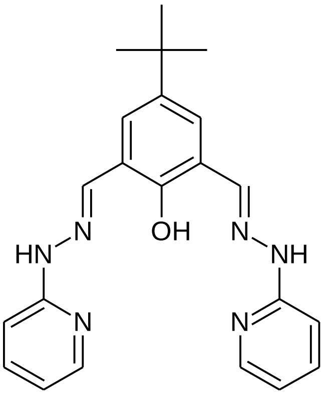


Compound 30



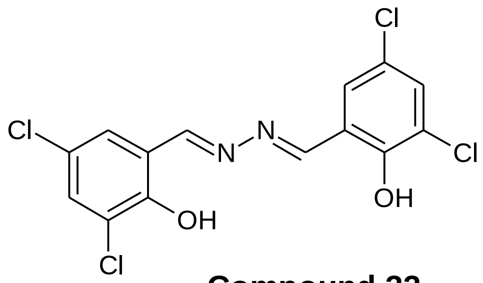
Compound 31

Kai Li and colleagues developed a zinc-detection fluorescence probe that is both selective and sensitive. Compound 32 was prepared by using 4-tert-butyl-2,6-diformylphenol and 2-hydrazinopyridine in absolute ethanol, resulting in 86 % yield. 1H NMR, Mass, and 13C NMR all proved it. When more than 1 equivalent zinc metal was added, the absorbance peak at 322 nm and 383 nm first decreased, then fell to their lowest point and varied very little. Strong peak on at 470 nm was detected following the addition of Zn^{2+} in its fluorescence spectra under the same circumstances reaching a peak when the amount of Zn^{2+} in the system exceeded 1.0 Equiv., Up to a 40-fold increase in fluorescence was achieved. In water at neutral pH, Compound 32 exhibits a 40-fold fluorescence enhancement response to Zn^{2+}. For Zn2+, it has a linearity range of 0.10–10.00 mol L1 and a limit of detection of 25 nmol L-1..[64].



Compound 32

Compound 33 was created by V. Raju and his colleagues. A novel versatile probe for detecting zinc metal ions has been developed. Compound 33 was prepared by using hydrazine with 3, 5-dichloro-2-hydroxybenzaldehyde in ethanol, resulting in a 93 % yield. ^{1}H NMR, Mass, IR, and ^{13}C NMR were all used to validate it. At 500 nm, Chemosensor 33 has a significant fluorescence enhancement. Compound 33 has high sensitivity and specificity for detecting Zinc metal ions. It demonstrates dramatic fluorescence amplification by the influence of CHEF in addition to zinc to compound 33[65].



Compound 33

Conclusion

The synthesis and application of organic chemosensors is a feasible approach to probe the cell biology of these chemosensors and has yet to reach its full potential. These organic chemosensors have been involved in the detection and quantification of cations of different nature**.**

Conflict of interest

The author declares no competing financial interest.

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