| **OrientationCompass with solid fill** | **QR audio** |
| --- | --- |

Through the preceding activities, some questions arose regarding the Alm Dish....

1. Can we recognize the value of the Alm Dish? What was its use? Was it part of a treasure or an everyday object?

2. Can we date it?

3. What are the ingredients of which it is composed? What are their properties?

4. Can we identify maintenance procedures?

*Discuss the above questions in the classroom as a whole*

**How can we answer these questions?**

**Record the results of the discussion**

| ***The students record the results of the discussion, concluding with the following***  **To answer the above questions we need to:**   * **Zoom in on the object to see details** * **Identify the ingredients from which it is made** * **Identify components that are an indication of preservation** |
| --- |

| *Record the views heard with a short video or audio recording  Name it “1.a Problems and Solutions”* | | *QR audio* |
| --- | --- | --- |
| **Conceptualization Questions outline** | **QR audio** | | |

*Discuss as a whole class.*

**How can we see item details?**

*Note or draw tools we can use   
to see details of an object*

| Instruments / Devices | Select |
| --- | --- |
| **Magnifying glass** |  |
| **Binoculars** |  |
| **Telescope** |  |
| **Optical microscope** |  |
| **Close up eye vision** |  |
|  |  |
|  |  |

| ***The students fill in their ideas above or draw the above instruments in this space.*** |
| --- |

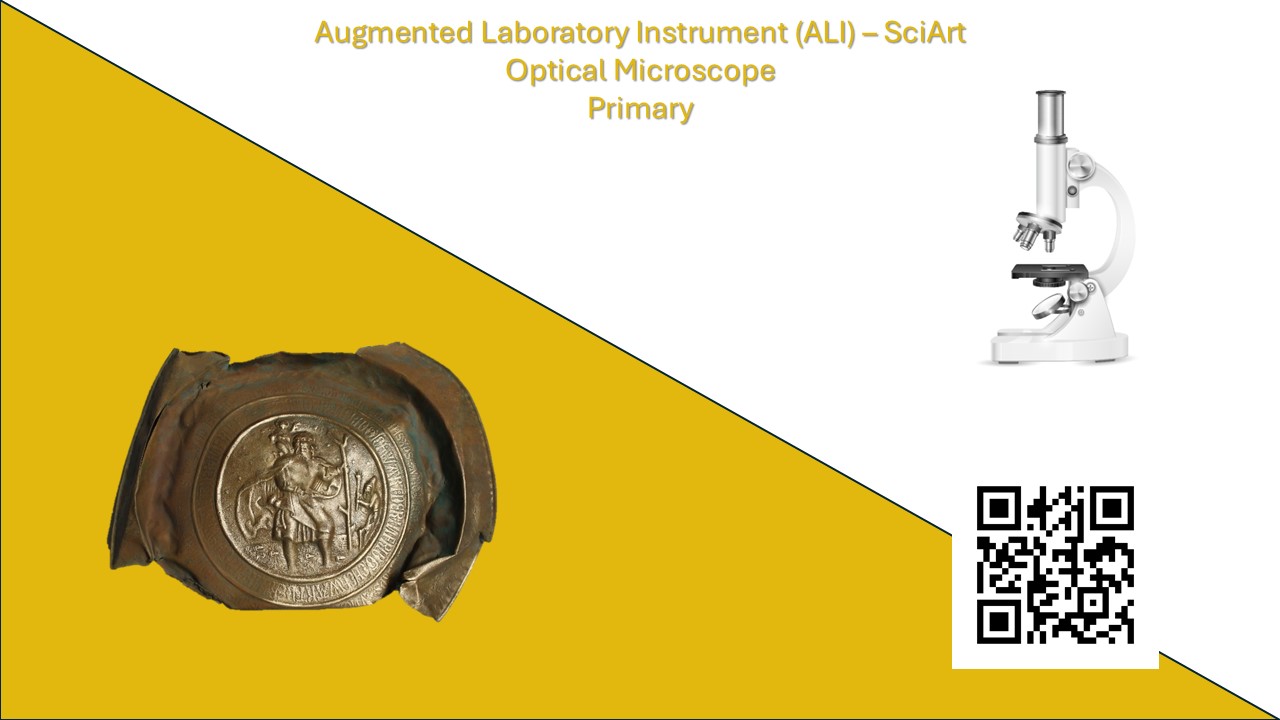
*Discuss as a whole class about the instrument that can give us the best results and choose it from the table above.*

***Through the discussion we come to the optical microscope.***

| *Record the views heard  with a short video or audio recording.*  *Name it “1.b Conceptualization”* | | *QR audio* |
| --- | --- | --- |
| **Research Research with solid fill** | **QR audio** | |

Use your mobile devices (tablets, mobile phones, etc.) and scan the QR below.

Watch the video and download the results for your chosen device for the Alm Dish by clicking on the **"Results"** button.

****

***Discuss with the whole class the results of this particular device***

* In the first point of interest, we observe the disc at its edge. Can you describe how does the sample taken from the disk appears in the optical microscope?



Picture 1 Picture 2 Picture 3

***The discussion with the students concludes that we can identify points of interest with the Optical Microscope, such as the area at the bottom right of the disc (Picture 1). By zooming in on this area we can take a sample without damaging the artifact (Picture 2). With the optical microscope (Picture 3), some formations are spotted, that look like small holes, which are all in groups and they all have the same direction. This informs us that the metallic dish was pressed and struck for its final configuration.***

***\*The point of interest is a good opportunity to discuss with students about how we intervene in a work of art for research or conservation purposes without destroying/altering it.***

* In the second point of interest, we observe gold traces in the relief part of the disc. Can you describe how they look under the optical microscope?



Picture 1 Picture 2 Picture 3

***Another point of interest is in the area with the relief decoration of the disc (Figure 1). By enlarging the area of interest we can observe evidence of wear and can take a sample (Figure 2). With an optical microscope we can observe traces of gold color (Figure 3).***

***\* This particular point of interest is a good opportunity to discuss with students about how we intervene in a work of art for research or conservation purposes, without destroying/altering it.***

| *Discuss and record what the device does with a short video or audio recording.*  *Why do we use it and what results does it give us?  Name it “1.c Research”* | *QR audio* |
| --- | --- |

| **Conclusion Thought outline** | **QR audio** |
| --- | --- |

* **Why do we see three different images for the same point of interest? Can you sort them from lowest to highest magnification?**

**The three images give us an increasingly higher magnification of the same point.**

**The higher the magnification, the greater the detail we can observe.**

* **Do you observe anything different in the images of the different areas of the object we focused on?**

*Write down your observations or draw the pictures below with arrows for the points of special interest.*

| **In the images taken by the Optical Microscope, the points of interest are the bottom edge of the disc and the gold traces observed in the relief area of the disc. So, it would be interesting to get more information about these two points.** |
| --- |

| *Record your answers  in two different short videos or audio recordings.*  *Name them "1.d Conclusion A", "1.d Conclusion B"* | | *QR audio* |
| --- | --- | --- |
| **Conceptualization Questions outline** | **QR audio** | | |

*Discuss as a whole class.*

**What do we need to do to get more information   
about the points of interest?**

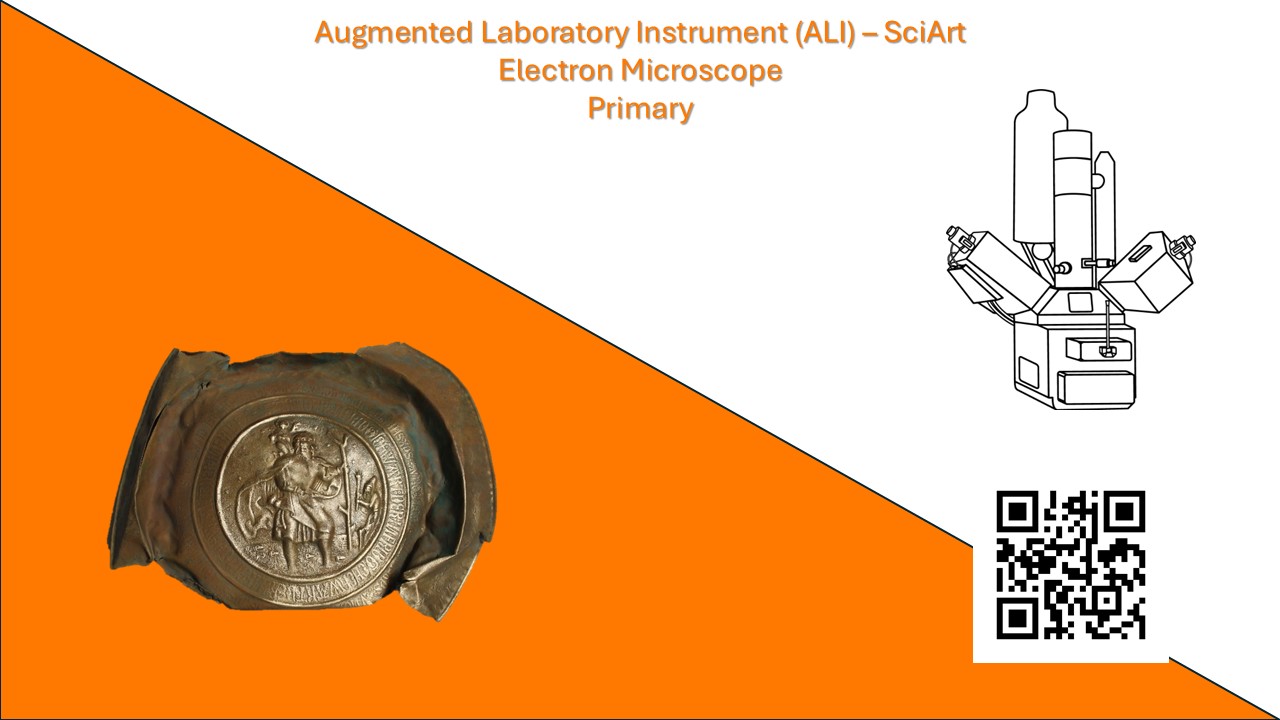
***A discussion is provoked in the class, in which we guide the students to focus on the need for further magnification.***

***The teacher introduces the Electronic Microscope as a solution for extra magnification.***

| *Record the views heard  with a short video or audio recording.*  *Name it “2.b Conceptualization”* | | *QR audio* |
| --- | --- | --- |
| **Research Research with solid fill** | **QR audio** | | |

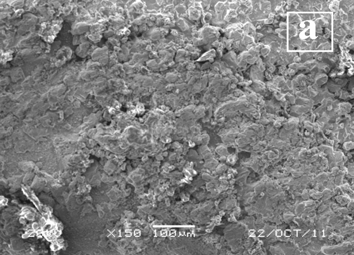
Use your mobile devices (tablets, mobile phones, etc.) and scan the QR below.

Watch the video and download the results the device gives for the Alm Dish by clicking the **"Results"** button.

****

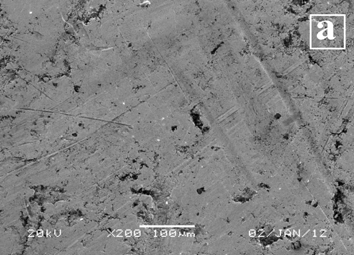
***Discuss the results of this device in the classroom***

* In the first point of interest, from the sample taken from the right edge of the disc, what do you observe in the SEM image? Can you describe its morphology?



***In the image from the SEM, we can observe the surface morphology of the dish. The surface is rough, which is an indication of wear. We cannot obtain any additional information regarding its composition.***

* In the second point of interest, from the sample taken from the gold traces in the embossed part of the disc, what do you observe in the SEM image? Can you describe its morphology?



***In the SEM image of the traces of golden colour, we do not observe any information about the type of material, except for the fact that it presents a relatively smooth surface.***

| *Describe how the device works and what we use it for*  *with a short video or audio recording.*  *Name it “1.c Research”* | | *QR audio* |
| --- | --- | --- |
| **Conclusion Thought outline** | **QR audio** | | |

* **Which one of the two different points of interest, scanned with the SEM method, has the highest magnification? How can we find it?**

**Image 2 has the highest magnification of 200x. We can read the magnification directly from the information given at the image's bottom. We can also calculate the magnification from the given scale.**

***The two images have a magnification of 150x (Figure 1) and 200x (Figure 2). We can read the magnification from the information given at the image’s bottom. We can also calculate the magnification from the given scale.***

* **Why do we get black and white images?**

**We get black and white images because SEM does not use natural light but electrons.**

* **What do we observe in the images? What might they mean for our object? Can we conclude the components in the points of interest (material on the edge of the disc and gold traces in the relief part of the disc)?**
* **No matter how high the magnification of the artifact is, it cannot give us clear answers about the components that the edge of the disc and the gold traces on its relief consist of.**
* **We assume from the points of different white-black gradation the existence of different materials. It would be interesting to use a new method to identify the components of the materials.**
* **So, we select the points where the magnification from SEM shows us that there are different materials to find their components using a new method, EDS.**

| *Record your answers  in three different short videos or audio recordings.*  *Name them "2.d Conclusion A", "2.d Conclusion B",  "2.d Conclusion C"* | | *QR audio* |
| --- | --- | --- |
| **Conceptualization Questions outline** | **QR audio** | |

*Discuss as a whole class.*

**What do we need to do to find the components   
of the points of interest of the artifact we are studying?**

**What should we recognize?**

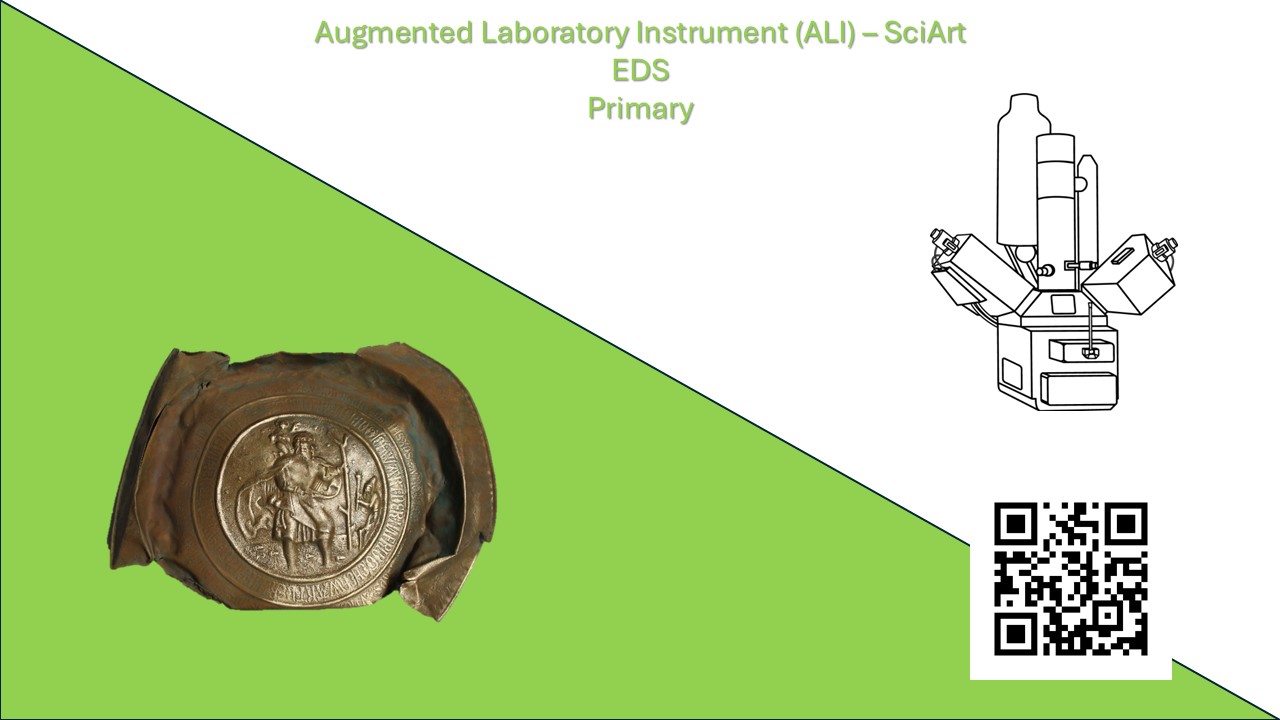
***A class discussion is provoked which leads to the need to identify the elements that the materials in the areas of interest (disc material and gold traces).***

***The teacher introduces the EDS method for the elemental analysis of the selected areas. "EDS, is an analytical method used to identify the elements found in a sample".***

| *Record the views heard  with a short video or audio recording.*  *Name it “1.b Conceptualization”* | | *QR audio* |
| --- | --- | --- |
| **Research Research with solid fill** | **QR audio** | | |

Use your mobile devices (tablets, mobile phones, etc.) and scan the QR below.

Watch the video and download the results of the Alm Dish method by clicking on the **"Results"** button.

****

***Study in your group and then discuss with the whole class   
the results of this particular method***

***Students observe the spectrum and identify the elements of the sample. The teacher explains to the students that an EDS spectrum is only obtained by selecting points of interest from the SEM images and asks the students to identify the elements found in the spectrum by the EDS method.***

* In the first point of interest, from the sample taken from the edge of the disk, what do you observe in the EDS spectrum? What elements does it consist of? Εικόνα που περιέχει κείμενο, λογισμικό, λογισμικό πολυμέσων, ορθογώνιο παραλληλόγραμμο

  Περιγραφή που δημιουργήθηκε αυτόματα

***This is the spectrum and the elemental analysis we get from the EDS method for the metal that was used for the main body of the disk. It consists mainly of copper with a small amount of zinc.***

***These are characteristics of the alloy known as brass.***

* In the second point of interest, from the sample we took from the gold layer, what do you observe in the EDS spectrum? What elements does it consist of?



***This is the spectrum and the elemental analysis we obtain from the EDS method regarding the traces of golden colour found on the relief of the disk. This specific composition indicates that the gold alloy that was used on the relief was derived from the reuse (melting) of jewelry.***

| *Discuss and record how the method works*  *with a short video or audio recording.*  *What results did it give us? What else did we have to do?*  *Name it “3.c Research”* | | *QR audio* |
| --- | --- | --- |
| **Conclusion Thought outline** | **QR audio** | | |

List the materials in which the elements found in our sample are found in the table below.

| **Points of interest** | **Chemical Compounds** |
| --- | --- |
| Material of the right edge of the disc | **Copper and zinc alloy meaning that the disc was made of brass** |
| Gold traces in the relief of the disc | **Gold (Au) 98%, Silver (Ag) 1% and Copper (Cu) 1%** |

| *Record your answers  in a short video or audio recording.*  *Explain how you got there.*  *Name them "3.d Conclusion"* | | *QR audio* |
| --- | --- | --- |
| **Conceptualization Questions outline** | **QR audio** | | |

*Discuss as a whole class.*

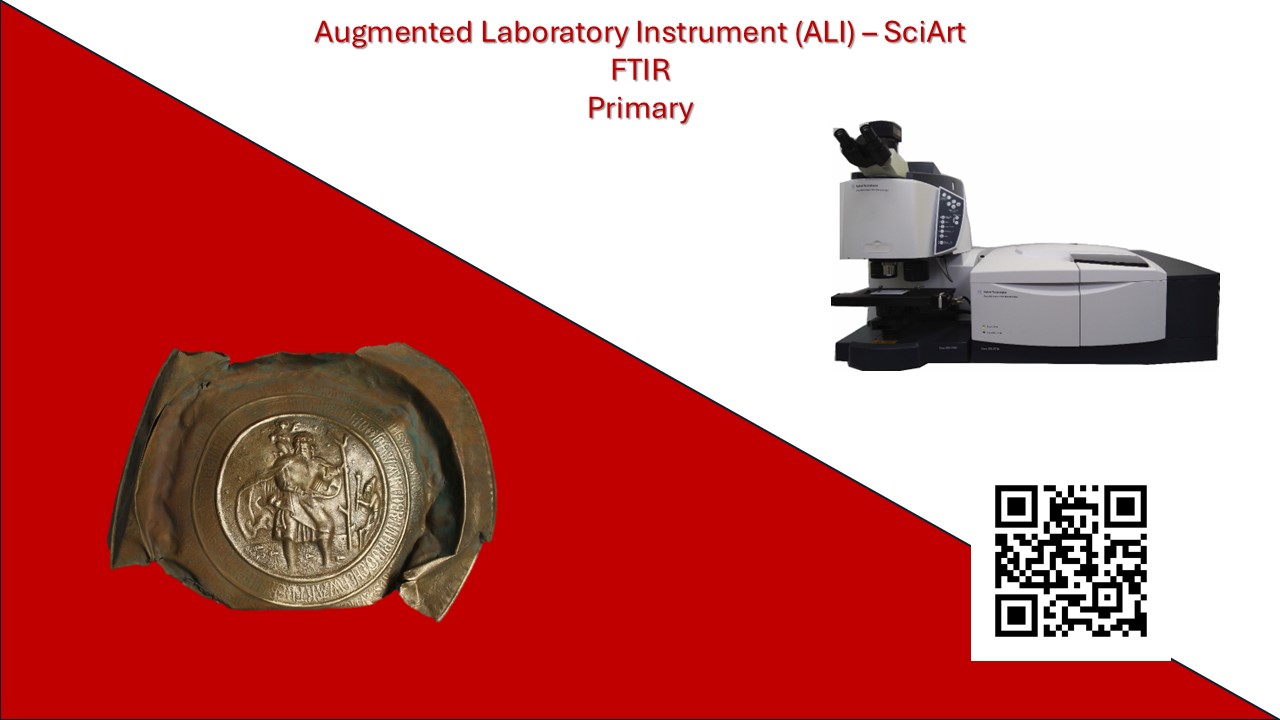
**What information will we get if we use the FTIR method to the two points of interest?**

***Students will use the FTIR method and they will find that this technique does not give results for the disc material and gold traces.***

| *Record the views heard  with a short video or audio recording.*  *Name it “4.b Conceptualization”* | | *QR audio* |
| --- | --- | --- |
| **Research Research with solid fill** | **QR audio** | | |

Use your mobile devices (tablets, mobile phones, etc.) and scan the QR below.

Watch the video and download the results of the Alm Dish method by clicking on the **"Results"** button.

****

***Discuss the results of this method with the whole class***

***The teacher explains to the students that the FTIR method does not give results for all materials. As seen from the results, we do not have a spectrum for brass and gold traces.***

* In the first point of interest, the sample taken from the disk edge, what do you observe in the FTIR spectrum? Does it give results?

Εικόνα που περιέχει γραμμή, γράφημα, διάγραμμα, στιγμιότυπο οθόνης

Περιγραφή που δημιουργήθηκε αυτόματα

***The method is not suitable for providing any results. It is likely not compatible with the materials that this particular layer consists of.***

* In the second point of interest, the sample taken from the gold traces, what do you observe in the FTIR spectrum? Does it give results?

Εικόνα που περιέχει γραμμή, γράφημα, διάγραμμα, στιγμιότυπο οθόνης

Περιγραφή που δημιουργήθηκε αυτόματα

***The FTIR method does not give results for the gold traces found on the disc.***

| *Discuss and record how the method works  with a short video or audio recording. What results did it give us?*  *Name it “4.c Research”* | | *QR audio* |
| --- | --- | --- |
| **Conclusion Thought outline** | **QR audio** | | |

* **Does the FTIR method give results for all materials? If not, list in the table below the materials that did not give results.**

| **Copper and zinc alloy** |
| --- |
| **Golden traces** |

| *Record your answers  in a short video or audio recording.*  *Explain how you got there.*  *Name them "4.d Conclusion"* | | *QR audio* |
| --- | --- | --- |
| **Conceptualization Questions outline** | **QR audio** | | |

*Discuss as a whole class.*

**What might the inability to identify a chemical compound by FTIR method mean for some materials?**

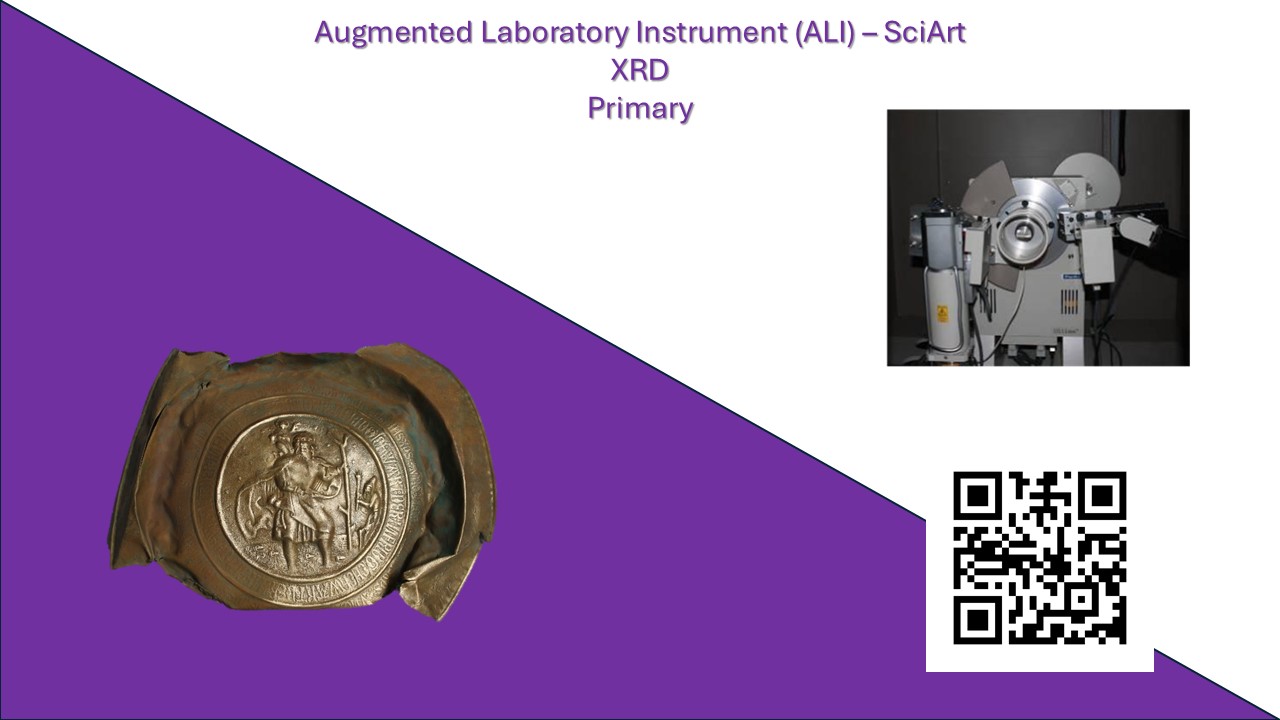
***A class discussion is provoked to show that each method has its limitations.***

***This is why we use more than one method when studying a sample. There are chemical compounds for which the FTIR method is unable to give results and that is why some of the elements we originally found using EDS did not appear in our results. Thus, the teacher introduces the need to use another method to accurately identify the composition of materials, the XRD method.***

| *Record the views heard  with a short video or audio recording.*  *Name it “5.b Conceptualization”* | | *QR audio* |
| --- | --- | --- |
| **Research Research with solid fill** | **QR audio** | | |

Use your mobile devices (tablets, mobile phones, etc.) and scan the QR below.

Watch the video and download the results of the Alm Dish method by clicking on the **"Results"** button.

****

***Discuss in the whole class the results of this particular method***

***Students observe the graph (diffractogram graph). The teacher initiates a discussion about the necessity to search for data from known materials and match them to the chemical compounds found to arrive at the specific materials present in our sample.***

Εικόνα που περιέχει κείμενο, γράφημα, διάγραμμα, γραμμή

Περιγραφή που δημιουργήθηκε αυτόματα

***The XRD pattern’s analysis confirms that the dish is manufactured by brass, which is a copper-zinc alloy.***

Εικόνα που περιέχει κείμενο, στιγμιότυπο οθόνης, γράφημα, διάγραμμα

Περιγραφή που δημιουργήθηκε αυτόματα

***The XRD diffraction pattern for the gold traces in the sample confirms that the gold detail is mainly composed of gold.***

| *Discuss and record how the method works  with a short video or audio recording.*  *What results did it give us?*  *Name it “4.c Research”* | | *QR audio* |
| --- | --- | --- |
| **Conclusion Thought outline** | **QR audio** | | |

* **Write down the material/chemical compound you have identified by using the XRD method.**

| **Points of interest** | **Chemical Compounds** |
| --- | --- |
| Material of the tray | **The disc is made of copper and zinc alloy** |
| Gold traces on the disc | **Gold traces are mainly composed of gold (Au)** |

| *Record your answers  in a short video or audio recording.*  *Explain how you got there.*  *Name them "4.d Conclusion"* | *QR audio* |
| --- | --- |

**Back to the initial questions...**

1. Can we recognize the value of the Alm Dish? Was it part of a treasure or an everyday object?

2. Can we date it?

3. What are the ingredients of which it is composed? What are their properties?

4. Can we identify maintenance procedures?

| **Conceptualization Questions outline** | **QR audio** |
| --- | --- |

*Discuss as a whole class.*

**How can we use the conclusions drawn from archaeometric methods to answer the initial questions?**

*Please provide questions that you can ask an AI machine. The answers it gives you, combined with the results you already have, will help address the initial questions*

| ***The teacher facilitates a class discussion to formulate the questions the students need to answer. Such questions may be:***   * **What is the value of these materials and how rare were they?** * **Where are these materials located?** * **What is brass? What are its properties? Where is brass used today?** |
| --- |

| *Record the questions you will ask on ChatGPT with a short video or audio recording.*  *Name it “6.b Conceptualization”* | *QR audio* |
| --- | --- |
| **Research Research with solid fill** | **QR audio** |

Use ChatGPT to get information on the above questions. Write down the information you need to answer the questions.

| **Question** | **ChatGPT answer key points** |
| --- | --- |
| What is brass? | **Brass is a** [**copper-zinc**](https://el.wikipedia.org/wiki/%CE%A8%CE%B5%CF%85%CE%B4%CE%AC%CF%81%CE%B3%CF%85%CF%81%CE%BF%CF%82) [**alloy**](https://el.wikipedia.org/wiki/%CE%9A%CF%81%CE%AC%CE%BC%CE%B1)**. The term 'brass' is derived from the Latin 'aurum' (gold) and 'aes' (copper), which denotes the golden colouring of the alloy.** |
| What are the properties of brass? Where is brass used today? | **Due to its good conductivity, brass is widely used in the manufacture of wires and cables, mainly for electrical and electronic applications. It is also used in the production of pipes, mainly for hydraulic and air conditioning applications, due to its resistance to corrosion. Because brass is resistant to corrosion by seawater, it is widely used in shipbuilding, mainly for valves and fittings. It is also used in jewellery and decorative objects because of its golden appearance and its resistance to corrosion. In some applications, such as in musical instruments, including percussion instruments and cymbals, brass is used for its excellent sound properties.** |

*Discuss in class the answers  
to the specific questions you posed on ChatGPT*

| *Note the main points of the answers for each question.  Did it help you find the answer?  How?*  *Name it “4.c Research”* | | *QR audio* |
| --- | --- | --- |
| **Conclusion Thought outline** | **QR audio** | | |

*Record the answers to the initial questions of the investigation.*

| 1. **Can we recognize the value of the Alm Dish (charity tray?)**   **What was its use? Was it part of a treasure or an everyday object?** |
| --- |
|  |
| **2. Can we date it?** |
|  |
| **3. What are the ingredients of which it is composed? What do we know about them?** |
|  |
| **4. Can we identify maintenance procedures?** |
|  |

|  | *QR audio* |
| --- | --- |

**Create a video of your answer to each   
interview question.**

**One of you will ask the question**

**and the other person will answer!!!!**

*Name the videos "Final Answer 1", "Final Answer 2", etc.*