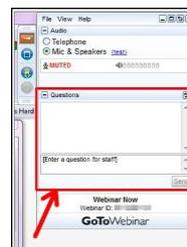




Have Questions?



Type them into questions box!

“Why am I muted?”

Don't worry. Everyone is muted except the presenter and host. Thank you and enjoy the show.

Contact ACS Webinars® at acswebinars@acs.org

1

Check out the ACS Webinar Library!

An ACS member exclusive benefit



Hundreds of presentations from the best and brightest minds that chemistry has to offer are available to you on-demand. The Library is divided into 6 different sections to help you more easily find what you are searching.

Professional Development

▶ View the Collection

Learn how to write better abstracts, deliver more engaging presentations, and network to your next dream job. Brush up on your soft skills and set a new career path by mastering what can not be taught in the lab.

Technology & Innovation

▶ View the Collection

From renewable fuels to creating the materials for the technology of tomorrow, chemistry plays a pivotal role in advancing our world. Meet the chemists that are building a better world and see how their science is making it happen.

Drug Design and Delivery

▶ View the Collection

The Drug Design Delivery Series has built a collection of the top minds in the field to explain the mechanics of drug discovery. Discover the latest research, receive an overview on different fields of study, and gain insight on how to possibly overcome your own med chem roadblocks.

Culinary Chemistry

▶ View the Collection

Why does food taste better when it is grilled or what molecular compounds make a great wine? Discover the delectable science of your favorite food and drink and don't forget to come back for a second helping.

Popular Chemistry

▶ View the Collection

Feeling burdened by all that molecular weight? Listen to experts expound on the amazing side of current hot science topics. Discover the chemistry of rockets, how viruses have affected human history, or the molecular breakdown of a hangover.

Business & Entrepreneurship

▶ View the Collection

How do ideas make it from the lab to the real world? Discover the ins and outs of the chemical industry whether you are looking to start a business or desire a priceless industry-wide perspective.

<https://www.acs.org/content/acs/en/acs-webinars/videos.html>

2

Join us in our efforts to increase the diversity of chemistry.



Valued donors like you have sustained ACS educational programs that are welcoming students from diverse backgrounds into our profession.

www.acs.org/donate



ACS Office of Philanthropy
Chemistry for Life®

3

A Career Planning Tool For Chemical Scientists



ChemIDP is an Individual Development Plan designed specifically for graduate students and postdoctoral scholars in the chemical sciences. Through immersive, self-paced activities, users explore potential careers, determine specific skills needed for success, and develop plans to achieve professional goals. **ChemIDP** tracks user progress and input, providing tips and strategies to complete goals and guide career exploration.

<https://chemidp.acs.org>

4

ACS Bridge Program



Are you thinking of Grad School?

If you are from an underrepresented racial or ethnic group, we want to empower you to get your graduate degree!

The ACS Bridge Program offers:

- A FREE common application that will highlight your achievements to participating Bridge Departments
- Resources to help write competitive grad school applications and connect you with mentors, students, and industry partners!



Learn more and apply at www.acs.org/bridge

Email us at bridge@acs.org

5

ACS Department of Diversity Programs

Advancing ACS's Core Value of Diversity, Inclusion & Respect



We believe in the strength of diversity in all its forms, because inclusion of and respect for diverse people, experiences, and ideas lead to superior solutions to world challenges and advances chemistry as a global, multidisciplinary science.

Contact Us:

https://app.suggestionox.com/r/DI_R

Diversity@acs.org

 @ACSDiversity

 ACS Diversity



acsvoices.podbean.com/



www.acs.org/diversity

6



Reactions: Chemistry Science Videos & Infographics



DEATH AND DECOMPOSITION



<https://youtu.be/OBWnP09UufE>

Are Human Burial Practices Messing Up Earth's Ecosystems?

Life depends on death — living things die, decompose and eventually become nutrients for other life. But when humans die, we're often embalmed and buried or cremated.

So are we breaking the circle of life? Also, check out episode 1 of [Vitals!](#)

www.acs.org/reactions

7



Enhancing Research Productivity Through Student-Led Laboratory Safety Teams



Date: Thursday, November 4, 2021 @ 2-3pm ET

Speakers: Jessica Martin, ACS Division of Chemical Health and Safety / Kall Miller, ACS Division of Chemical Health and Safety / Monica Nyansa, ACS Division of Chemical Health and Safety / Sarah Zinn, ACS Division of Chemical Health and Safety

Moderator: Ralph Stuart, ACS Division of Chemical Health and Safety

[Register for Free!](#)

What You Will Learn:

- The motivation behind graduate student-led safety initiatives
- How lab productivity is often inextricably linked to lab housekeeping
- How LSTs can empower future lab leaders to collaborate on resolving safety continuity challenges

Co-produced with: ACS Division of Chemical Health and Safety ACS Committee on Chemical Safety

Careers in Science and Engineering:

Everything that You Need to Know



Professor Ashutosh Sharma
Institute Chair Professor,
Indian Institute of
Technology, Kanpur

Date: Wednesday, November 10, 2021 @ 7:30am ET (6-7pm IT)

Speaker: Ashutosh Sharma, Indian Institute of Technology, Kanpur

Moderator: Deeksha Gupta, American Chemical Society

[Register for Free!](#)

What You Will Learn:

- What are the current career options and job opportunities for chemistry graduates in India
- How to choose a career based on personal strengths and values
- How to bridge gaps to increase your chance of employability

This special broadcast is targeted for an audience based in India and is co-produced with ACS International and ACS Publications.

Sustainability Through Innovation

A Conversation with Industry Experts



Date: Wednesday, November 10, 2021 @ 2-3pm ET

Speaker: Lee Ellen Drechsler, Procter & Gamble

Moderator: Rebekah Paul, American Chemical Society

[Register for Free!](#)

What You Will Learn:

- Real life innovations where the chemical industry has incorporated sustainability into their operations
- Future sustainable innovations being developed in corporate R&D
- Professional opportunities for the next generation in the chemical industry

Co-produced with: ACS Communications and ACS Industry Member Programs

www.acs.org/acswebinars

8



Bloodstains & Biomolecules

From Crime Scene to the Silver Screen



FREE Webinar | TODAY at 2pm ET



THIS ACS WEBINAR WILL BEGIN SHORTLY...

9



Bloodstains & Biomolecules: From Crime Scene to the Silver Screen



THERESA STOTESBURY
Assistant Professor, Forensic Science,
Ontario Tech University



MONICA MATTESI
Science Educator,
Stony Brook University

Presentation slides are available now! The edited recording will be made available as soon as possible.

www.acs.org/acswebinars

This ACS Webinar is co-produced with ACS Reactions.

10

Bloodstains & Biomolecules

From Crime Scene
to the Silver Screen

Dr. Theresa Stotesbury



11

Where in the world



HI
EVERYONE!



Ontario Tech University acknowledges the lands and people of the Mississaugas of Scugog Island First Nation. We are thankful to be welcomed on these lands in friendship. The lands we are situated on are covered under the Williams Treaties and the traditional territory of the Mississaugas, a branch of the greater Anishinaabeg Nation, including Algonquin, Ojibway, Odawa and Pottawatomi. These lands remain home to a number of Indigenous nations and people.

ACS Webinar_2021_Stotesbury

<https://studentlife.ontariotechu.ca/services/community/indigenous/land-acknowledgement/>



12

Outline

- **Bloodstain Pattern Analysis**
 - *tricks* of the domain
 - forensic chemistry
- **Fake Blood**
 - blood substitutes
 - *Jack-o-* all trades or per use basis?
 - forensic blood substitutes
 - hybrid inorganic-organic sol-gel materials
 - Case specific examples
- **Forensic Tissue Simulants**
 - bonus *treat!*



ACS Webinar_2021_Stotesbury

13

Bloodstain Pattern Analysis

Bloodstain pattern analysis (BPA) is a field that primarily focuses on the study of the *size, shape and distribution of bloodstains in order to determine the physical events which gave rise to their origin*

Who? What? Where? When? Why? How? What else?

Who?: DNA

- identifying the blood source

What?: Is it blood

- presumptive testing methods

ACS Webinar_2021_Stotesbury

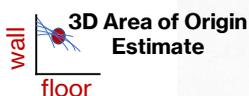
14

Bloodstain Pattern Analysis

Bloodstain pattern analysis (BPA) is a field that primarily focuses on the study of the *size, shape and distribution of bloodstains in order to determine the physical events which gave rise to their origin*

Hypothesize - impact pattern

- **Why?:** Stain size, shape, distribution
- **How?:** A bloodstain pattern resulting from an object striking liquid blood
- **Where?**

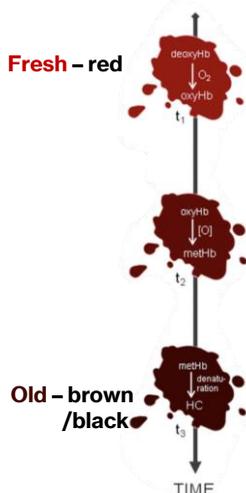


ACS Webinar_2021_Stotesbury

15

Bloodstain Pattern Analysis

Bloodstain pattern analysis (BPA) is a field that primarily focuses on the study of the *size, shape and distribution of bloodstains in order to determine the physical events which gave rise to their origin*



ACS Webinar_2021_Stotesbury

Zadora G, Menzyk A. In the pursuit of the holy grail of forensic science – spectroscopic studies on the estimation of time since deposition of bloodstains. Trends Anal Chem 2018 Apr;105:137-65.

16

Bloodstain Pattern Analysis

Bloodstain pattern analysis (BPA) is a field that primarily focuses on the study of the *size, shape and distribution of bloodstains in order to determine the physical events which gave rise to their origin*

Training:

- Basic BPA
- Advanced BPA
- Fluid Dynamics
- Chemical Enhancement
- Fabrics
- Understudy
- ...much more

All (most) which require handling blood



Who? What?
Where?
When? Why?
How?
What else?

ACS Webinar_2021_Stotesbury

17

Other blood sources?

Semi-synthetics?

Synthetics?

So what happens if human blood cannot be sourced or used in forensic research and training?

Validation?

ACS Webinar_2021_Stotesbury

18

Audience Survey Question

ANSWER THE QUESTION ON BLUE SCREEN IN ONE MOMENT



So what makes a good forensic blood substitute?

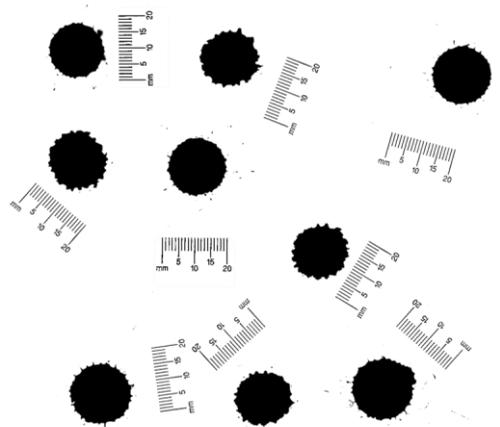
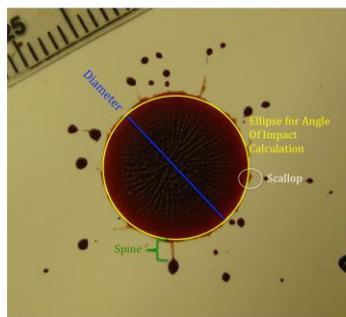


- Visual appearance (opacity, chromophore shifts, etc.)
- Oxygen transport
- Viscosity
- Wettability and other surface interactions
- Something else? (Let us know in the chat!)

ACS Webinar_2021_Stotesbury

ACS Reactions. The Chemistry of Hollywood Fake Blood. (27 October 2017) <https://www.youtube.com/watch?v=8OC5rjstl>

Requirements of silver screen ≠ crime scene



Fluid	Splashing + Spreading Score (I/2)	Stain Formation and Angle of Impact (I/1)	Candidate Molecule	Found in	Reason for Inclusion	Observed Outcome
Whole Human Blood (Male, EDTA anticoagulant)	12	1	Glycerol	SBS 002	High molecular weight	More "blood-like" than "water-like" drip stains
50% v/v Pam's Liquid Clover Honey	12	1	SBS 003			
10% v/v Devil's Cloak Paint	11	1	SBS 004		Used in previous research	
SBS 005	8	1	Xanthan gum	SBS 005	Promotes shear thinning behavior	More "blood-like" than "water-like" drip stains
5% v/v Devil's Cloak Paint	7	1	Dextran	SBS 001	Powder of complex glucose molecules	Increased "blood-like appearance"
Bond Substitute	6	1			Used in some SBS	High sedimentation rate
SBS 004	0	1			to observe flow in ultrasound technology [11]	
50% v/v Devil's Cloak Paint	4	1	Starch	SBS 005	High molecular weight	SBS 005 had the highest score out of all the synthetics
SBS 003	1	1				Can improve the score with increasing [glycerol]
10% v/v Pam's Liquid Clover Honey	0	1				
5% v/v Pam's Liquid Clover Honey	0	1				
75% v/v Devil's Cloak Paint	0	1				
Spatter Blood	0	1				
75% v/v Pam's Liquid Clover Honey	0	1				
SBS 001	0	1				
Water (Millipore, 1% v/v dye)	0	1	Leucithin	SBS 004	High molecular weight	Addition to SBS 003 increase its performance in spreading dynamics
SBS 002	0	1				
Raw Devil's Cloak Paint	0	1				
Raw Pam's Liquid Clover Honey	0	1				
Canola Oil	0	1				

-, a stain did not form and therefore was not measured.

ACS Webinar_2021_Stotesbury

Stotesbury T, Taylor MC, Jerry MC. Passive drip stain formation dynamics of blood onto hard surfaces and comparison with simple fluids for blood substitute development and assessment. Journal of forensic sciences. 2017 Jan;62(1):74-82.

🔪 So what makes a good forensic blood substitute?

Forensic blood substitutes are essentially
standard reference materials

Design considerations suggest an FSB:

1. is chemically safe, and preferably free of biohazardous risks
2. holds scientific validity in a relevant forensic context
3. uses practical fabrication and demonstrative processes
4. offers advantageous features for implementation in education and training



ACS Webinar_2021 Stotesbury

21

Stotesbury T, Bruce C, Illes M, Hanley-Dafoe R. Design considerations for the implementation of artificial fluids as blood substitutes for educational and training use in the forensic sciences. *Forensic Science Policy & Management: An International Journal*. 2016;7:81-6.

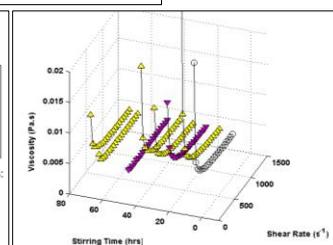
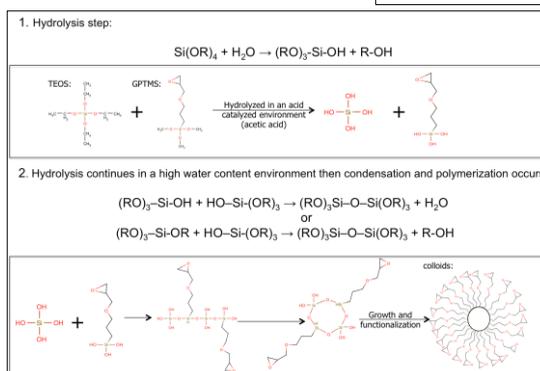
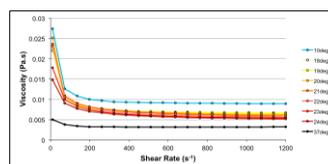
🔪 Sol-gel based FBS

- **Solution-gelation (sol-gel) chemistry is a 2 step process:**
 - Formation of a colloidal suspension of solid particles, or *sol*,
 - And then polymerizes to form a *gel*

- **BPA mechanisms parallel deposition processes used in sol-gel applications**

- **Not your typical sol-gel**
 - Hybrid inorganic/organic material
 - High R value (silicon:water) to promote long-term stability

- **3 sol-gels characterized for:**
 - Physical
 - Chemical
 - Biological simulations

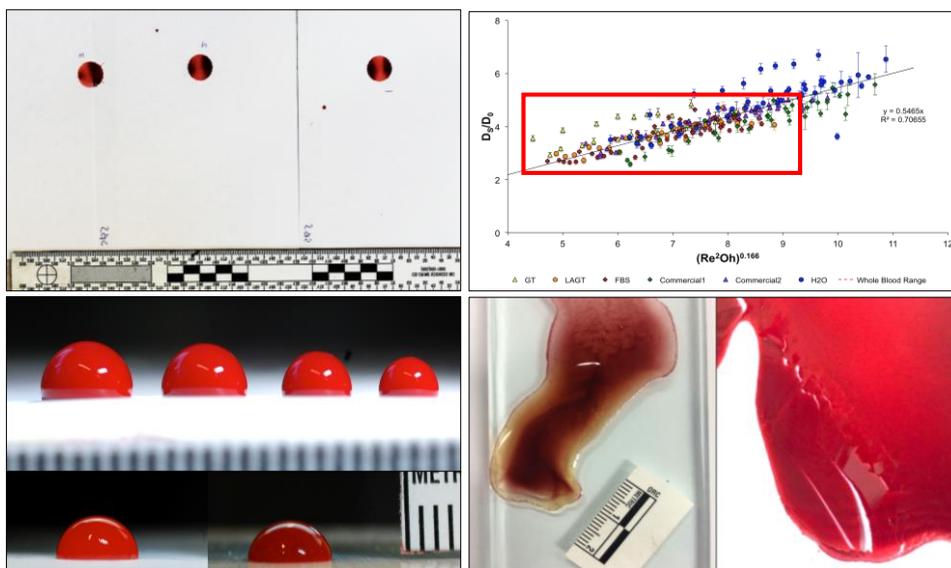


ACS Webinar_2021 Stotesbury

22

Stotesbury T, Illes M, Wilson P, Vreugdenhil AJ. The application of silicon sol-gel technology to forensic blood substitute development: Investigation of the spreading dynamics onto a paper surface. *Forensic Science International*. 2017 Jun 1;275:308-13.

Sol-gel based FBS

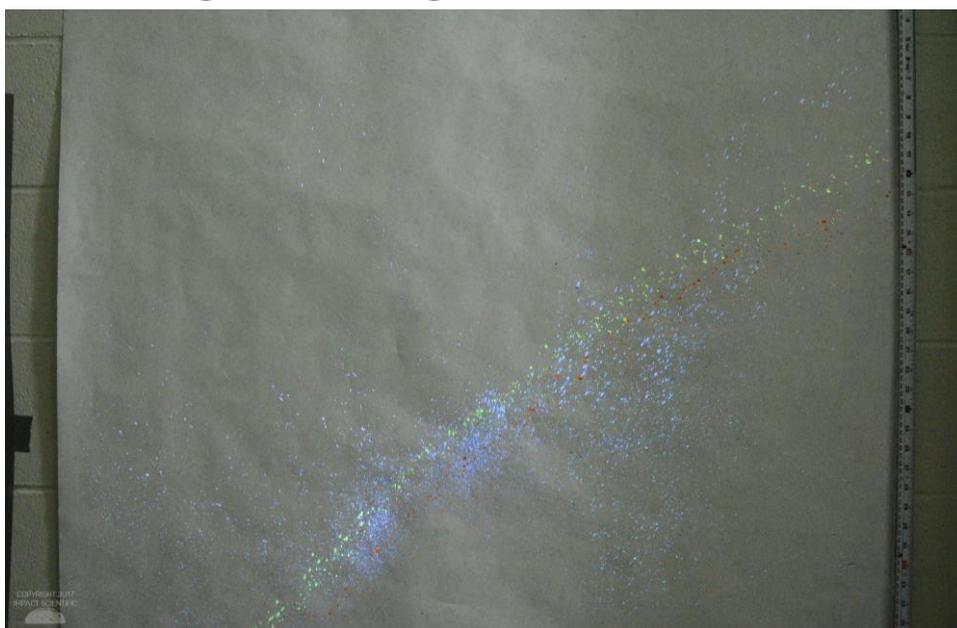


ACS Webinar_2021_Stotesbury

Stotesbury T, Illes M, Wilson P, Vreugdenhil AJ. The application of silicon sol-gel technology to forensic blood substitute development: Mimicking aspects of whole human blood rheology. *Forensic science international*. 2017 Jan 1;270:12-9.

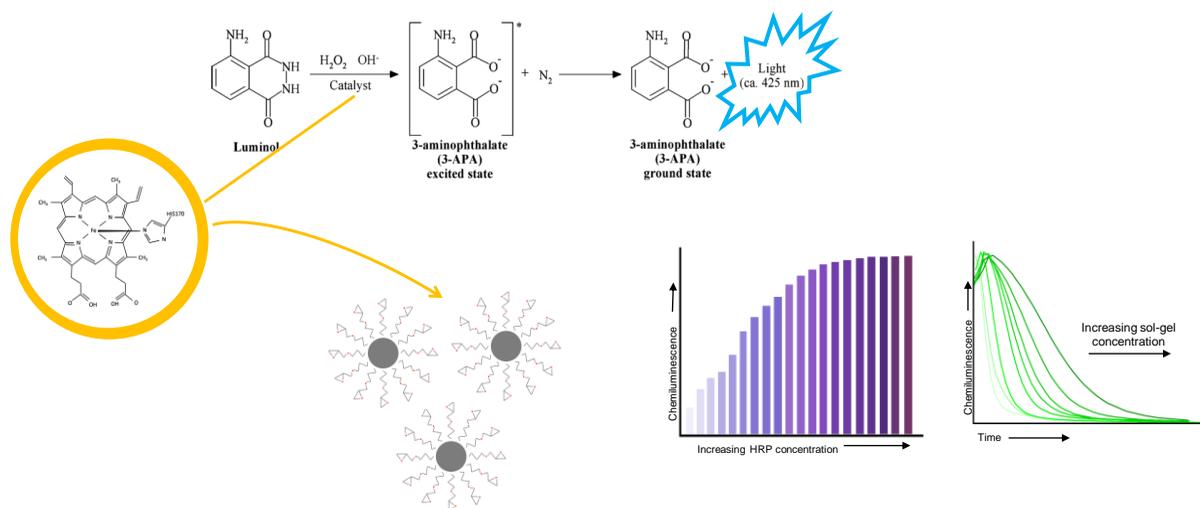
23

The training advantage



24

Chemical enhancement



ACS Webinar_2021_Stotesbury

25

Chemical enhancement



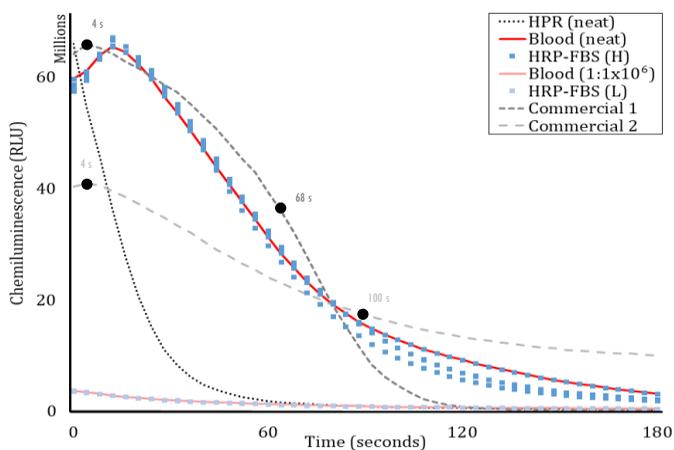
FBS high & low intensity materials

- similar kinetic profiles to that of neat whole blood and 10^6 dilution

Commercial products

- product 1 = liquid for training
 - similar emission maximum, with different kinetic profile
- product 2 = card for control test
 - different kinetic profiles

	R^2	p-value
FBS (High; Low)	0.995; 0.995	0.835; 0.998
Commercial 1	0.566	0.003
Commercial 2	0.379	<0.001

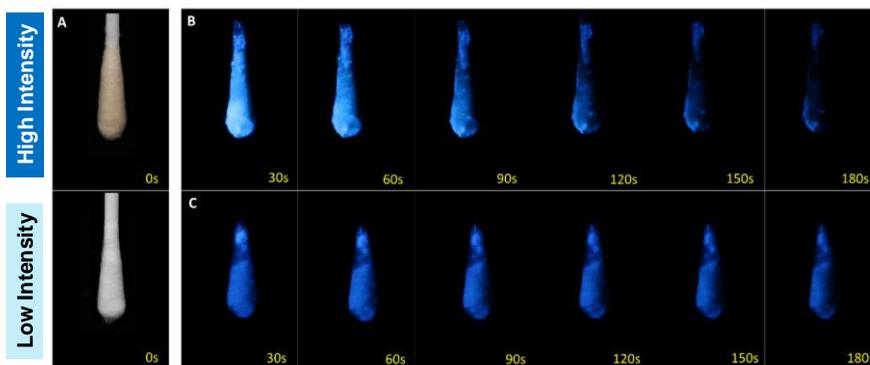


ACS Webinar_2021_Stotesbury

Polacco S, Wilson P, Illes M, Vreugdenhil A, Stotesbury T. Luminol reagent control materials in bloodstain pattern analysis: a silicon sol-gel polymer alternative. *Forensic Chemistry* 12(1):91-8.

26

Chemical enhancement



ACS Webinar_2021_Stotesbury

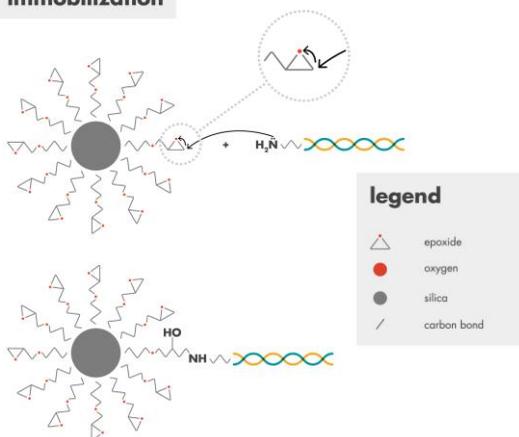
Polacco S, Wilson P, Illes M, Vreugdenhil A, Stotesbury T. Luminol reagent control materials in bloodstain pattern analysis: a silicon sol-gel polymer alternative. *Forensic Chemistry* 12(1):91-8.

27

DNA containing materials

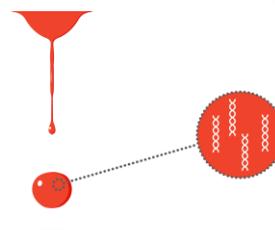


DNA immobilization



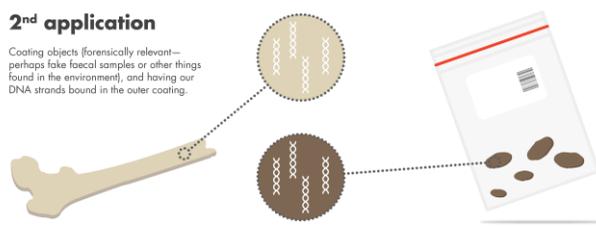
1st application

Having the DNA bound within a Forensic Blood Substitute (FBS).



2nd application

Coating objects (forensically relevant—perhaps fake faecal samples or other things found in the environment), and having our DNA strands bound in the outer coating.

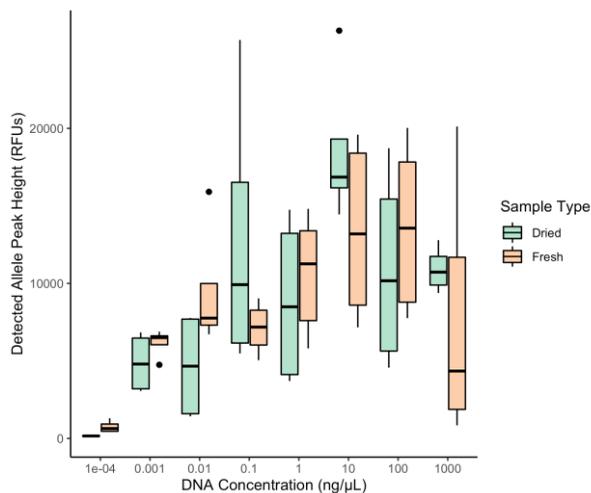
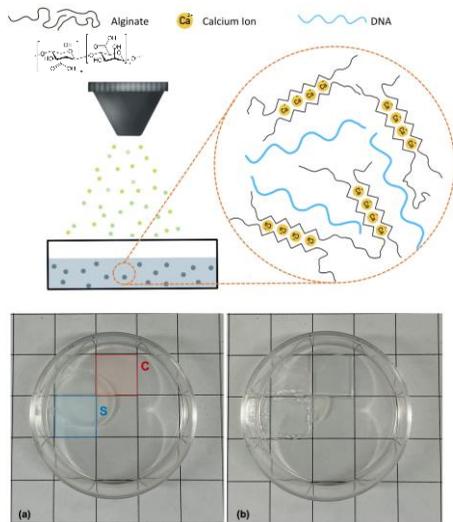


ACS Webinar_2021_Stotesbury

Orr A, Wilson P, Stotesbury T. Inclusion of deoxyribonucleic acid in sol-gel based forensic blood substitutes for application to forensic science. (poster presentation) Canadian Society of Forensic Science, 2018 Gatineau, QC .

28

It doesn't stop at blood!

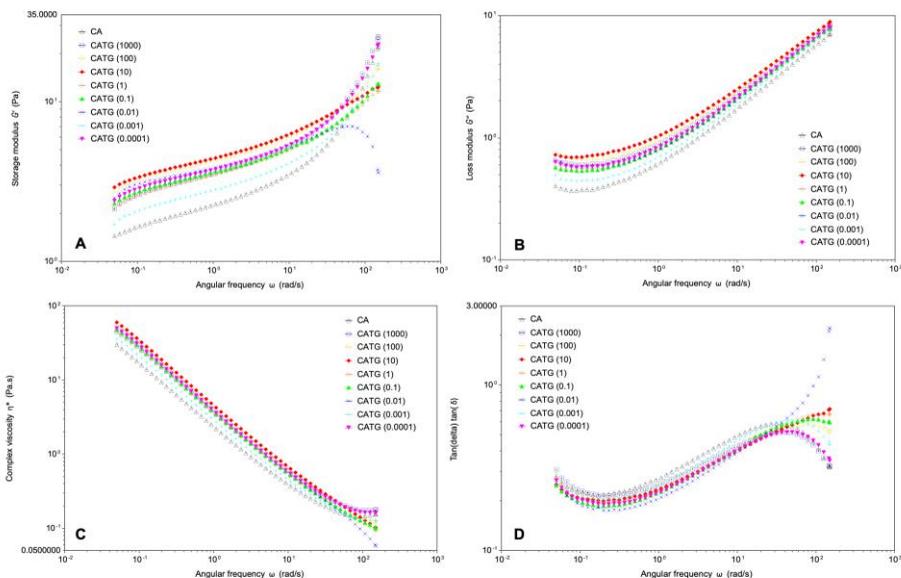


ACS Webinar_2021_Stotesbury

Orr A, Wilson P, Stotesbury T. Calcium-Alginate Tissue Gels (CATG): Proof-of-Concept Biomaterial Development. *Forensic Science International*. 2021 Oct 13:111055.

29

It doesn't stop at blood!



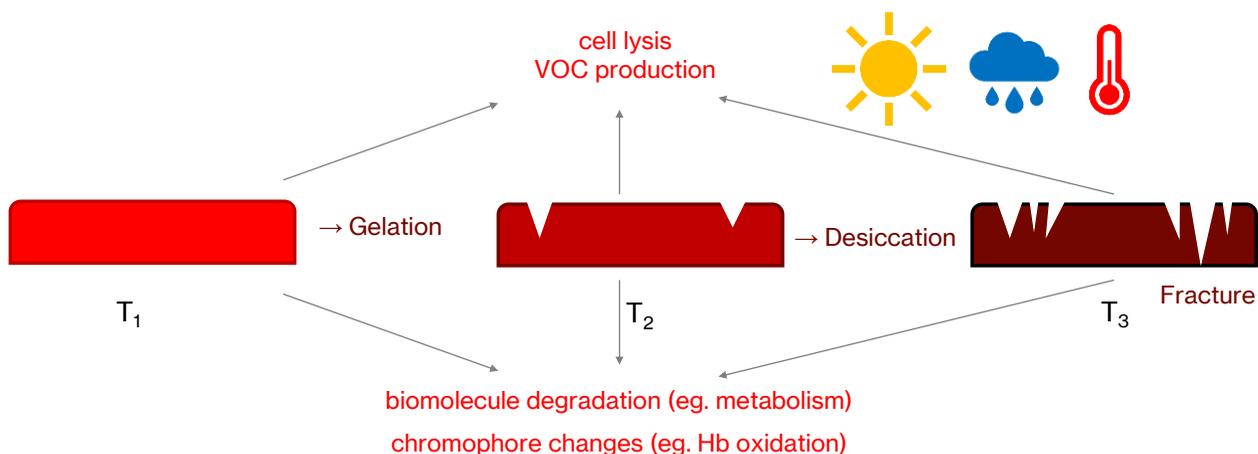
ACS Webinar_2021_Stotesbury

Orr A, Wilson P, Stotesbury T. Calcium-Alginate Tissue Gels (CATG): Proof-of-Concept Biomaterial Development. *Forensic Science International*. 2021 Oct 13:111055.

30

Where are we headed next?

Chemical and **physical** changes occur to a bloodstain over **time**



ACS Webinar_2021_Stotesbury

31

Summary

- Bloodstains and bloodstain patterns contain a **wealth of biological, chemical and physical information** useful to a forensic scientist
- Forensic blood substitutes are still being developed as standard reference materials for ***ex-vivo* blood simulation**
 - Silicon sol-gel chemistry has demonstrated its utility in creating safe, robust, stable and valid FBSs
 - Alginate-based biomaterials are demonstrating promise in soft tissue simulants (including blood)



ACS Webinar_2021_Stotesbury

32

 **THANK YOU!**



Want to discuss further?



On Twitter:
[@theresasstotes](https://twitter.com/theresasstotes)



By email:
theresa.stotesbury@ontariotechu.ca



Collaborators & Co-PIs:

- Dr. Andrew Vreugdenhil
- Dr. Mark Jermy
- Dr. Michael Taylor
- Dr. Mike Illes
- Dr. Naomi Stock
- Dr. Paul Wilson



ACS Webinar_2021_Stotesbury

33



ACS
Chemistry for Life®

Bloodstains & Biomolecules

From Crime Scene to the Silver Screen



FREE Webinar | **TODAY** at 2pm ET



ACS Webinars
CLICK • WATCH • LEARN • DISCUSS

ASK YOUR QUESTIONS NOW IN THE QUESTIONS WINDOW...THE Q&A IS ABOUT TO BEGIN!

34



Bloodstains & Biomolecules: From Crime Scene to the Silver Screen



THERESA STOTESBURY
Assistant Professor, Forensic Science,
Ontario Tech University



MONICA MATTESI
Science Educator,
Stony Brook University

Presentation slides are available now! The edited recording will be made available as soon as possible.

www.acs.org/acswebinars

This ACS Webinar is co-produced with ACS Reactions.

35



Reactions: Chemistry Science Videos & Infographics



DEATH AND DECOMPOSITION



<https://youtu.be/OBWNpO9UufE>

Are Human Burial Practices Messing Up Earth's Ecosystems?

Life depends on death — living things die, decompose and eventually become nutrients for other life. But when humans die, we're often embalmed and buried or cremated.

So are we breaking the circle of life? Also, check out episode 1 of [Vitals!](#)

www.acs.org/reactions

36



Enhancing Research Productivity Through Student-Led Laboratory Safety Teams



Date: Thursday, November 4, 2021 @ 2-3pm ET

Speakers: Jessica Martin, ACS Division of Chemical Health and Safety / Kall Miller, ACS Division of Chemical Health and Safety / Monica Nyansa, ACS Division of Chemical Health and Safety / Sarah Zinn, ACS Division of Chemical Health and Safety

Moderator: Ralph Stuart, ACS Division of Chemical Health and Safety

[Register for Free!](#)

What You Will Learn:

- The motivation behind graduate student-led safety initiatives
- How lab productivity is often inextricably linked to lab housekeeping
- How LSTs can empower future lab leaders to collaborate on resolving safety continuity challenges

Co-produced with: ACS Division of Chemical Health and Safety ACS Committee on Chemical Safety

Careers in Science and Engineering:

Everything that You Need to Know



Professor Ashutosh Sharma
Institute Chair Professor,
Indian Institute of
Technology, Kanpur

Date: Wednesday, November 10, 2021 @ 7:30am ET (6-7pm IT)

Speaker: Ashutosh Sharma, Indian Institute of Technology, Kanpur

Moderator: Deeksha Gupta, American Chemical Society

[Register for Free!](#)

What You Will Learn:

- What are the current career options and job opportunities for chemistry graduates in India
- How to choose a career based on personal strengths and values
- How to bridge gaps to increase your chance of employability

This special broadcast is targeted for an audience based in India and is co-produced with ACS International and ACS Publications.

Sustainability Through Innovation

A Conversation with Industry Experts



Date: Wednesday, November 10, 2021 @ 2-3pm ET

Speaker: Lee Ellen Drechsler, Procter & Gamble

Moderator: Rebekah Paul, American Chemical Society

[Register for Free!](#)

What You Will Learn:

- Real life innovations where the chemical industry has incorporated sustainability into their operations
- Future sustainable innovations being developed in corporate R&D
- Professional opportunities for the next generation in the chemical industry

Co-produced with: ACS Communications and ACS Industry Member Programs

www.acs.org/acswebinars

37



Learn from the best and brightest minds in chemistry! Hundreds of webinars on diverse topics presented by experts in the chemical sciences and enterprise.

Edited Recordings are an exclusive ACS member benefit and are made available once the recording has been edited and posted.

Live Broadcasts of ACS Webinars® continue to be available to the general public several times a week generally from 2-3pm ET!

A **collection of the best recordings** from the ACS Webinars Library will occasionally be rebroadcast to highlight the value of the content.

www.acs.org/acswebinars

38



ACS Webinars® does not endorse any products or services. The views expressed in this presentation are those of the presenter and do not necessarily reflect the views or policies of the American Chemical Society.



Contact ACS Webinars® at acswebinars@acs.org

39



Enhancing Research Productivity

Through Student-Led Laboratory Safety Teams



Date: Thursday, November 4, 2021 @ 2-3pm ET

Speakers: Jessica Martin, ACS Division of Chemical Health and Safety / Kall Miller, ACS Division of Chemical Health and Safety / Monica Nyansa, ACS Division of Chemical Health and Safety / Sarah Zinn, ACS Division of Chemical Health and Safety

Moderator: Ralph Stuart, ACS Division of Chemical Health and Safety

[Register for Free!](#)

What You Will Learn:

- The motivation behind graduate student-led safety initiatives
- How lab productivity is often inextricably linked to lab housekeeping
- How LSTs can empower future lab leaders to collaborate on resolving safety continuity challenges

Co-produced with: ACS Division of Chemical Health and Safety ACS Committee on Chemical Safety

Careers in Science and Engineering:

Everything that You Need to Know



Professor Ashutosh Sharma
Institute Chair Professor,
Indian Institute of
Technology, Kanpur

Date: Wednesday, November 10, 2021 @ 7:30am ET (6-7pm IT)

Speaker: Ashutosh Sharma, Indian Institute of Technology, Kanpur

Moderator: Deeksha Gupta, American Chemical Society

[Register for Free!](#)

What You Will Learn:

- What are the current career options and job opportunities for chemistry graduates in India
- How to choose a career based on personal strengths and values
- How to bridge gaps to increase your chance of employability

This special broadcast is targeted for an audience based in India and is co-produced with ACS International and ACS Publications.

Sustainability Through Innovation

A Conversation with Industry Experts



Date: Wednesday, November 10, 2021 @ 2-3pm ET

Speaker: Lee Ellen Drechsler, Procter & Gamble

Moderator: Rebekah Paul, American Chemical Society

[Register for Free!](#)

What You Will Learn:

- Real life innovations where the chemical industry has incorporated sustainability into their operations
- Future sustainable innovations being developed in corporate R&D
- Professional opportunities for the next generation in the chemical industry

Co-produced with: ACS Communications and ACS Industry Member Programs

www.acs.org/acswebinars

40