Mineralization, $CaCO_3$ calcification and biomimetic synthesis studies performed (from 1996 to 2016) in the laboratories of Prof. Dr. Cuneyt Tas led to the development of **14** different mineralization/calcification media (*click the below names of media to see their peer-reviewed publications*):

1.) ***27 mM HCO3-Tris-SBF*** (←this link describes step-by-step preparation of 27 mM HCO3-Tris-SBF)

SBF: synthetic body fluid (having 27 mM HCO_3) or
simulated body fluid (having 4.2 mM HCO_3)

The Japanese formulation (of 1990) of SBF then became the ISO 23317-2007 standard with its 4.2 mM HCO_3. Human blood plasma contains 6.43 times more HCO_3 than 4.2 mM. Human blood plasma contains 27 mM HCO_3. The false claims in ISO 23317-2007 was partially corrected in ISO 23317-2025 version, but it is still based on the incorrect 4.2 mM HCO_3 concentration.

The *Tas* labs used the "27 mM HCO3-Tris-SBF" in numerous studies (including those involved *in vitro* osteoblast cell culture work) and also provided its 1.5X SBF version.

Visit the articles in the links below to learn more about "27 mM HCO3-Tris-SBF."
https://en.wikipedia.org/wiki/Simulated_body_fluid
https://www.cuneyttas.com/haurea1.pdf
https://www.cuneyttas.com/sbfureas.pdf
https://www.cuneyttas.com/Turk-J-Med-Sci-paper.PDF
https://www.cuneyttas.com/hasbf37.pdf
https://www.cuneyttas.com/hacomb.pdf (SBF with Cu^{2+}, Zn^{2+} and Fe^{3+} dopants)
https://www.cuneyttas.com/Brushite-JACerS.pdf
https://www.cuneyttas.com/TTCP-paper.pdf
https://www.cuneyttas.com/In-vitro-whisker-JBMR.pdf
https://www.cuneyttas.com/SBF-comparison-JMSMM.pdf
https://www.cuneyttas.com/Ti-foam-SBF-osteoblasts.pdf
https://www.cuneyttas.com/Crack-free-SBF-coating.pdf
https://www.cuneyttas.com/ApCaP-whiskers-H2O2.pdf
https://www.cuneyttas.com/BoneSubs-MSE-C.pdf
https://www.cuneyttas.com/Struvite.pdf
https://www.cuneyttas.com/Brushite-microgranules.pdf
https://www.cuneyttas.com/Physiological-media-CaP-Review.pdf

2.) ***Lac-SBF*** (←this link provides step-by-step preparation recipe of 27 mM HCO3-Lactic-Lactate-SBF)

This SBF perfectly matches the ion concentrations of human blood plasma and it does not contain any abiotic Tris or abiotic Hepes in it.

The peer-reviewed Journal articles below proved that the Lac-SBF is an excellent solution to nucleate nanosize and low crystallinity apatitic calcium phosphate on material surfaces or even to form monodisperse, monosize spheres of X-ray amorphous calcium phosphate.

https://www.cuneyttas.com/Lactic-lactate-SBF.pdf
https://www.cuneyttas.com/Brushite-microgranules.pdf
https://www.cuneyttas.com/ACP-spheres-in-SBF.pdf
https://www.cuneyttas.com/Aragonite-in-Lac-SBF.pdf

3.) **10X SBF** (←this link provides step-by-step preparation recipe of 10X SBF)

This 10X SBF solution is for rapid formation of low crystallinity, apatitic calcium phosphate on metal, ceramic and polymer surfaces.

4.) **Brushite-pregnant precipitate-free solution** (←this link provides step-by-step preparation recipe of brushite crystallization solution)

Brushite ($CaHPO_4 \cdot 2H_2O$, dicalcium phosphate dihydrate, DCPD) is a calcium phosphate that can be produced in ton quantities using inexpensive and robust synthesis recipes, such as the one described in the above link (or the one here https://www.cuneyttas.com/Brushite-to-whitlockite.pdf). Brushite is a reactive calcium phosphate and can be readily transformed into either apatitic calcium phosphate (Ap-CaP) or octacalcium phosphate (OCP, $Ca_8H_2(PO_4)_6 \cdot 5H_2O$) when using proper hydrothermal processes. OCP synthesized from DCPD is a material that can help forming bone mineral *in vivo*.

5.) **BM-3** (←this link provides step-by-step preparation recipe of a DCPD-to-OCP transformation solution)

https://www.cuneyttas.com/DCPD-to-OCP-biomineralization.pdf
BM-3 solution (with a Ca/P molar ratio of 2, just like the DMEM (Dulbecco's Modified Eagle Medium)) has the impressive power of transforming brushite (DCPD) into OCP (octacalcium phosphate), see Table 1 of the specified article to prepare the BM-3 solution. The BM-3 solution does not contain any abiotic Tris or abiotic Hepes.

6.) **BM-7** (←this link provides step-by-step preparation recipe of a DCPD-to-Ap-CaP transformation solution)

https://www.cuneyttas.com/DCPD-to-OCP-biomineralization.pdf, this article gave the preparation recipes of 8 unique mineralization solutions.

BM-7 solution (with a Ca/P molar ratio of 2.5) has the ability to transform DCPD into biphasic OCP and Ap-CaP (apatitic calcium phosphate).

The same BM-7 solution forms X-ray amorphous calcium phosphate (ACP) on 5 M NaOH- or 5 M KOH-treated titanium coupons of high basicity, as disclosed and detailed in the below peer-reviewed Journal article.
https://www.cuneyttas.com/Titan-in-5M-NaOH-vs-KOH.pdf

7.) **SIEM** (saline ionic essentials medium; free of Ca^{2+} and HPO_4^{2-} ions)

The preparation recipes of 4 more novel mineralization media, including SIEM, were developed in the *Tas* laboratories and disclosed in the below article.

https://www.cuneyttas.com/Physiological-media-CaP-Review.pdf

Some of those new solutions were also used and discussed in the below study.
https://www.cuneyttas.com/Ca-metal.pdf

8.-12.) **Aragonite Coating Solutions**: ACS-1, ACS-2, ACS-3, ACS-4, ACS-5

ACS-1 through ACS-5 are useful for understanding the conditions of the formation of aragonite or magnesian-calcite in solutions roughly inspired by the artificial seawater composition.

Coral reefs contain aragonite (thanks to the high Mg^{2+} content of seawater), whereas sea stars (*a.k.a.*, starfish) crystallize magnesian-calcite but not aragonite in their hard tissues.

13.) **Whitlockite synthesis solution**

https://www.cuneyttas.com/Brushite-to-whitlockite.pdf

Whitlockite ($Ca_9Mg(HPO_4)(PO_4)_6$), named after Herbert Percy Whitlock (1868-1948) who found it in nature, is quite easy to synthesize if one starts with a brushite (DCPD) powder and immerse the powder in a simple aqueous solution with 1.5 mM $MgCl_2 \cdot 6H_2O$. As disclosed in the above article, one obtains single-phase whitlockite at 70°C or 115°C after 1 day of immersion, however, the immersion time of DCPD rises to 3 weeks if the temperature of reaction was 37°C.

14.) **$CaHPO_4$ to apatitic calcium phosphate (Ap-CaP) transformation solution**

Monetite ($CaHPO_4$, dicalcium phosphate anhydrous, DCPA) is a calcium phosphate of high reactivity in aqueous solutions and is not difficult to synthesize. There are two main routes to its synthesis: (1) calcine DCPD (brushite) powder at 200°C in air for 2 h or (2) synthesize it in ethanol as described in the article above.

The recipe of the solution (having 142 mM Na^+, 5 mM K^+, 50 mM Ca^{2+} and its pH increased to around 10 by adding 0.01 mL of concentrated NH_4OH) that is able to transform DCPA into Ap-CaP was given here.

Monetite (DCPA) powder immersed in this solution at 37°C for 6 days produced, as expected, an Ap-CaP powder of high surface area and high surface reactivity as shown in Fig. 5 of the article here.