modelled the IL-17 increases Cadherin-11 for arthritis and in rheumatoid arthritis detection [8]. Mestas Pedro, et al. investigated the role of Cadherin-11 in liver fibrosis caused by carbon tetrachloride [9].

Biosensors are devices that detect the concentrations of biological substances and convert them to electrical signals [10]. Biosensors are analytical tools that include biologically sensitive materials immobilized as recognition elements (such as enzymes, antibodies, antigens, microorganisms, cells, tissue, nucleic acid, and other biologically active substances), physicochemical transducers, and other biologically active substances (such as electrochemical electrodes, photodiodes, and signal-amplifying devices) [11,12]. Laser biosensor architecture components are less expensive, reliable, and precise than test strips. SPR, waveguides, optical fibre, and other laser based detection methods are used in various biosensors [13]. Laser based biosensors are essential in many fields, such as immunoassays and drug screening, due to their high sensitivity and accuracy [14]. Optical fibres could be used to miniaturize the most critical laser based detection approach used in many instruments [15]. In biosensors, laser detection based on transient waves is commonly used. In recent years, laser biosensors have proven to be handy tools in various fields, including pharmaceutical research, analytical biochemistry, food environmental experiments, and diagnostic methods [16]. Biosensors are used in applications such as disease observation, drug detection, pollutant detection, disease by microorganisms, and biomarkers, which are disease markers in body fluids (urine, saliva, blood, sweat) [17].

There is no simple technique for detecting and evaluating rheumatoid arthritis in its early stages (RA). The aim of this study is to determine CDH11 for diagnostic purposes and determine its concentration by using optical biosensor; instead of conventional technique (ELISA); which offers rapid and more accurate results for RA.

## MATERIALS AND METHODS

**Sample collection:** Ten millilitres of blood were drawn from each patient's, and then centrifuged to obtain serum, and this serum was divided into two parts, each one of them was five millilitres in size. The first part was used to manually detect of Cadherin-11 (CDH11) using an ELISA technique, the other part (5 ml) is used for detection the Cadherin-11 (CDH11) by using optical biosensor.

**Biological measurement:** The ELISA technique has been used to assay CDH11 level in human serum. The sandwich-ELISA method is used in this technique where the micro ELISA strip plate has been pre-coated with a CDH11 antibody and the standards or samples are placed in the appropriate micro ELISA strip plate wells and mixed with the appropriate antibody. Then, in each Micro Elisa strip plate well, a Horse Radish Peroxidase (HRP)-conjugated antibody specific for CDH11 is added and incubated. Other elements have been washed away. Each well receives the TMB substrate solution. Only the wells containing CDH11 and HRP-conjugated CDH11 antibodies will appear blue before turning yellow when the stopping solution is added. At 405 nm, the Optical Density (OD) is measured spectrophotometric-ally. The OD value is proportional to CDH11 concentration. Comparing the OD of the sample to the standard curve could calculate the concentration of CDH11 in the samples.

### Laser biosensor set-up structure

The multimode optical fibre with a 30 cm length has been cut (from the middle) to produce two fragment of multimode fibre with 15 cm of each one and about 2 cm of coreless optical fibre insert between them, then a groove was made on both sides. The buffer part was removed from the optical fibre by immersing it in 40% acetone for 30 minutes and then washing it with distilled water to remove all impurities and thoroughly cleaning it. In 10 minutes, a portion of the fibre is immersed in pure Hydrofluoric acid (HF) 40% to remove the fibre's cladding, and then it is washing with distilled water. The entire fibre (30 cm) was inserted into the aplastic device using an adhesive silicone. The fibres' ends are connected to a transformer device. Optical fibre connectors connect the terminal tools to the optical fibres. Splicing connected two organized fibres to form a continuous optical waveguide. The laser exporter (a blue diode laser) will be connected to the first end of the fibre, which is connected to a power supply. A diode laser with a 450 nm wavelength and an output power has been used. This laser wavelength has been chosen depending on the absorption spectra of the protein, where it matched the absorption peaks of the protein Cadherin-11, where it is measured by using a spectrophotometer. The other side has been connected to a spectrum analyser (ocean HR2000) to measure the intensity of signal. The optical spectrum analyser (Ambient Optics HR2000) was then connected to the spectrometer (*via* a USB port to a computer), with an accuracy of 0.035 nm at a high wavelength and working in the 200-1100 nm wavelength range (Figure 1).

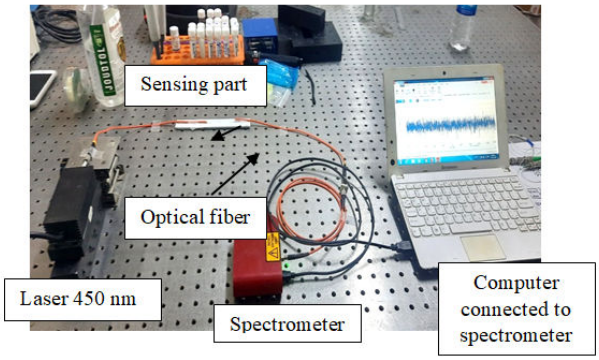


**Figure 1: Set up of biosensor.**

## RESULTS AND DISCUSSION

### Measurement the concentration of CDH11

A serum sample for 7 patients (male and female) for measuring the concentration of CDH11 after different treatment (chemical and biological) by conventional method and optically detection by biosensor to detect CDH11 and determine its concentration spectrally *via* the intensity and wavelength of transmitted light. Table 1 show the concentration of CDH11 after chemo (MTX) treatment measured by ELISA technique.

**Table 1: The concentrations of CDH11 after chemical treatment.**

| Age | Gender | Treatment (chemical, biological) | CDH11 N.V (6–200 pg/ml) | No. |
|---|---|---|---|---|
| 16 | M | MTX | 22.7 Normal | 1 |
| 33 | F | MTX | 28.8 Normal | 2 |
| 15 | F | MTX | 280 ↑ | 3 |
| 28 | F | MTX | 307.5↑ | 4 |
| 16 | M | MTX | 512.6 ↑ | 5 |
| 22 | M | MTX | 618.2 ↑ | 6 |
| 10 | F | MTX | 790 ↑ | 7 |

The statistical analysis of these results show a significant value of CDH11 after treatment (MTX) in Table 2

**Table 2: Statistical analysis of CDH11 MTX treatments.**

| Treatment | Cadherin frequency (%) | | | | Probability |
|---|---|---|---|---|---|
| | Males | | Females | | |
| | Normal | High | Normal | High | |
| MTX | 1 (50.0) | 2 (100.0) | 3 (75.0) | 1 (11.1) | P>0.05 |

By laser biosensor, the CDH11 is detected and the concentration of CDH11 is determined by through the change in the intensity of transmitted light and shifting of the transmitted wavelength with the change of the concentration of CDH11 after treatment with MTX (chemical therapy) as the optical spectrum analyser is shown in Figure 2 where it represent the intensity of transmitted light as a function of the transmitted wavelength with respect to the concentration of CDH11. Where the spectrum of CDH11 is determine at its standard and normal level as a result of matching its peak absorption with the source of light wavelength, and then the change of the transmitted intensities and shifting of the wavelength were got as the concentration of CDH11 increase. Where with the increasing of the CDH11 concentration, the absorption of light will be increased and the intensity of transmitted light will be decreased while the wavelength of the transmitted light will be increased. So the optical biosensor succeeds in detecting CDH11 and its concentration with very high accuracy for diagnostic purposes of rheumatoid arthritis.

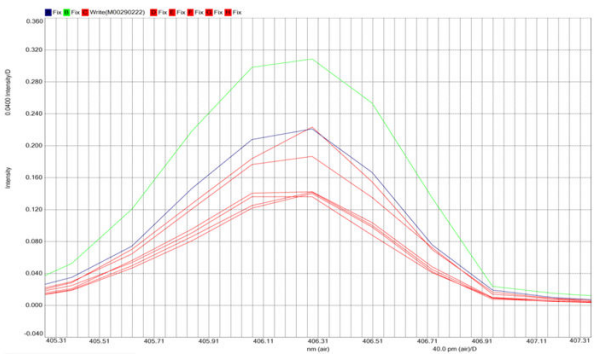

**Figure 2: Intensity of transmitted light as a function of transmitted wavelength with respect to the concentration of CDH11.**

Green line (source); blue line (normal concentration) Red line (different concentration of CDH11)

## CONCLUSION

In the present paper an optical biosensor have been used for detection on rheumatoid arthritis by detecting on CDH11 in blood serum for the patient of rheumatoid arthritis. An MM-no core-MM fibre sensor and the laser source (405 nm) detect Cadherin-11 (CDH11) levels. The biosensor gave an excellent result for the examined serum where it was succeed in detecting for CDH11. According to the study's findings, the highest laser intensity corresponds to the lowest protein

concentration and vice versa. Finally, we conclude that the optical biosensor is a more effective, more stable, sensitive, with a rapid diagnosis and cheaper method for detecting CDH11 more than the traditional method.

**REFERENCE**


1. Ma D, Liang N, Zhang L. "Establishing Classification Tree Models in Rheumatoid Arthritis Using Combination of Matrix-Assisted Laser Desorption/Ionization Time-of-Flight Mass Spectrometry and Magnetic Beads." Front Med 2021; 8:1–12.
2. Driver CB, Stoppler MC, "Rheumatoid Arthritis (RA): Early Signs," Symptoms, Causes, Treat. Diet 2020.
3. Imas JJ, Zamarreno CR, Zubiate P, et al. Optical biosensors for the detection of rheumatoid arthritis (Ra) biomarkers: A comprehensive review. Sensors 2020; 20:1–51.
4. Pedroza M, Welschhans RL, Agarwal SK. Targeting of cadherin-11 decreases skin fibrosis in the tight skin-1 mouse model. PLoS One 2017; 12:1–9.
5. Dou C, Yan Y, Dong S. Role of cadherin-11 in synovial joint formation and rheumatoid arthritis pathology. Mod Rheumatol 2013; 23:1037–1044.
6. Manning JE, Lewis JW, Marsh LJ, et al. Insights into Leukocyte Trafficking in Inflammatory Arthritis–Imaging the Joint. Front Cell Dev Biol 2021; 9:1–4.
7. Vergara D, Bianco M, Pagano R, et al. An SPR based immunoassay for the sensitive detection of the soluble epithelial marker E-cadherin. Nanomedicine 2018; 14:1963–1971.
8. Park YE, Woo YJ, Park SH, et al. IL-17 increases cadherin-11 expression in a model of autoimmune experimental arthritis and in rheumatoid arthritis. Immunol Lett 2000; 140: 97–103.
9. Pedroza M, To S, Smith J, et al. Cadherin-11 contributes to liver fibrosis induced by carbon tetrachloride. PLoS One 2019; 14:1–11.
10. Damborsky P, Svitel J, Katrlík J. Optical biosensors. Essays Biochem 2016; 60:91–100.
11. Correia R, James S, Lee SW, et al. Biomedical application of optical fibre sensors. J Opt 2018; 20:1–26.
12. Abed HASL, Alameri LM. Detection of the Level of Human Alt Liver Enzyme Concentration By Using Laser Biosensor Multimode Fibres (Mmf). Biochem Cell Arch 2019; 19:3829–3833.
13. Shatti R, Al-ameri LMH. Optically Sensing for Thyroid Profile Hormones in Blood. Med Leg Updat 202121:172–176.
14. Mohammed SE, Al-ameri LMH. Laser Bio stimulation Effect on Human Sperm Motility. Iraqi J Laser 2021; 20:39–42.
15. Salman NA, Taher HJ, Mohammed SA. Tapered Splicing Points SMF-PCF-SMF Structure based on Mach Zehnder interferometer for Enhanced Refractive Index Sensing. Iraqi J Laser 2017; 16:19-24.
16. Al-Ameri LMH, Faris RA, Belal SJ, "Detection of HbA1c in Blood Using Diode Laser (491) nm," Syst Rev Pharm 2021; 12:700–704.
17. Addanki S, Amiri IS, Yupapin P. "Review of optical fibres-introduction and applications in fibre lasers." Results Phys 2018; 10:743–750.