Building the Next Generation of RNA Medicines

March 2021

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ARCTURUS THERAPEUTICS Company Highlights

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Arcturus is a Clinical-Stage mRNA Vaccines and Medicines Company

Publicly Traded (Nasdaq: ARCT)

- Headquarters: San Diego, CA
- Number of Employees: 124
- Founded: 2013

Promising Therapeutic Candidates

- LUNAR-COV19 (COVID-19 Vaccine)
- LUNAR-OTC (Ornithine Transcarbamylase Deficiency)
- LUNAR-CF (Cystic Fibrosis)
- Additional Earlier Stage Programs



Arcturus Technologies Validated by Multiple Strategic Partners



ARCTURUS THERAPEUTICS Proprietary mRNA Technologies Driving Promising Therapeutic Programs



Broad and Strong Intellectual Property Portfolio



Arcturus Pipeline of mRNA Medicines



Franchise	Product Name	Indication	Route of Administration	Cell Target	Prevalence Worldwide	Stage	Anticipated Milestones
VACCINES	LUNAR-COV19 (ARCT-021)	COVID-19	Intramuscular	Myocytes & Dendritic Cells	Global	Phase 2	Phase 3 Initiation Q2 EUA H2 2021
	LUNAR-FLU	Influenza	Intramuscular	Myocytes & Dendritic Cells	Global	Preclinical	IND/CTA H1 2022
HEPATIC	LUNAR-OTC (ARCT-810)	Ornithine Transcarbamylase Deficiency	Intravenous	Periportal Hepatocytes	> 10,000	Phase 1b	Phase 2 Multiple Dose Study CTA Q2 2021
RESPIRATORY	LUNAR-CF (ARCT-032)	Cystic Fibrosis	Inhaled	Bronchial Epithelial Cells	> 70,000	Preclinical	CTA Q4 2021

EUA = Emergency Use Authorization; CTA = Clinical Trial Application; IND = Investigational New Drug Application

Multiple mRNA Therapeutic and Vaccine Programs in Clinical Development with Milestones

Partnerships Maximize Platform



Program	Partner	Indication	
LUNAR-HBV	Johnson "Johnson	Hepatitis B Virus (HBV)	
LUNAR-NASH	Takeda	Nonalcoholic Steatohepatitis (NASH)	
LUNAR-GSD3		Glycogen Storage Disease Type III	
LUNAR-RARE		Undisclosed Rare Disease	
LUNAR-RPL	Undisclosed Large Pharma	Vaccines	
LUNAR-AH	Undisclosed Animal Health Pharma	Vaccines	

Greater than \$1 Billion in Potential Milestones & Royalties

ARCTURUS THERAPEUTICS LUNAR[®] Delivery Technology

Biodegradable, highly optimized for each cell type



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Rapid Biodegradation of Vehicle





RNA Processing and Translation

STARR™ mRNA Expression Superior to Conventional mRNA

Self-Transcribing and Replicating mRNA (STARR™) delivered with LUNAR[®] provides higher protein expression and potentially longer-lasting duration of protein expression in mouse









LUNAR-COV19 (ARCT-021) COVID-19 Vaccine Candidate

Arcturus COVID-19 Vaccine Candidate has Significant Advantages

- Duke-NUS Partnership
 Duke-NUS
 Medical School
- mRNA Vaccine: No Adjuvants, No Viral Vector Used, Readily Updatable as New Variants Arise
- Self-amplifying (STARR[™]) mRNA and LUNAR[®] Non-viral Delivery Technology

Catalent. Recipharm

- Promising Clinical Data Demonstrate Humoral and Cellular Immunogenicity, and Tolerability Data
- Potential Single-Shot: Simpler Logistics for Vaccinating Large Populations
- Very Low Dose: Enables Rapid Global Scale-up
- Readily Manufactured: Arcturus Processes + Strategic Partnerships
- Lyophilized Formulation: No need to be stored at ultra-cold temps, improved supply chain & distribution benefits

ARCTURUS THERAPEUTICS Preclinical Data: Robust Immune Response



Humoral Immunity



Neutralizing antibody titers and high seroconversion at low doses



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(10)		inters (Geometric Mean)
0.2	80 %	58
2	100 %	218
10	100 %	≥ 320

Cellular Immunity



Single administration with a very low dose of Arcturus COVID vaccine results in potent immune reaction STARR™ mRNA generates neutralizing antibodies (anti-SARS-CoV-2 Spike Glycoprotein IgG) and a cellular T-cell mediated immune response at a much lower dose level compared to conventional mRNA

ARCT-021 Significantly Effective in Challenge Models



ARCT-021 significantly effective in a virus challenge study in the human ACE2 transgenic mouse model; single dose provided complete protection from SARS-CoV-2 infection and death, compared to control mice which experienced 100% mortality

Primate Model (macaque)



7 Days After SARS-CoV-2 Virus Challenge

- Lung viral titers exceeded 13,100 (median) in non-vaccinated primates (PBS)
- Lung viral titers = 6.5 (median); more than 2000X lower in primates administered a single shot of ARCT-021

Single administration of ARCT-021 significantly effective in primate model (macaque); vaccinated macaques show substantial (3.30 log lower) reductions in median lung viral titers



ARCT-021 Clinical Trial and Manufacturing Update

Phase 1/2 Clinical Trial

- Completed dosing all subjects (n=106), including older adults
- At interim analysis, observed high seroconversion rates for IgG binding antibodies, and Th1 dominant CD4+ immune responses, neutralizing antibodies (PRNT50) Geometric Mean Titer (GMT) levels in the range of titers observed in convalescent serum
- Favorable safety and tolerability observations; no subjects have withdrawn from dosing

Phase 2 Clinical Trial Ongoing

- More than 500 participants dosed across USA and Singapore
- Two dose levels being evaluated: 5 μ g and 7.5 μ g

Phase 3 Clinical Trial; EUA

- Expect to commence Phase 3 clinical trial Q2 2021; targeting Emergency Use Authorization H2 2021
- Lyophilized (freeze-dried) version of ARCT-021 vaccine product on track to be evaluated in Phase 3 clinical trial

Manufacturing

• With our global manufacturing partners, we are on track to manufacture finished doses of lyophilized ARCT-021 in Q1 2021 for stockpiling purposes, and have laid the foundation to produce hundreds of millions of doses of lyophilized ARCT-021 over the next 18 months



Lyophilization Process Advantage Over Conventional Frozen Liquid X



Lyophilized version of ARCT-021 maintains key quality attributes of the frozen liquid equivalent

Collecting stability data at -20°C, 2-8°C, and Room Temperature

Simpler handling: No dry ice at point of care, lower risk of degradation from uncontrolled temperature fluctuation



LUNAR-OTC (ARCT-810) Ornithine Transcarbamylase (OTC) Deficiency

OTC Deficiency Market Opportunity





Ornithine Transcarbamylase (OTC) Deficiency: The most common urea cycle disorder

- The urea cycle converts neurotoxic ammonia to water-soluble urea that can be excreted in urine
- Deficiency in OTC causes elevated blood ammonia, which can lead to neurological damage, coma, and death
- 10,000 worldwide prevalence



Unmet Medical Need

- Present standard of care involves a strict diet (low protein, high fluid intake) plus ammonia scavengers (sodium phenylbutyrate)
- Present standard of care does not effectively prevent life-threatening spikes of ammonia
- Severe OTC Deficiency patients are typically referred for liver transplant, currently the only cure



LUNAR-OTC Aims to Restore Enzyme Function

• Expression of OTC enzyme in liver has potential to restore normal urea cycle activity to detoxify ammonia, preventing neurological damage and removing need for liver transplantation

LUNAR-OTC

Disease Normalization Following Single and Repeat Dosing in OTC Mouse Model

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LUNAR-OTC

Exceeds Therapeutic Target of 10% Enzyme Replacement at all Doses in OTC-Deficient Mouse Model

- OTCD impacts ureagenesis (ammonia detoxification)
- The main site of ureagenesis is the periportal region of the liver*
- Establishing 10% of natural enzyme levels is expected to be therapeutically significant



Dose Level

*Li, L. et al. PGC-1α Promotes Ureagenesis in Mouse Periportal Hepatocytes through SIRT3 and SIRT5 in Response to Glucagon. Scientific Reports. 6:24156 | DOI: 10.1038/srep24156, April 2016 *Lamers, W.H., Hakvoort, T.B.M., and Köhler, E.S. 'Molecular Pathology of Liver Diseases' in Monga S.P.S. (ed.), *MOLECULAR PATHOLOGY LIBRARY SERIES*, Springer Publishing, New York, pp. 125-132 | DOI: 10.1007/978-1-4419-7107-4

LUNAR-OTC treatment increases OTC expression in mouse periportal hepatocytes (main site of ureagenesis)



ARCT-810 Clinical Update

Phase 1 Clinical Trial Completed

- Double blind, randomized 2:1 active to placebo, dose-escalation trial in healthy adult volunteers
- All Adverse Events (AEs) mild or moderate
- Favorable PK profile: No LUNAR[®] lipids detectable after 48 hours following drug administration
- No steroid premedication
- Completed dose escalation of all cohorts (0.1, 0.2, 0.3, and 0.4 mg/kg)

Phase 1b Clinical Trial in OTC-Deficient Patients Ongoing

- Commenced patient enrollment
- First subject has been dosed
- Up to 12 patients; up to 3 dose levels
- All doses within anticipated range for therapeutic biological effect

Primary Goal: Identify safest doses to take forward into multiple dose clinical trials

Primary Endpoints: Safety and tolerability

Secondary Endpoints: Pharmacokinetics

Exploratory Endpoints: Biomarkers include ureagenesis, plasma ammonia levels and plasma OTC enzyme activity, and urine orotic acid levels

Next Milestone: CTA submission in Q2 2021 for Phase 2 Multiple Dose Study in OTC Deficient Patients





LUNAR-CF (ARCT-032) Cystic Fibrosis

Cystic Fibrosis Market Opportunity





Cystic Fibrosis: The most common rare disease in the United States

- Caused by genetic mutations in the CFTR gene, resulting in aberrant flux of ions in and out of cells, causing thick mucus buildup in lung airways
- Chronic airway obstruction leads to infection and inflammation, which causes permanent tissue scarring and respiratory failure
- 70,000 worldwide prevalence



Unmet Medical Need

- No CFTR functional corrector is approved for treatment of all patients
- Present standard of care does not effectively prevent long-term effects of mucus accumulation.
 CF patients with late-stage loss of respiratory function require lung transplant



LUNAR-CF Aims to Restore CFTR Function

- An mRNA replacement therapy has the potential to deliver a new copy of CFTR into the lungs of CF patients, independent of any genotype
- A functional CFTR protein can restore chloride channel efflux in the airways, reducing mucus accumulation, tissue scarring and minimizing the progressive respiratory dysfunction observed in CF patients

Delivery of LUNAR[®]-mRNA to Rodent Airways



Nebulization: Upper/Lower Airways

LUNAR[®] Targets Mice Epithelial Airways (TdTomato), Including Ciliated Cells (TdTomato/FoxJ1)



LUNAR® + Luciferase mRNA



Efficient delivery of LUNAR®-mRNA formulations in rodent airways

LUNAR[®], an aerosolized delivery platform for lung





Aerosolized LUNAR[®] droplets are in the optimal breathable range (1-5 microns) Aerosolized LUNAR[®] maintains activity as measured by EGFP protein expression & Nasal Potential Difference (NPD)

Delivery of LUNAR[®]-mRNA into Epithelial Airways in Ferret

EGFP conversion in tracheal epithelial airways observed in the ROSA26TG Ferret model

- BUILDING INNOVATIVE
- Untreated Treated В Dapi 4 5 LL I IdTomato Status at 41 ... Name
- Ferrets are an excellent species for modeling certain human lung diseases*
- Novel LUNAR[®] formulations of CRE mRNA were tested in a transgenic ROSA26TG ferret model
- Activation of EGFP expression indicates that LUNAR[®] targets epithelial airways
- Anticipated next steps: CTA Q4 2021

LUNAR[®] effectively delivered mRNA to the tracheal epithelial airways in a Ferret model

*Yu, M., Sun, X., Tyler, S.R. et al. Highly Efficient Transgenesis in Ferrets. Sci Rep 9, 1971 (2019)

In collaboration with John Engelhardt



Moving Forward

Anticipated Near-Term Milestones and Cash Position



ARCT-021 (LUNAR-COV19)				
Phase 3 Initiation Emergency Use Authorization (EUA)	Q2 2021 H2 2021			
ARCI-810 (LUNAR-OIC)				
Phase 2 Multiple Dose Study Clinical Trial Application	Q2 2021			
ARCT-032 (LUNAR-CF)				
Clinical Trial Application (CTA)	Q4 2021			
Cash Position				
\$463.0 Million as of December 31, 2020				

Management Team





Joseph E. Payne, MSc President & CEO Pad Chivukula, Ph.D. Andrew Sassine, MBA CSO & COO CFO



ultrager





Steve Hughes, M.D. Chief Medical Officer



Lance Kurata, J.D. Chief Legal Officer

MINTZ



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UC San Diego













Appendix

LUNAR-COV19 Preclinical Seroconversion Data



Seroconversion Rate (% of Animals) – STARRTM mRNA vs. Conventional mRNA

Single	LUNAR [®] Delivery					
Dose (µg)	STARR TM	mRNA (%)	Conventional mRNA (%)			
	Day 10	Day 19	Day 10	Day 19		
0.2	40	60	20	20		
2	80	100	20	0		
10	100	100	40	80		

100% of mouse seroconverted by day 19 at a single low dose (2 μ g)

Preclinical Data: Anti-Spike Protein Levels Continue to Increase Up to 50 Days



Single Administration of LUNAR-COV19



- **Higher titers** (anti-SARS-CoV-2 Spike Glycoprotein IgG) elicited by STARR[™] mRNA
- Titers continue to increase up to 50 days with STARR[™] mRNA; plateau reached with conventional mRNA
- Dose dependent increase in IgG titers; Luminex bead assay, 1/2000 serum dilution

Preclinical Data: Neutralizing Antibodies Continue to Increase for 60 Days

Single Administration (small dose, 2µg) of LUNAR-COV19



PRNT50

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Virus neutralization assay: Serum dilutions are incubated with SARS-CoV-2 virus, then added to cells. The cells die forming plaques, which are counted. The serum dilution that reduces the number of plaques by 50% is recorded (PRNT50). Maximum serum dilution tested was 1/320

After single dose (2 μg) of LUNAR-COV19, neutralizing antibodies continue to increase for 60 days (>300 titer)



Preclinical Data: Arcturus Vaccine elicits a Balanced Cell Mediated Immune Response

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Results Summary

- RNA dose dependent increase in IFN-γ positive CD8⁺ T-cells
- Th1 biased CD4⁺ response and stable Th1/Th2 ratio with increased RNA dose indicate balanced cell mediated immune response

Arcturus Safety Profile

External Validation

 Multiple strategic partnerships over many years confirms the positive potential safety profile of Arcturus LUNAR[®] and mRNA

Arcturus is committed to developing safe mRNA products

• 15 studies over several years with strategic partners

Top Safety Concern for RNA Medicines is Delivery

Arcturus LUNAR[®] Delivery Technology is well tolerated in non-human primates (NHPs)

- ✓ @ 15 mg/kg single dose of non-coding siRNA
- ✓ @ 3 mg/kg x eight (8) weekly doses of non-coding siRNA (total of 24 mg/kg over 2 months)

Arcturus mRNA chemistry shows promising efficacy and tolerability data

Efficacy of OTC mRNA in mouse model @ 0.1 – 1 mg/kg



ATX Lipids are Effective and Biodegradable





Next Generation ATX Lipids Retain Degradability & Improve Delivery Efficiency

ATX 2.0 Lipid is Biodegradable and Clears in vivo





- ATX Lipid (the major component in LUNAR[®] technology) is degraded in vivo
- ATX 2.0 Lipid half-life in the liver is approximately 20 hours

A R C T U R U S T H E R A P E U T I C S

Key Existing Country Relationships

Singapore

Research Partnership with Duke-NUS Medical School

Financial Support from the Economic Development Board of Singapore

- \$10 M Grant for Research and Preclinical Work
- \$6.7 M Grant for Phase 1/2 Clinical Trial
- Executed Manufacturing Support Agreement for \$46.6 Million Non-Recourse Loan
- Up to \$175 Million in vaccine purchases

Israel

Supply Agreement with Israel Ministry of Health

- Announced August 18, 2020
- Up to \$225 Million in vaccine purchases (with MOH election for 500,000 Initial Reserve Doses)
- \$12.5 M Initial Reserve Payment was paid in Oct 2020







Drug Substance: mRNA Design



Arcturus' proprietary mRNA optimization platform

Sustained hEPO activity in NHPs upon repeat dosing







Proprietary mRNA Optimization Platform Demonstrates Sustained Activity Upon Repeat Dosing in NHPs

A R C T U R U S T H E R A P E U T I C S

Drug Substance (mRNA) Manufacturing



Arcturus Internal non-GMP mRNA Production Capabilities: Up to 30 g in Less Than One Week

A R C T U R U S T H E R A P E U T I C S

Drug Substance (mRNA) Manufacturing





Non-GMP Lots Produced at Arcturus

GMP Lots Produced at CMO as part of recent GMP campaign

Three 12.5 g lots produced in recent GMP campaign are of equivalent quality and yield

ARCTURUS THERAPEUTICS LUNAR® Versatility

Compatible with RNA of Various size





LUNAR[®] Formulations Successfully Encapsulate RNA of Varying Sizes and Chemistries